Diabetes Type 2 Self-Management Education Program: Short Messaging from Patient Portal to Web-enabled Device

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DIABETES TYPE 2 SELF-MANAGEMENT EDUCATION PROGRAM:
SHORT MESSAGING FROM PATIENT PORTAL TO WEB-ENABLED DEVICE

by

LYNN S. HOLCOMB

EVIDENCE-BASED PRACTICE PROJECT REPORT

Submitted to the College of Nursing and Health Professions of Valparaiso University,
Valparaiso, Indiana in partial fulfillment of the requirements For the degree of

DOCTOR OF NURSING PRACTICE

2015

Student  Date  Advisor  Date
DEDICATION

The journey to this doctorate degree, and the completion of this EBP project, spanned two decades. There has been but one person who has made this journey with me. Through the endless hours of study, and bearing witness to the fears, frustrations, and self-doubting, he stood there: sometimes silently, sometimes loudly, but always there. There are no great accomplishments made alone, but with others’ great things can be done. I dedicate this EBP project, and this doctorate degree to Mark Holcomb. I can neither quantify nor qualify his contributions in this effort. I can only say that it would not have been possible without him.
ACKNOWLEDGMENTS

There have been many who have contributed to this EBP project. I would first like to acknowledge Dr. Christine Kurtz. She had the unenviable task of pushing, critiquing, and praising. She knew exactly when to do all and for that I thank her. I would like to acknowledge Unity Surgical and Medical Hospital. There is no way that an employer could have been more supportive than they. They encourage dreaming—of all the possibilities to provide patient-centered care—and demand innovative approaches. I would also like to acknowledge the staff at Unity Family Medicine. They were with me from day one of this EBP project as if it were their own. They would not accept failure.

There are many more to acknowledge, and they all have carried on as if acknowledgement of their role had no importance in the task at hand. I appreciate them all. Finally, my late father, Richard R. Rosencrants. I wish you were here to bear witness to what this EBP project has started to achieve for diabetic patients and their care. I can take pride in the excellent writing skills you have passed on to your children, and to the ways you pushed us to succeed—even though you were not always aware that’s what you were doing.
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ABSTRACT

Only one in eight adults with diabetes reaches target goals for disease management, which can lead to clinical complications, costly both economically and in quality and duration of human life. The standard of care is a quarterly 15-minute face-to-face visit—arguably inadequate to impart self-care knowledge. The purpose of this EBP project was to deliver a 30-day diabetes self-management education program (DSMEP) utilizing widely accessible web-based technology to facilitate adults with diabetes to reach targeted goals. Using the Chronic Care Model as a framework, the DSMEP design was based on an extensive literature review of the delivery of DSMEP in an asynchronous manner via web-enabled devices. The program consisted of two daily short messages of diabetes self-management content with two-way message capability allowing participants to respond or seek clarification. Participants’ \((N = 16)\) pre-DSMEP A1C values were converted to an estimated average glucose (eAG) value using the A1C Average Glucose Study Group formula, which were compared to their 30-day DSMEP mean blood glucose values using a paired \(t\)-test. A RM-ANOVA was performed to determine at what point in the DSMEP blood glucose values had the most significant improvement. Participants completed a pre- and post-intervention Diabetes Self-Management Questionnaire (DSMQ), allowing for comparison of self-reported self-management skills using a paired \(t\)-test. The pre-intervention eAG was 193.8 (\(sd = 38.58\)), and the post-intervention mean glucose value was 151.9 (\(sd = 28.07\)) (\(t = -41.85, p < .001\)). The pre- and post-intervention DSMQ sum scale and glucose monitoring control subscale results showed statistically significant improvement. Improvements were also noted in dietary management and physical activity behaviors. Results indicate that a DSMEP delivered from a patient portal to a web-enabled device is an effective way to significantly improve the mean daily blood glucose value of the adult with diabetes type 2 and improvement in self-reported diabetes self-management skills.
CHAPTER 1

INTRODUCTION

Health care expenditure in the U.S. for 2012 was 17.2% of the gross domestic product, with projections to reach 19.9% by 2022 (Center for Medicare and Medicaid Services, 2014). While our expenditure is the highest in the world, our outcomes continue to be among the lowest of developed countries. Much of the cost is incurred in the management of chronic diseases such as dyslipidemia, hypertension, chronic obstructive pulmonary disease, and diabetes. Over 90 million Americans suffer from one or more chronic diseases, accounting for approximately three-quarters of the national health care expenditure (Agency for Healthcare Research and Quality, 2008). The U.S. health system is spending more on health care of the chronically ill with dismal and unsatisfactory results. The Affordable Care Act (ACA) of 2010 included several provisions that are intended to improve the incidence, detection, and management of chronic disease (Thorpe, 2012); however, before an improvement can be made or change can be implemented, one must know the best available evidence.

Evidence-Based Practice

Implementation of evidence-based practice is a process that begins with a clinical question or dilemma about an individual or group, the search for, and appraisal of the best research or evidence available, and the application of those findings along with clinical expertise and patient preferences using scientific theory and an evidence-based practice framework (Schmidt & Brown, 2012). Appraisal of the evidence requires a systematic approach with appraisal tools that are recognized as having rigor, ensuring that the evidence retrieved is based on sound science and is applicable to the population in question. Synthesizing applicable evidence and integrating that summation with clinical expertise and patient preference guides the clinical decision for change. The final
step of the EBP process is evaluation of the clinical change and the effect or outcome it has on the population.

This EBP was designed utilizing the evidence-based process to implement a short-messaging service via web-enabled technology aimed at improving the ability of adult patients to self-manage their diabetes type 2, improving their clinical outcomes. The Model of Diffusion of Innovation, designed to help providers understand how new ideas can be implemented into existing practice (Russell C. L., 2012), was used to guide this EBP project. This report will review diabetes and its current treatment, introduce the clinical question, review the body of evidence for change, discuss the plan for change implementation, evaluate the change results, and close with discussion and future implications for practice.

**Background**

Type 2 diabetes is a progressive endocrine disorder due to an insulin secretory defect and/or target tissue insulin resistance (American Diabetes Association (ADA), 2014). There are approximately 25.8 million Americans, or 8.3% of the population, afflicted with diabetes, and an estimated one-third more of the U.S. population has prediabetes (Ahmad & Tsang, 2013). Diabetes is usually diagnosed based on plasma glucose values; a) fasting plasma glucose ≥ 126, b) glucose tolerance test ≥200, or c) A1C ≥ 6.5 (ADA, 2014). Prediabetes diagnostic criteria are; a) fasting plasma glucose of 100-125, b) glucose tolerance test value of 140-199, or c) A1C 5.7-6.4% (ADA, 2014).

The American Diabetes Association (ADA) Standards of Medical Care-2014 includes that treatment recommendations for the adult patient with prediabetes should begin with referral to a support program to target lifestyle modifications such as weight reduction, diet modification, adequate exercise routine, smoking cessation, and initiation of Metformin (ADA, 2014). Treatment recommendations for the adult patient with diabetes includes, but are not limited to: a) comprehensive medical evaluation, b)
collaborative health care team approach, c) glycemic control through self-monitoring blood glucose (SMBG) and quarterly A1C levels, d) pharmacological intervention as appropriate, e) dietary assessment and plan, f) physical activity, and e) diabetes self-management education and support (DSME) (ADA, 2014). The ADA standards also recommend implementation of the Chronic Care Model (CCM) as the framework for management of the diabetic patient.

The current U.S. health care system approaches the management of diabetes with a patient-provider face-to-face visit every three to six months, wherein patients are given a plan of care, diabetic education, moral support, and a chance to ask questions: all in a 15-20 minute time slot. However, only one in eight U.S. diabetic patients meet their target goals for blood pressure readings, lipid levels, as well as plasma glucose levels (Harris et al., 2010). Is this current standard of care to blame for poor outcomes, or is that we simple do not have the time to teach a patient how to self-manage their diabetes?

**Diabetes Self-Management**

Diabetes self-management is most effective when the patient possesses the knowledge, skill, and ability necessary for diabetic self-care. This self-management encompasses good life style behaviors that include ADA dietary choices, adequate physical activity, monitoring of own plasma glucose levels, adherence to medication regimen, smoking cessation, inspection of feet on a regular basis, managing sick days, and real-time decision making based on findings of one or all of the above (ADA, 2014). In order to accomplish self-management skills that affect clinical outcomes, collaboration and communication with one’s health care team is essential (ADA, 2014). Many health care systems are not designed adequately to be responsive to a patient’s efforts to self-manage (Nundy et al., 2012). Use of the Chronic Care Model, as recommended by the ADA’s Standards of Medical Care for Diabetes-2014, opens the door for innovative
interventions created to improve the efforts of health care teams and the self-management skill set of the patient.

**Innovative Diabetes Self-Management**

The Affordable Care Act addresses the need for better chronic disease management (CDM) with several provisions aimed at improving the health outcomes of the diabetic patient (Ahmad & Tsang, 2013). The Agency for Healthcare Research and Quality funds several projects aimed at studying the effect health information technology (Health IT) has on CDM (AHRQ, 2008). Those projects have provided evidence that electronic health records (EHR’s), telehealth, remote monitoring devices, and short-messaging services (SMS’s), to name a few, are effective at improving chronic disease outcomes (AHRQ, 2008). Web-enabled technology has the potential to combine the expertise of the health care team, the knowledge needs of the patient, through use of a medium that patients have already adopted into their daily lives: delivery of DSME via a SMS can improve patients’ ability to self-manage their diabetes. There is also the potential to change our patients’ perceptions of health care from occurring in a building they arrive at once every three months to a process they take part in every day.

**Clinical Agency Background**

The primary care practice is a subsystem of a medical and surgical hospital, both located in Mishawaka, Indiana. The family practice staff consists of one doctor of osteopathy, one board-certified family nurse practitioner, three medical assistants, two front-office staff, and one practice manager. Office hours are Monday through Friday from 8:00am to 5:00pm, with on-call service fielding after-hour needs. There are four other family practices within the system, and staff float between clinics as needed. The practices see patients of all ages for wellness, acute illness, or chronic disease management. The hospital system is equipped with an EHR system that has clinical guidelines imbedded. They are connected to a shared system that is utilized by many
practices and hospitals throughout the region. The clinic is also starting phase-two of ‘Meaningful-Use’, which requires the implementation and use of a patient portal to communicate with patients. The portal software contains technology that enables the use of short messaging that is capable of two-way communication. The clinic will be launching that technology ahead of schedule to accommodate the implementation of this project with potential for future patient-care team communication applications.

**Purpose of EBP Project**

The purpose of this EBP project is to design, implement, and evaluate Diabetes Self-Management Education Program (DSMEP) delivered via a web-enabled patient portal, using short messaging to assist and improve in the self-management skills of the adult patient with diabetes type 2. The PICOT question is: "In the adult patient with diabetes type 2, can a four-week diabetes self-management education program delivered from a patient portal to a web-enabled device in an SMS platform improve the patient’s self-care knowledge and behaviors and SMBG daily average compared to usual care?"

**Significance of this EBP Project**

The target health system treats patients with diabetes type 2 on a daily basis. This health system is charged with the diagnosis, treatment design, implementation, and evaluation of diabetes type 2 management for those patient’s. The ADA cites diabetes self-management as being a cornerstone to reach desired clinical outcomes (ADA, 2014), yet research indicates only 16% of diabetic patients report adhering to recommended self-management activities (Quinn et al., 2011). The patient with diabetes can no longer be a passenger in their care, expecting their provider and health care team to plan, execute, evaluate, and be responsible for their destination. In contrast, health care systems need to adopt innovative interventions that empower patients with diabetes to take the wheel with better self-management education and skills. Therefore,
this EBP project is not only significant to the target health system, but to all health systems nationwide.
CHAPTER 2
THEORETICAL FRAMEWORK AND REVIEW OF LITERATURE

Theoretical Framework: Chronic Care Model

The American Diabetes Association (ADA) Standards of Care has recommended the use of the Chronic Care Model (CCM) as a strategy for improving diabetes care (ADA, 2014). The CCM promotes evidence-based health care system changes necessary to manage the patient with chronic disease (Stellefson, Dipnarine, & Stopka, 2013). The episodic framework of quarterly face-to-face visits with intermittent and often unpredictable acute flares has proven wholly inadequate (Dancer & Courtney, 2010). The CCM provides an alternative framework that facilitates self-management and communication between care team, patient, and community.

There are six components within the CCM:

1. Health system
2. Community
3. Self-management support
4. Decision support
5. Clinical information systems
6. Delivery system design (Siminerio, 2010).

Health System

A health system is the practice or organization that provides structure and commitment to the implementation of the CCM. It is composed of administrative staff, clinical staff, operations, mission statement, values, and goals. Health systems can be both a system and a sub-system, depending from which component of the CCM the intervention originates (Dancer & Courtney, 2010).
Community

Traditionally, community has been the geographical area in which one resides, works, and socializes. The CCM emphasizes the use of community resources to support health care goals. Resources can be church groups, community programs, hospital-based programs, local government policies regarding health practices, family and friend support, pharmacy support, etc. The modern definition of community expands to the internet, connections via web-based technology, and global health initiatives. The community of today, as it applies to the CCM, is a borderless web of resources and health care policies, both geographical and virtual (Siminerio, 2010).

Self-management support

Self-management support is aimed at helping patients acquire the self-care skills and knowledge needed to manage their chronic disease on a day to day basis. Self-management includes, but is not limited to, appropriate dietary choices, physical activity, good social habits, medication adherence, self-assessment, and monitoring of health status. Evidence indicates that patients who are active in their care have better physical and psychological outcomes (Siminerio, 2010).

Decision support

Clinical guidelines and treatment algorithms should be based on scientific evidence and patient preference. In the CCM, these types of decision support systems should be part of the daily practice infrastructure, and available to both the practitioner and patient whose participation in the decision making process is key to successful outcomes (Dancer & Courtney, 2010).

Clinical information systems

Clinical information systems (CIS) within the CCM are the infrastructure of decision support and patient-provider communication. Ideally, the CIS includes a database that is imbedded with evidence-based standards of care or guidelines, has the
ability to scan disease-specific populations to give an overall view of quality of care provided, is able to provide guideline directed alerts and reminders to the health care team, and has secure message service (SMS) capability (Siminerio, 2010).

**Delivery system design**

Delivery system design is the architecture of a care organization, guiding implementation of innovative interventions aimed to improve patient care. It describes who, what, why, and where, and is the component of the CCM that has the potential to improve quality of care and health care outcomes (Dancer & Courtney, 2010).

**Application of the Chronic Care Model to use of SMS**

The ADA recommends self-management support and education for the treatment of all diabetics, stating that “diabetic self-management education (DSME) enables patients to optimize metabolic control, prevent and manage complications, and maximize quality of life in a cost effective manner” (ADA, 2014, pg.S30). Evidence has directed health care providers to maximize self-management skills in chronically ill patients, but the current infrastructure of most health systems does not allocate the resources necessary to provide patients with the knowledge and skills needed to self-manage, mainly due to low or no reimbursement for DSME. The CCM is a framework for creating a system that delivers innovative, evidence-based care, using a resource that is already prevalent in society: web-based technology (Nundy et al., 2012). Because the CCM relies on technology to put evidence-based guidelines into daily practice and to facilitate communication between patient and provider, it is ideal to use as a framework for a SMS via web-based technology intervention to enhance the self-management of patients with diabetes.

**Health System**

The health system must adopt the innovative solution of SMS via web-based technology in order for the intervention to work. There must be a commitment to policy
development and system redesign. The target health system for this EBP has a mission statement supporting innovative thinking: “At our Medical and Surgical Hospital, our mission is to provide a state-of-the-art hospital with a dedicated health care team to unite patients and providers through innovations that transcend traditional health care, maximizing the patient’s outcome, allowing us to provide exceptional, compassionate care” (Unity Medical and Surgical Hospital, 2015). Their vision statement also supports commitment to delivery of patient-centered, quality care: “At our Medical and Surgical Hospital, we are committed to continually improve the quality of services we provide. Our partnership with physicians is leading us on a journey of delivering cutting edge medicine to become THE premier surgical hospital” (Unity Medical and Surgical Hospital, 2015). The target health system of this EBP project has been a committed partner, willing to adopt the intervention into practice, planning to create a new evidence-based protocol.

**Community**

The community is the patient's link to resources that help actualize goals of chronic disease self-management. In the case of using SMS via web-enabled technology, the patient’s community begins with the health care team that initiates and responds to SMS activity. The health care team consists of the primary care provider, medical assistants, front-office staff, the office manager, and the hospital system’s IT Director. That team will be able to link the participant to other community-level resources such as dietary counsel and education, foot care, eye care, or support groups, all aimed at diabetic care and self-management support.

**Self-management support**

SMS via web-enabled technology reinforces, on a daily or weekly basis, the information delivered to the patient in the clinical setting during standard face-to-face visits. Research has indicated four domains that improve self-management of diabetes
when SMS via web-enabled technology is implemented: a) education, b) medication reminders, c) glucose monitoring reminders, and d) foot care reminders (Nundy et al., 2012).

**Decision support**

When SMS interventions are used in a two-way communication design, the care team has the ability to provide real-time intervention decisions, motivational support for self-management decisions already made, and clinical visit decisions based on SMS content for time periods in-between visits. SMS also facilitates communication between the patient and care team, which promotes patient-centered decisions (Nundy et al., 2012).

**Clinical information systems**

The success of SMS intervention requires a CIS embedded with evidence-based guidelines that is interactive between multiple modalities, fostering communication between patients and health care teams (Siminerio, 2010). The CIS must have patient portal capability to be compliant with Medicare’s meaningful use requirements, allowing patients to access their electronic health records and communicate via SMS with their health care team. The target health system currently uses an EHR that is embedded with clinical guidelines, interacts with many other community health systems, and includes a patient portal.

**Delivery system design**

The use of web-based technology allows for existing health systems to support the use of the CCM without major redesign (Nundy et al., 2012). SMS via web-based technology was used in the development of self-management skills in-between quarterly face-to-face visits. Project design was an adaptive process in which this new intervention was integrated into existing practice.
**Strengths and Limitations of the Chronic Care Model**

The CCM has great potential as a framework for innovative approaches to modern health care designed to create partnerships in health between health systems and communities, care teams and patients. Research has shown that application of the CCM to the management of patients with diabetes improves the coordination of care, communication of stakeholders, and integration of modern technology, meeting the patient where they are on their health care continuum (Stellefson, Dipnarine & Stopka, 2013). The design strength of the CCM is that health care occurs daily and interactively instead of during the often one-directional quarterly face-to-face clinic visit.

The CCM has been criticized for its inability to meet the needs of a diverse population; however, systematic reviews support CCM-based interventions as effective for managing diabetes in diverse populations (Stellefson et al., 2013). The CCM is designed to engage the community as a resource, lending to the idea that self-management can occur anywhere with the right skills, knowledge, and support. The limitation of interventions based on CCM is the lack of research available to support its implementation. Only in use in health care since 2001, the CCM Model is a relative newcomer compared to other theoretical models whose use in EBP has been researched for decades (Dancer & Courtney, 2010).

**EBP Model: Diffusion of Innovation**

Rogers’ Diffusion of Innovations Theory (DOI) is commonly used as the theoretical framework for technological interventions. Technological developments are frequently categorized as innovative or “on the cutting edge,” often designed as a mechanism to spread (diffuse) information or knowledge. Rogers defines diffusion as the way in which and innovation is communicated over a period of time to society, thus the four key components of the diffusion of innovations are; a) innovation, b) communication, c) time, and d) society (Sahin, 2006).
**Application of DOI to SMS Intervention**

**Innovation.** The innovation element of this EBP project is the use of the short message service via web-enabled devices to interact with patients who have diabetes type 2 in-between face-to-face visits in order to improve their self-management skills, as evidenced by a decrease in their SMBG values. The messages will a) remind patients to perform self-monitored plasma glucose tests and take medication, b) provide disease educational information (e.g. dietary education, exercise benefits), and c) allow for two-way interaction regarding health status changes and receive real-time intervention management. This innovation will provide the communication between care teams and patients necessary to have successful self-management of diabetes (ADA, 2014).

**Communication.** The communication channels used to diffuse this new innovation were; a) face-to-face clinic visits upon intake into the EBP, b) a Lunch n’ Learn presentation on the innovation at the target clinic’s affiliated surgical hospital prior to the start of the project describing the EBP, how it affects patients, their social system, and their community, c) word of mouth from patient to patient throughout the community, and d) word of mouth from the project manager to colleagues.

**Time.** There are two elements of time when considering the rate of innovation diffusion and this EBP. Web-enabled technology has already been adopted by the masses. There is an awareness-knowledge regarding a significant component of this innovation. The second time element is the health care system’s adoption of this technology. Health systems’ willingness to change protocol and adopt innovations have been historically slow (Ahmad and Tsang, 2013). However, this EBP’s target system’s mission emphasizes the use of innovation to improve the patient experience and outcome.

**Social system.** In order for the innovation to be adopted, it has to be accepted by the patient’s social system (Sahin, 2006). Innovation cannot exist in a vacuum. To be
accepted it must be integrated into society. The patients cannot feel like the innovation sets them apart from others or limits them from fully engaging their social environment. This EBP’s innovation builds upon the momentum of web-enabled technology: it is not abnormal to see someone texting in public, reading a message, or surfing the internet. Use of web-enabled technology has become the social norm allowing the SMS innovation and diabetes self-management to occur in the daily course of life.

**The Innovation-Decision Process**

The innovation-decision making process involves five steps: a) knowledge, b) persuasion, c) decision, d) implementation, and e) confirmation (Sahin, 2006).

**The knowledge stage.** In this step, participants are introduced to the innovation and are given the information about what the innovation is, why the innovation is preferable, and how the innovation works (Sahin, 2006). This EBP project builds on the participants’ familiarity with messaging, since web-enabled technology is a widely accepted. The participants know what the technology is and how it works, but will need to know why, when used as the delivery medium for SMS intervention, it will work to improve their diabetes self-management skills and clinical outcomes. They will have awareness-knowledge and how-to-knowledge, but will need to be educated on the principles-knowledge (Sahin, 2006).

**The persuasion stage.** The persuasion stage is when participants form an opinion about the innovation, which is largely dependent on the participants’ peers, family, and social support opinions (Sahin, 2006). This stage represents a personal connection to the innovation. Participants in this EBP project will have to move from knowledge of the innovation to belief that it will work for them in their environment without altering their perceived positive attributes. This EBP project, again, draws on the pervasive use and acceptance of web-enabled technology in today’s society.
**The decision stage.** This stage of DOI is when participants of this EBP accept or reject the innovation. Rogers believed that the innovation-adoption rates were higher with shorter implementation time frames (Sahin, 2006). Therefore, this EBP project was designed as a four-week diabetes type 2 educational program, as research indicates that participation in SMS via web-based technology is high in the first four weeks and drops off in the subsequent 8 and 12 week periods (Cotter et al., 2014).

**The implementation stage.** This stage applies to adoption of the intervention into practice. There was still the potential to reject the intervention at this stage if participants experienced technological issues or uncertainty (Sahin, 2006). The EBP project team had to function as change agents in this phase to support participants’ adoption and evaluate the need for modifications to the intervention.

**The confirmation stage.** The participants, at this stage, have adopted the innovation, but seek supporting evidence that they have made a good decision (Sahin, 2006). The participants received this evidence in two major ways; a) two-way communication throughout the project supported participants’ beliefs that the intervention provided daily support, answers to clinical questions, and confirmation of good decisions made, and b) the EBP project team provided the participants with clinical outcomes data that were measured throughout the project, reinforcing decisions to adopt or reject the intervention.

**DOI Attributes and Adoption Rates**

Rogers identifies five attributes of innovations that influence the rate of adoption: a) relative advantage, b) compatibility, c) complexity, d) trialability, and e) observability (Sahin, 2006).

Relative advantage and compatibility are similar attributes. Relative advantage relates to the benefits the new innovation has over previous ideas. This EBP has a relative advantage over standard care because it does not require the
participant/adopter to be present in a classroom or a clinic in order to receive the educational content of the program. The relative advantage for health systems is a reduction in cost: a) no physical location requirement, b) innovation can be reused without staff involvement, and c) patient interaction can happen on a soft schedule.

Compatibility relates to how an innovation fits with the adopters’ values, life experiences, and current needs. This EBP is designed to fit with the accepted social norms of today’s society and its use of web-based technology. Delivering health care to a web-enabled device has much less of an impact on the adopter, with less time off work, fewer trips to a clinic, and less stigma of a chronic illness to be witnessed by observers. This innovation is compatible with technological requirements that health systems must employ for reimbursement.

The more complex an innovation, the slower the rate of adoption (Sahin, 2006). This EBP’s innovation is user-friendly. Society has demonstrated its ability to use web-enabled technology to create and send messages on many devices. Health systems, on the other hand, have not been as quick to implement web-based messaging as a tool to communicate with patients. However, current reimbursement criteria has pushed health systems to develop and adopt messaging technology as a tool to improve patient-health team communication, making this EBP’s intervention timely (Sahin, 2006).

Trialability is the “test drive” of the innovation. Adopters need to be able to experiment with the innovation, try it, and modify it if needed. This was an important concept for the health system adopting this EBP. They were able to use this EBP as a trial run for messaging via a patient portal, required for reimbursement in the coming year for many forms of patient-health care team communications.

The observability of an innovation relates to others’ perception or ability to see positive results. Participants share information given to them through this innovation to family members, friends, co-workers, and others, piquing their interest. Members of
health care teams see the positive impact the innovation has on patient outcomes or team time commitment and become interested in knowing more. This diffusion of information can lead to others’ adoption of the innovation.

The characteristics of an innovation are what determines its rate of adoption: the time frame it takes one to adopt the innovation. The innovation adopters fall under one of five descriptors based on the time it takes them to adopt the innovation; a) innovator, b) early adopter, c) early majority, d) late majority, and e) laggards (Sahin, 2006). Understanding the innovation’s attributes and how they affect the rate of adoption, and applying that knowledge to the innovation design and implementation plan can facilitate early-adoption to practice.

Barriers and Facilitators of DOI

There are several advantages to using SMS via web-enabled technology for the adult patient with diabetes type 2. One advantage is real-time feedback on: a) questions regarding self-management, b) glucose readings, and c) medication reactions. The asynchronous communication allows for information to be shared between the health care team and the patient at times convenient to the patient. Potential barriers to SMS via web-based technology are poor motivation to utilize technological tools or achieve effective self-management, inability to read or write, and concerns over privacy (Pelletier, Jethwani, Bello, Kvedar, & Grant, 2011).

The SMS via web-based technology innovation is compatible with current guidelines in the care of the diabetic patient in that it augments face-to-face clinical visits, offers ways of communicating needs and concerns between patient and care team, and supplements the time and tools available to teach diabetes self-management (ADA, 2014).

A patient portal was used as the technological platform for this EBP, and exists as part of the EHR software currently in use by the target health system. The user
complexity is low requiring the same skills needed to create messages or emails. The program is HIPPA secure, so there will be no further encryption needed by the target clinic’s IT department. The health system’s implementation of meaningful use stage 2 requirements occurred concurrently with this EBP implementation. This was both a barrier and facilitator. There were technological issues with the use of the patient portal that had to be overcome during EBP implementation, which created some frustration and delay. However, resolving the issues facilitated a smoother meaningful use implementation. The impetus for resolving technical issues was related to achievement of meaningful use implementation, pulling away attention from this EBP project, which could have been a barrier. However, the technology had to function the same way for both this EBP and meaningful use. Resolving meaningful use’ technical issues also resolved the technical issues of this EBP.

The SMS via web-based technology innovation is a four-week program, a short and practical duration, and lent itself well to early adoption because of its trialability (Pelletier et al., 2011). Therefore, the SMS content needed to be focused on improvement of diabetes self-management due to the relatively short duration. The short duration could be a potential barrier and is discussed in the observation and evaluation phase of this EBP project.

**Literature Search**

Professional nurses gather knowledge in various ways. The decision to implement knowledge into practice requires a review and analysis of the best available research, looking at its relevance and potential impact on clinical practice, while considering the target population’s position along their health care continuum and the effect of evidence-based clinical practice on their outcomes (Long, 2012). Evidence-based models guide us through the organization and implementation process starting with seeking, summarizing, and synthesizing knowledge. That process includes
evaluating the strength and relevance of evidence relating to the clinical question using a formalized appraisal tool or model that has been accepted and utilized to ensure evidence-based practice is based on sound research (Long, 2012). The Haynes 5S model organizes information in a way that reveals its potential contribution and relevance to the description and implementation of evidence-based clinical practice (Russell, 2012).

The Haynes 5S model provides an organizing framework in the shape of a pyramid and includes five levels of evidence: a) studies, b) synthesis, c) synopses, d) summaries, and e) systems (Russell, 2012). The pyramid includes many types of evidence from the highest level, systems, to the lowest level, studies. Because the decision to use evidence to change clinical practice affects human lives, nursing should first seek the highest level of evidence and proceed down the pyramid.

**Description of Evidence Level and Quality**

Determination of level of evidence for this paper was completed using Melnyk and Fineout-Overholt’s “Rating System for the Hierarchy of Evidence” (Melnyk & Fineout-Overholt, 2011). This system consists of seven levels of evidence, with Level I being the strongest of evidence to Level VII being the weakest (see Table 1).

The John Hopkins Nursing Evidence-Based Practice (JHNEBP) Appraisal tools for research and non-research publications were utilized to appraise the research evidence and systematic and literature reviews for this project (Johns Hopkins University School of Nursing, 2014). The AGREE II tool was utilized for appraisal of the clinical guidelines (Brouwers et al., 2010).
Table 2.1.  

**Rating System for the Hierarchy of Evidence**

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I (strongest)</td>
<td>Evidence from a systematic review or meta-analysis of all relevant RCT's; clinical guidelines developed from systematic review of relevant RCTs</td>
</tr>
<tr>
<td>Level II</td>
<td>Evidence obtained from well-designed RCT's</td>
</tr>
<tr>
<td>Level III</td>
<td>Evidence obtained from well-designed controlled trials without randomization</td>
</tr>
<tr>
<td>Level IV</td>
<td>Evidence from well-designed case-control and cohort studies</td>
</tr>
<tr>
<td>Level V</td>
<td>Evidence from systematic reviews of descriptive and qualitative studies</td>
</tr>
<tr>
<td>Level VI</td>
<td>Evidence from single descriptive or qualitative study</td>
</tr>
<tr>
<td>Level VII</td>
<td>Evidence from the opinion of authorities and/or reports of expert committees</td>
</tr>
</tbody>
</table>


The JHNEBP Appraisal tools were modified to apply a point value to each appraisal construct: a “yes” answer was replaced with a point value of one, and a “no” answer was assigned a zero point value (see Tables 2 & 3). The evidence was then given a quality rating of A, B, or C (see Table 3). Determination of the level and quality of evidence allows for development of clinical interventions that are based on the best, most reliable evidence available, thereby producing the desired outcome (Melnyk & Fineout-Overholt, 2011).

The clinical guidelines were evaluated using the “Appraisal of Guidelines for Research and Evaluation” (AGREE II-GRS) tool. Clinical or practice guidelines are often
used to shape health care policies or guide clinical care decisions, and therefore, should be evidence-based and formulated by experts in the clinical area they address (Brouwers et al., 2010). The AGREE II-GRS guideline assessment tool comprises five domains of guideline strength; a) process of development; b) presentation style; c) completeness of reporting; d) clinical validity; and e) overall quality. Each area has constructs that are given a rating from 1(lowest quality) to 7(highest quality) (Brouwers et al., 2010).
### Table 2.2.

**JHNEBP Research Appraisal Tool Constructs**

<table>
<thead>
<tr>
<th>Study Body</th>
<th>Study Construct</th>
<th>Melnyk &amp; Fineout-Overholt Evidence Level</th>
<th>Melnyk &amp; Fineout-Overholt Evidence Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength of</td>
<td>• Was sample size adequate and appropriate?</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Study Design</td>
<td>• Were study participants randomized (if appropriate)?</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>• Was there an intervention?</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Was there a control group (if appropriate)?</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>• If there was more than one group, were groups treated equally except for</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>intervention?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Was there adequate description of data collection methods?</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Study Results</td>
<td>• Were results clearly presented?</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Was an interpretation/analysis provided?</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Study</td>
<td>• Were conclusions based on clearly presented results?</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Conclusions</td>
<td>• Were study limitations identified and discussed?</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total Points</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Study Rating</td>
<td>• A: High 8-10/10 (6-8/8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• B: Good 6-7/10 (5/8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• C: Low/Major Flaws &lt;5/10 (&lt;4/8)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study Body</th>
<th>Study Construct</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systematic Review</td>
<td>• Is the question clear?</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Are search strategies specified and reproducible?</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Are search strategies appropriate to include all pertinent studies?</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Are criteria for inclusion and exclusion specified?</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Are details of included studies (design, methods, and analysis) presented?</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Are methodological limitations disclosed?</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Are the variables in the study similar so that the studies can be combined?</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Were conclusions based on the evidence presented?</td>
<td>1</td>
</tr>
<tr>
<td>Total Points</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Literature Review,</td>
<td>• Was evidence based on the opinion of an individual?</td>
<td>1</td>
</tr>
<tr>
<td>Expert Opinion,</td>
<td>• Is the individual an expert on the topic?</td>
<td>1</td>
</tr>
<tr>
<td>Case Study</td>
<td>• Was the author’s opinion based on scientific evidence?</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Is the author’s opinion clearly stated?</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>• Were potential biases acknowledged?</td>
<td>1</td>
</tr>
<tr>
<td>Total Points</td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Study Rating

- A: High Quality 7-8/8
- B: Good Quality 5-6/8
- C: Low Quality/Major Flaws ≤5/8

<table>
<thead>
<tr>
<th>Study Rating (Systematic Reviews)</th>
<th>Study Rating (Literature Review, Expert Opinion, Case Study)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: High Quality- Expertise is clearly evident- 5/5</td>
<td>A: High Quality- Expertise is clearly evident- 5/5</td>
</tr>
<tr>
<td>B: Good Quality-Expertise appears to be credible-4/5</td>
<td>B: Good Quality-Expertise appears to be credible-4/5</td>
</tr>
<tr>
<td>C: Low Quality/Major Flaws- Expertise is not discernable- ≤3/5</td>
<td>C: Low Quality/Major Flaws- Expertise is not discernable- ≤3/5</td>
</tr>
</tbody>
</table>

Search Engines and Key Words

A comprehensive search of the academic electronic databases Cochran, CINHAL, and Medline was conducted seeking the best evidence on the benefits of diabetes self-management and the use of web-based interventions, and its impact on chronic disease management for the adult with type 2 diabetes. Guided by the organizational framework of the Haynes 5S model, the COCHRANE database search was performed first, with the key terms “diabetes self-management”, “text message”, “short message”, and “web-based interventions”. Secondly, search terms were entered into CINAHL and MEDLINE databases using two combinations: a) “diabetes” AND “short message” OR “text message” AND “web-based interventions”, and b) “diabetes self-management” AND “short message” OR “text message” AND “web-based interventions”. Additional search strategies included citation chasing, hand searching of the relevant professional website of the ADA, and a google search, which resulted in the U.S. Department of Health and Human Services Environmental Scan.

Inclusion and Exclusion Criteria

Resources that met inclusion criteria: a) were written in English, b) included target population of adults with type 2 diabetes between the ages of 18-75, c) had primary focus of diabetes management, web-based short messaging interventions, and self-management efficacy, d) were published between 2007 to current, and e) were peer-reviewed. Exclusion criteria were resources that: a) did not provide a focused discussion on the effects web-based short messaging interventions have on diabetes type 2 self-management and, b) web-based short messaging interventions were used for administrative or other purpose, or c) included other chronic diseases or the use of other web-based interventions.
Search Results

The electronic database search of CINAHL and Medline resulted in 86 potential resources and the Cochrane database search yielded 5 potential systematic reviews for a total 91 potential articles. Abstract review eliminated 78 articles and 4 systematic reviews due to: a) being about diabetes but not related to intervention, b) different focus for intervention (i.e. administrative reminders), c) correct intervention with wrong disease focus, or d) a redundant resource. Citation chasing of the nine included articles yielded three potential articles. A google search provided an environmental scan from the Department of Health and Human Services, and hand searching the ADA website produced diabetes care guidelines. The included articles were then thoroughly read and reviewed for content and relevance. Four resources were then eliminated for participant, intervention, or application incongruences. Eleven resources were chosen for inclusion in this evidence review (Figure 1).

Table 4 summarizes the citation, study design and sample, intervention, major findings, level of evidence, and strength rating of the eleven chosen resources. This review includes evidence from one environmental scan (level I) (U.S. Department of Health and Human Services, 2014), one meta-analysis (level 1) (Liang et al., 2011), three systematic reviews (one level V and two level I) (Cotter et al., 2014; Pal et al., 2013; Yeager & Menachemi, 2011), one clinical guidelines (level I) (American Diabetes Association, 2014), three quasi-experimental studies (level IV) (Fischer et al., 2012; Nes et al., 2012; Nundy et al., 2014), and two qualitative studies (level VI) (Nundy et al., 2013; Wade-Venturo et al., 2013).
Figure 2.1. Literature Review Process

Potential Resources
- CINAHL & MEDLINE (n=86)
- COCHRANE (n=5)

Abstracts reviewed
- Excluded (n=82)
- Included (n=9)

Included (n=9)
- Fischer et al. (2012)
- Hunt, Sanderson, and Ellison (2014)
- Hussein, Hasan, and Jaradat (2011)
- Liang et al. (2011)
- Nundy, Dick, Solomon, and Peek (2013)
- Nundy, Dick, Chou, Nocon, Chin, Peek (2014)
- Wade-Venturo, Mayberry, and Osborn (2013)
- Yeager and Menachemi (2011)
- Pal et al. (2013)

Excluded (n=82)
- Diabetes unrelated (n=14)
- Other use of intervention (n=15) (e.g.: vaccine or appointments reminders)
- Included other chronic disease data (n=44)

Citation Chase (n=3)
- Harris et al. (2010)
- Nes et al. (2012)
- Cotter, Durant, Agne, and Cherrington (2014)

Excluded (n=4)
- Frazetta, Willet, and Fairchild (2012): Did not have conclusions based on interventions
- Harris et al. (2010): Conclusions based on design of smartphone app
- Hunt, Sanderson, and Ellison (2014): Intervention not a close match
- Hussein, Hasan, and Jaradat (2011): Did not focus on self-management outcomes

Hand Search (n=3)
- American Diabetes Association (2014)
- Frazetta, Willet, and Fairchild (2012)
- U.S. Department of Health and Human Services (2014)

Total Resources (n=11)
### Table 2.4.

**Included Literature: Major findings and Evidence Level and Quality**

<table>
<thead>
<tr>
<th>Author, Year, Study Title</th>
<th>Design/ Methods/ Sample Size/</th>
<th>Population/ Setting</th>
<th>Intervention</th>
<th>Findings/Recommendations</th>
<th>Level of Evidence/ Quality Rating</th>
</tr>
</thead>
</table>
| Fischer et al., 2012      | Quasi-Experimental Study/ 47 Participants/ 3 Month Study/ Follow-up Focus Groups | Adults with Diabetes/ Spanish Speaking/ English Speaking/ Family Health Center, Denver, Colorado | Patient Relationship Manager (Software) was created to automatically send text messages to participants reminding them to do their SMBG and return results 3 times a week as well as reminding them to keep their appointments | • Participants responded in correct format 67.3% of 1585 prompts demonstrating ease of use.  
• More than 75% of cohorts responded to >50% of prompts, demonstrating willingness to use platform.  
• Two-thirds of cohorts provided SMBG levels when prompted compared to 12% at preceding two clinical visits, demonstrating improved compliance.  
• Focus groups reported increased accountability for self-management of their diabetes due to text messaging.  
• Focus groups reported feeling more supported through text messaging. | Level IV/ Quality Rating A/ 6/8 |
| Nes et al., 2012          | Quasi-Experimental Study/ 15 Participants/ 3 Month Study | Adults with DM II/ General Practitioner Clinics in Oslo, Norway | Use of smartphones to complete three daily diaries with daily situational feedback given the first month, weekly the second and third months. Secure server used to provide two-way communications | • Cognitive behavioral therapy via mobile phone technology is effective in improving self-management for the adult patient with DM II.  
• Daily interaction in the 1st month of Diabetes management was more effective in improvement of self-management skills when compared to the 2nd and 3rd months.  
• Personalized SMS feedback based on patient’s daily entries most effective for behavior modification.  
• ADDQoL-19 (a diabetes related quality of life questionnaire that quantifies impact diabetes has on areas of life) improved with SMS intervention.  
• PAID (a self-report of diabetes related distress), improved with SMS intervention.  
• Some participants found the phones difficult to use. | Level IV/ Quality Rating B/ 5/8 |
|                           |                               |                     |              |                          | Limited sample size |
|                           |                               |                     |              |                          | Did not describe tools used to evaluate (ADDQOOL-19, PAID) |
|                           |                               |                     |              |                          | Interventions developed based on research by key stakeholders |
|                           |                               |                     |              |                          | Used theoretical framework |
|                           |                               |                     |              |                          | Did not give statistical significance of findings |
Nundy et al., 2014

Mobile phone diabetes project led to improved glycemic control and net savings for Chicago plan participants

Quasi-Experimental Study/348 participants/Controlled Pilot/Pre-post design/6 month

Adult health plan members with a diagnosis of DM I or DM II at University of Chicago Primary Care

Intervention was employing CareSmarts software for two-way directional short message communication platform to deliver diabetes self-management education and monitor biologials

- Patient satisfaction with software was evaluated using Likert Scale with 77% stating they would like to participate in a similar program in the future.
- Days of following a healthy eating plan increased from 4.5 days per week to 5.2 days per week (p=0.03).
- Number of days monitoring SMBG rose from 4.3 days per week to 4.9 days per week (p=0.03).
- Number of days reported practicing foot care increased from 3.6 days per week to 4.3 days per week (p=0.01)
- Adherence to diabetes medication as measured by proportion of days covered increased from 83 percent to 91 percent (p=0.03)
- A1C values went from average of 7.9 to 7.2 (p=0.01) in treatment group.
- No A1C value change in control group.
- Leverages mobile technology to enable existing health system resources to support chronic disease care.
- Asynchronous communication with low burden of participation, accessible wherever patient happens to be.

Nundy, Dick, Solomon, Peek, 2013

Developing a behavioral model for mobile phone-based diabetes interventions

Qualitative Study/18 participants/Post 4 week Controlled Pilot study/In-Depth 60 Minute Interview

African American Adults with DM II/University of Chicago Primary Care Practice

Intervention of Pilot Study was SMS-DMCare, a text message software that sent daily medication reminders, a daily or semi-weekly question about medication adherence, weekly question about foot care, appointment reminders, and SMBG reminders

- Two-way interaction with SMS intervention led participants to a feeling that they were being monitored by somebody, which increased their feeling of support, awareness of the seriousness of diabetes, and accountability for better self-management.
- Provider feedback provided reinforcement for good self-management behaviors, or redirection for undesired ones.

Level VI/Quality Rating A/6/8

Small sample size
Narrow target population (African American)
Good description of study construct
Good statistical analysis description
Potential bias discussed
Wade-Venturo, Mayberry, and Osborn, 2013
Secure messaging and diabetes management: Experiences and perspectives of patient portal users

Qualitative Study/54 participants/focus group and survey/survey only/focus groups varied by non-users, medium users, and high users as self-reported
Adults with DM II who were MHAV users (patient portal)
Qualitative analysis and quantitative analysis of data based on survey methods and focus group feedback to determine why participants use SM service via patient portal, the barriers to use, and why they don’t use it. Use of features were compared to A1C values to determine if there is any correlation

- Participants felt that SM opened communication to care team.
- Participants felt that use of SM saved everyone time.
- Participants felt that patient initiated SM elicited a more rapid response than a call to the office.
- Participants felt that face-to-face visits were enhanced because of the SM service. The provider had more information on them to discuss at visits.
- Participants felt that SM service was a great platform to clarify information or directions given during face-to-face.
- Those who reported low use of portal state that they have little belief in timely responses or security of service.
- Most common negative experience was no response to patient-initiated SM service.
- Use of SM service was associated with greater A1C control, which was supported by other studies.
- Patients are willing to use SM via patient portal for enhancement of their care if providers support it verbally.

Level VI/Quality Rating A/7/8
Good sample size except for generalization of association of SM use to glycemic control due to potential confounders not accounted for
Demographics for participants are similar and narrow compared to general population
Good description of study construct and statistical analysis
Discussion of limitations and bias

Liang, et al., 2011
Treatment effect of mobile phone intervention for diabetes on glycaemic control: a meta-analysis

Meta-Analysis/22 Randomized studies published between Jan. 1990-Feb. 2010/1657 total participants
Search of three electronic databases and citation chasing for studies that used mobile phone interventions and reported changes in A1C values in patients with diabetes.

- Significant reduction in A1C
- Reduction in A1C values were statistically more effective for DM II participants than for DM I.
- Subgroup analysis revealed SMS via mobile phone combined with Diabetic Educator achieved greater reduction of A1C compared to SMS alone.
- The effect of SMS intervention did not substantially differ by sample size, study design, quality scores, intervention content, technologies and frequency, the mean baseline A1C, or characteristics of participants.

Level I/Quality Rating A/7/8
Good sample size except for generalization of association of SM use to glycemic control due to potential confounders not accounted for
Demographics for participants are similar and narrow compared to general population
Good description of study construct and statistical analysis
Discussion of limitations and bias
<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Search Method</th>
<th>Target Behaviors Data</th>
<th>Findings</th>
<th>Level I/Quality Rating</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Cotter, Durant, Agne, and Cherrington, 2014 | Systematic Review of 8 RCT's and 1 quasi-experimental | Search of PubMed and citation chasing of resulting articles                   | Target behaviors data extraction table created | - Web utilization declined over extended period of time in all studies.  
- Two studies showed improvement in lifestyle and diet choices when comparing web-based interventions to usual care.  
- Two studies demonstrated improved A1C values using web-based interventions.  
- Limited research on specific behavior modification techniques using web-based interventions.  
- Interactive interventions that allow for personalized feedback have higher participation. | B/5/8                 | Clear objective for review  
Well described search strategy, but difficult to reproduce  
Did not statistically synthesize data  
Did not explain the method for creating the data extraction tables  
Discussion of limitations and bias  
Limited connection to clinical practice |
| Pal et al., 2013                         | Systematic Review: The Cochran Collaboration, 16 RCT's | Search of nine electronic databases, conference proceedings, and citation chasing for RCT's that included computer-based self-management interventions for adults with DM II | Taxonomy for behavior change was utilized to describe active ingredients of intervention/ Multiple statistical analysis of like-interventions | - Computer-based interventions had small, but statistically significant reduction of A1C.  
- Mobile phone based interventions showed largest improvements.  
- Heterogeneous interventions across studies make synthesis of treatment effect challenging.  
- Studies showed positive effect of interventions on knowledge and understanding.  
- Studies showed positive effects on self-efficacy.  
- Studies showed a positive effect on dietary changes/choices.  
- Improvement was identified in lipid control  
- Paucity of studies that gave details about interventions used for educational purposes to determine statistical significance | A/8/8                  | Clearly defined purpose for review  
Well defined search strategy  
Clear description of analysis process  
Assessed for bias of individual studies and explained process thoroughly |
Yeager, V.A., Menachemi, N., 2011
Text messaging in health care: A systematic review of impact studies

Systematic Review
61 Included Studies:
31 RCTs,
30 Observational/27 studies investigated SMS impact on disease outcomes/
24 studies investigated SMS impact on public health outcomes/
10 studies investigated SMS impact on administrative processes

Search of PubMed database using “SMS,” “texting,” “text messaging,” And “SMS messaging.”/Inclusion criteria were English-language publications, appearing in peer-reviewed journals, published before and including 2009, and studies involving SMS use in health care

Sorted studies into focal groups based on nature of each study/Extraction of characteristics/Descriptive statistical analysis used to examine distributions of each variable

- Impact studies show overall positive outcomes on health care across a wide variety of health care domains.
- SMS interventions lower participant’s blood glucose levels.
- SMS interventions lower A1C levels.
- SMS intervention produces significant improvement in quality of life.
- SMS improved participant’s self-management skills
- Of 61 studies reviewed, 50 (82%) found SMS had positive impact on primary outcome.

American Diabetes Association, 2014
ADA Standards of Medical Care in Diabetes-2014

Clinical Guidelines for the medical management of patients with diabetes/
Target audience are professionals who have responsibility of providing medical care and interventions for patients with diabetes

- Care should be aligned with the components of the CCM to ensure productive interactions between a proactive provider team and an informed and activated patient.
- Provide self-management support.
- Provide decision making support at time of need instead of being reactive.
- Diabetes Self-Management Education can be provided either via phone or telehealth
- Diabetes Self-Management includes informed decision making, self-care behaviors, problem solving, and active collaboration with the health care team.
- DSME has been linked to better clinical outcomes; lower A1C level, lower self-reported weight, improved quality of life, lower costs, and healthy coping skills.

Level V/
Quality Rating A/7/8
Clear purpose for review/Search strategies are well defined/Large quantity of studies reviewed (61)/Identified the limitations of conclusions based on gaps in available evidence/Data extraction and analysis process clearly defined/Appropriate use of statistical analysis/Good comparison of studies that had positive findings to those that had negative findings to verify rigor.

Level I/
AGREE II-GRS/6.8/7/Well represented task-force/Reviewed by ADA’s Professional Practice Committee (PPC)
| PPC performs continual search for new evidence |
| Guidelines updated annually based on new evidence |
| Uses classification system for evidence since 2002 |

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<th>Environmental Scan/Includes 7 Systematic Reviews, made up of 60 studies, looking at the evidence of text messaging interventions on patient behaviors and health outcomes/Utilized research that is pending publication from the AHRQ’s Innovations Exchange: Includes 11 studies</th>
<th>Studies covered a range of health topics such as health promotion, disease prevention (weight reduction, physical activity, smoking cessation), disease management (diabetes, hypertension, asthma).</th>
<th>Health messaging for various diseases and purposes. * Administrative purposes * Appointment reminders * Vaccine reminders * Disease education * Communication * Medication management</th>
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Appraisal of Relevant Evidence

Meta-Analysis

A meta-analysis quantitatively synthesizes and analyzes multiple primary studies that address a similar research question (Johns Hopkins University School of Nursing, 2014). This paper includes a meta-analysis (Liang et al., 2011) on the effects of mobile phone intervention for glycemic control in diabetes self-management. The clinical question is clearly stated in the abstract and introduction identifying what types of evidence the reader can expect. The search strategies included entering the key terms of “diabetes”, “diabetes mellitus”, “mobile phone”, “cellular phone”, and “text message” into the electronic databases PubMed, EMBASE, and Cochrane library. The criteria for inclusion were clearly stated and relatable to the clinical question. The authors included a table that lists the 22 study references, designs, target populations, sample sizes and setting, mobile phone technology, and the interventions tested.

Data extraction of study variables was performed by two investigators and are similar between all trials, leading to a statistical pooling of outcomes that is applicable to the clinical question. The statistical process was clearly explained. The authors also addressed subgroup analysis, providing statistical outcomes for each subgroup and explaining the significance of those outcomes. The authors identified potential confounding and selection bias of original research as a potential limitation of this analysis, and discrepancies in study sample size appeared to play a role in the statistical significance of A1C improvement, leading to stronger effects. The authors also identified the lack of a “gold standard” in calculating the missing standard deviation, potentially leading to random errors (Liang et al., 2011). This evidence is a Level I with a quality rating of A, receiving 7/8 construct points.
Systematic Reviews

Systematic reviews are rigorous syntheses of research findings related to a specific clinical question (Schmidt and Brown, 2012). This paper uses three systematic reviews as supportive evidence (Cotter et al., 2014; Pal et al., 2013; Yeager & Menachemi, 2011).

Cotter et al., (2014) published a systematic review that identified the evidence supporting the use of internet interventions to promote diabetes education and lifestyle modification among adults with diabetes type 2. This was a review of 8 randomized control trials and 1 quasi-experimental study with a control group. The researchers searched PubMed database for references published through January 2013, with subsequent citation chasing seeking studies that described an internet intervention, targeted adults with diabetes type 2, focused on lifestyle or behavior modifications, and included an evaluation component. The nine studies measured markedly different outcomes, so data extraction was designed around the seven American Association of Diabetes Educators targeted behaviors: a) healthy eating, b) being active, c) monitoring, d) taking medication, e) healthy coping, f) reducing risks, and g) problem solving.

The web-based interventions were highly disparate among the 9 included studies, ranging from one-on-one diabetes education to weekly information blogs with peer-to-peer support (Cotter et al., 2014). The measured outcomes varied significantly as well. Although the purpose of this review was to synthesize supporting evidence for internet interventions in the management of adults with diabetes type 2, the varied approaches did not allow for a meta-synthesis; however, some commonalities can be extracted. First, any of the studied interventions that were behavior-theory based resulted in more significant outcome improvement. Secondly, interventions that were interactive and allowed opportunities for peer support had a more positive impact on the
targeted outcomes. The degree of impact of participant engagement and interaction was not, however, consistent among the studies. This review exposed the need for further research on the correlation between web-based programs, their software design, participant interaction, and the targeted outcomes.

The systematic review by Cotter et al. (2014) did have some limitations. The search of one database was a potential limiter to complete saturation of relevant evidence. The variations in study designs hampers generalizability of the findings, providing a limited connection to clinical practice. This review is a Level I evidence with a quality rating of B, scoring 5/8.

The second systematic review is about computer-based diabetes self-management interventions for the adult with diabetes type 2 (Pal et al., 2013). This review of 16 randomized controlled trials (RCT’s) was derived from 9 databases, as well as conference proceedings, and citation chasing. Selection criteria included RCT’s of computer-based self-management interventions for adults with diabetes type 2. Data extraction followed a taxonomy for behavior changes techniques that described the main components of the interventions studied.

Pal et al. (2013) described computer-based interventions in terms of behavior change theories and techniques. Combined with the type of technology used, the authors synthesized the evidence into a theory-based rationale for future use of intervention components. The authors cited source limitations due to the brief descriptions of potential study interventions, making the task of inclusion or exclusion difficult, often ending up in the hands of the steering committee. Another limitation was the varied study designs from interventions used to outcomes measured, making a comparison or synthesis difficult. However, all 16 RCT’s measured A1C levels as an outcome, 11 of which could be combined in a meta-analysis. This review found a small
but statistically significant A1C reduction using computer-based self-management interventions, but suggests that further research be done to better isolate intervention components to specific outcomes, enabling better intervention design for use in clinical practice. This review is a Level 1 evidence with a quality rating of A, scoring 8/8.

The third systematic review for this paper (Yeager & Menachem, 2011) was the largest and most comprehensive review of the impact text messaging has on health care systems as a whole. This is a review of 61 papers, 50 of which reported a positive effect on outcomes measured. PubMed database searches and subsequent citation chasing were performed seeking English-language, peer-reviewed studies that involved text messaging in health care and were published in 2009 or earlier. Twenty-seven of the included articles reported the impact of texting on disease outcomes, 24 focused on the impact on public health outcomes, and the remaining 10 focused on health care administrative subjects. Data extraction and analysis methods are well defined in the article.

The overall conclusion of this review is that SMS interventions have a positive impact on all aspects of health care, but recognizes the gaps in the research. The authors identified that most studies on this subject are done outside of the United States, and publication of research often falls outside of diabetes/endocrinology specific journals, where key decision making stakeholders typically search for relevant information applicable to their profession. This potentially limits stakeholders’ exposure to research published in technology trade publications, possibly leading them to undervalue the positive impact of SMS interventions on disease outcomes. The authors also identified the lack of studies designed in the primary care setting and the potential influence on the statistical outcome of the intervention: an endocrinology care team specializes in focused care of the diabetic patient verses the primary care team who
treats the diabetic patient as well as the well child, the adult patient with COPD, etc. This review is a Level V evidence with a quality rating of A, scoring 7/8. It was determined to be a Level V evidence because 30 observational studies were included with the 31 RCT's.

**Environmental Scan**

This paper includes an environmental scan from The U.S. Department of Health and Human Services (HHS) that summarizes the evidence of the impact health text messages can have on consumer knowledge, behaviors and health outcomes (U.S. Department of HHS, 2014). The Agency for Healthcare Research and Quality (AHRQ) defines an environmental scan as a literature review combined with unpublished literature and publicly available information on innovative programs that they sponsor (Agency of Healthcare Research and Quality, 2014). This HHS environmental scan is a summation of seven systematic reviews and a synthesis of evidence from the AHRQ Health Care Innovations Exchange, which will be explained later in this section. The systematic reviews included in this environmental scan were focused on research that examined text messaging as a component of health promotion, disease prevention, or disease management programs. The seven systematic reviews encompassed 60 studies; 17 studies were cited in more than one of the included systematic reviews. This environmental scan included studies that evaluated the acceptance and effectiveness of health text messaging interventions published between January 2009 and October 2012. This scan did not disclose the search methodology used to find the included evidence.

The environmental scan also included evidence from the AHRQ Health Care Innovations Exchange, which is designed to accelerate the rate at which evidence-based programs are adopted in order to improve quality and reduce disparities (U.S. Dept. of HHS, 2014). The Innovations Exchange, a division of AHRQ, sponsors innovative pilot
studies aimed at improving the delivery and effectiveness of health care, and covers all
aspects of care. The findings of each pilot are available on the Innovations Exchange
website prior to publication (Agency for Healthcare Research and Quality, 2014). This
environmental scan included eleven pilots that examined the effects of text messaging
interventions on various aspects of health care. Although these were unpublished pilot
studies at the time of the environmental scan publication, the AHRQ has rigorous
guidelines for sponsored research, and having access to evidence that is pending peer-
reviewed publication, especially in the area of technological innovation, is beneficial
(U.S. Department of HHS, 2014).

This environmental scan provided tables with complete data on the systematic
reviews, including review references, background and design of included studies, key
summations, and implications for future research (U.S. Department of HHS, 2014). This
scan also included descriptive summations of all seven reviews, including commonalities
in study design and method limitations: small sample sizes, lack of long-term outcomes,
inability to isolate the effect of the SMS intervention from other health care components,
inconsistencies in intervention features (e.g., frequency, content, direction, and duration
of messages). This scan did not attempt to provide a statistical synthesis of the
individual review findings, which was not possible as some of the individual reviews did
not provide a statistical summation of the findings. Although this scan did not focus on
diabetes solely, it did focus on the use of mobile text messages as a medium to deliver
evidence-based disease care, prevention strategies, and assist in health care
administration tasks, thereby making it a relevant and invaluable resource for this paper.
This scan did include many RCT’s, but did not stay exclusive to them, and did not
provide a statistical synopsis of the findings of each systematic review or of the AHRQ
Health Innovations pilots, so its evidence is Level V, with a quality rating of A, receiving a score of 7/8.

**Clinical Guidelines**

This report also includes the American Diabetes Association Standards of Medical Care in Diabetes-2014 into its evidence (ADA, 2014). These guidelines provide clinical recommendations in the care of patients with diabetes using the best scientific evidence for a scholarly synopsis. These guidelines were evaluated using the AGREE II appraisal tool as previously described.

The overall scope and purpose for these guidelines are clearly defined by the ADA as a means to disseminate the best evidence, through standards of care, to the health care community charged with the management of all patients who currently have, or are at risk for, diabetes mellitus (ADA, 2014). Per the AGREE II instrument, these standards receive a 7/7 for scope and purpose.

The ADA ensures stakeholder involvement with the ADA Professional Practice Committee (PPC) as well as the ADA Executive Committee of the Board of Directors, who review all ADA standards of care, position statements, scientific statements, and consensus reports. The target users are identified as “clinicians, patients, researchers, payers, and other interested individuals in the components of diabetes care, general treatment goals, and tools to evaluate the quality of care” (ADA, 2014, p.S14). There is adequate reference to the consideration of the patients’ values and preferences when making clinical decisions, but the standards do not disclose how, or if that was incorporated into the development of these standards. In the domain of stakeholder involvement, a score of 6/7 is assigned per AGREE II.

The ADA defines the inclusion of evidence techniques in the introduction of their standards. They utilize systematic reviews in development of their standards. The
reviews undergo a critical peer review, then go before the PPC prior to approval for use. The ADA developed a system for grading scientific evidence in 2002, and have been utilizing that for standard development and revisions annually. Each of the clinical recommendations included in the ADA Standards of Medical Care for Diabetes, based on scientific findings, has an evidence strength rating of A, B, or C. Recommendations based on expert opinion are clearly demarcated with an E. In the domain of rigor of development, these guidelines were assigned a score of 7/7 using the AGREE II tool.

The recommendations are listed in a very clear and methodical manner, starting with the identification of the patient with diabetes, the diagnosis or recognition of risk factors for diabetes, and on through all stages of life, co-morbid issues, and quality of living considerations. The recommendations have targeted, unambiguous treatment strategies for all aspects of care. In the domain of clarity of presentation, the guidelines were assigned a score of 7/7 using the AGREE II.

The ADA Standards of Medical Care clearly describes the facilitators and barriers to implementation of recommendations as well as discloses the economic implications of their adoption or rejection. The standards have multiple resources cited at the end of each recommendation to assist in the implementation process, utilizing the Chronic Care Model as theoretical framework. In the domain of applicability, they were assigned a score of 7/7 using the AGREE II.

The guidelines do not reveal any funding or affiliation issues with the PPC or BOD. All members of the PPC are required to disclose potential conflicts of interest with industry. These disclosures are discussed at the onset of each Standards of Care revision meeting. Members of the committee, their employers, and their disclosed conflicts of interest are listed in the “Professional Practice Committee for the 2014
Clinical Practice Recommendations” (ADA, 2014). In the domain of editorial independence, they were assigned a score of 7/7 using the AGREE II.

The ADA Standards of Medical Care in Diabetes are developed with the best science available. Targeted to those charged with participating in the care of the patient with diabetes, they are complete and easy to implement across the patients’ lifespan, include resources to facilitate their implementation, and are rigorously reviewed and updated. The overall quality rating of these guidelines are is 6.8/7 using the AGREE II.

**Quasi-Experimental Studies**

This paper includes 3 quasi-experimental studies (Nes et al., 2012; Fischer et al., 2012; Nundy et al., 2014), which can be a controlled trial without randomization, or a case control or cohort study. Quasi-experimental studies are Level IV evidence (Melnyk & Fineout-Overholt, 2011).

The first quasi-experimental pilot study (Nes et al., 2012) is a 3-month study consisting of 15 participants. The aim of this study was to determine the feasibility of a 3-month web-based intervention delivered by a smartphone to support self-management in the patient with type II diabetes. The inclusion criteria was referred to, but not disclosed, and the researchers indicated the goal was fifteen participants, but did not discuss why the goal was so low. The researchers provided a very thorough table and descriptive overview of the tools used to extract data and of the statistical process used to evaluate the outcomes. The descriptive discussions of the study process and outcomes were well done, allowing readers to understand the study design and process as if they were a participant. The findings were very relatable to the target population, and they answered the clinical question as planned. The researchers did discuss the limited value of their positive findings due to the small sample size, and recommended this study be repeated on a larger scale. This evidence is Level IV, given a quality rating A, achieving 7/8.
The second quasi-experimental pilot study (Fischer et al., 2012) was a 3-month study aimed at assessing the feasibility of engaging adults with diabetes in self-management behaviors between clinic visits by using a SMS intervention to provide SMBG prompts and appointment reminders. This study had 47 participants, included Spanish and English speaking adult patients with diabetes who were receiving their primary care from a federally funded health center in Denver, CO. The study included a description of the study design, IRB process, and software platform used in the intervention. The study used the Power Analysis Sample Size 2008 software to measure and report the outcomes, and related those outcomes to the target population. The appointment attendance outcome was underpowered due to the small sample size, and that outcome was not statistically significant. This evidence is Level IV, quality rating A, achieving a score of 7/8.

The third quasi-experimental controlled study (Nundy et al., 2014) was a six-month mobile health, short messaging project aimed at adults with a diabetes type 1 or 2 diagnosis. The researchers implemented a CareSmarts software program designed to provide self-management support and team-based care management through automated messaging. It is a theory driven behavioral intervention designed to use cueing, education, self-efficacy, social support, and health beliefs to improve self-care. The study enrolled 348 participants, 74 in the intervention group, and 274 in the control group. This study was expanded from a previous 4-week quasi-experimental pilot study done by the same researchers.

Nundy et al. (2014) had some limitations. There was a potential for researcher bias because they designed and market the software tested in this study. The sustainability of the program using the CareSmarts software is questionable as it does not currently integrate with the University of Chicago Medical Centers’ EHR. There was
a good description of the study constructs, statistical analysis, and participant selection. This evidence is Level IV, quality rating A, achieving a score of 7/8.

**Qualitative Studies**

This paper includes 2 qualitative studies (Nundy et al., 2013; Wade-Venturo et al., 2013) which have importance for the knowledge of diabetes self-management and intervention design since self-management is largely behavior-based.

The first qualitative study (Nundy et al., 2013) design is a post-controlled pilot study, completed 4 weeks prior, which sought to evaluate the effect a text message-based diabetes self-management program has on glycemic control. The original controlled trial was part of the AHRQ Innovations Exchange program. This qualitative study utilized in-depth interviews lasting approximately 60 minutes. The interviews were transcribed verbatim and entered into Atlas 4.2 software, designed to detect characteristic patterns. Six research investigators examined any unidentified characteristics. This study applied the findings to several theoretical models to provide meaning and context to them. Study limitations were discussed: first, because this was a follow-up study to a designed intervention, its findings may not be generalizable to other web-enabled designed interventions. Second, the pilot study was of short duration, and participants feelings and beliefs my not generalize to longer interventions. This evidence is Level VI, with quality rating A, achieving a score of 7/8.

Wade-Vuturo et al.(2013) published a mixed-methods qualitative study on the use of patient portals, secure messaging, and the potential benefits for diabetes management for adults with diabetes type 2. There were 54 adult participants with diabetes type 2 who had used a patient portal secure messaging (SM) feature and were asked to take part in a focus group with subsequent survey or take a survey alone. The objective was to: a) understand why patient portal users with diabetes type 2 used SM,
b) why they do not use SM, and c) to determine the relationship between SM use and glycemic control.

The generalizability of these findings may be limited--all portal users were from the same clinic, using the same system at a single academic medical center. Also, most participants self-reported some college education: results may be different in a population without advanced education. Finally, the sample size did not allow for confounders’ effects to be examined in the relationship of SM use and A1C reduction. This evidence is Level VI, with quality rating A, achieving a score of 7/8.

**Literature Findings**

**Diabetes Care Guidelines**

The ADA Standards of Medical Care in Diabetes-2014 (ADA, 2014) recommend that patients with diabetes type 2 follow a plan of care that includes lifestyle changes (diet modification, regular exercise, smoking cessation), blood glucose control (measured as glycosylated hemoglobin (A1C) or self-monitored blood glucose (SMBG) values), medication adherence, regular clinical appointments, and self-management support and education (ADA, 2014). The standards also include the recommendation that people with diabetes and pre-diabetes should receive self-management education and support at the time of diagnosis and as determined by health care teams, patient confidence, and biological outcomes periodically thereafter (ADA, 2014). The ADA’s research indicates that self-management support improves diabetes knowledge and self-care behaviors which correlate to improvement in clinical outcomes - lower A1C, reduction in weight, improved quality of life, and lower health care costs. The ADA cites the National Standards for Diabetes Self-Management Education (NSDSME) as the
recommended resource for the design, implementation, and monitoring of diabetes self-management programs.

The NSDSME maintain that education curricula need to reflect current evidence and practice guidelines and should contain these specific topics to meet criteria for credentialing and reimbursement: a) description of the diabetes disease process and treatment options, b) incorporation of nutritional management into lifestyle, c) incorporation of physical activity into lifestyle, d) use of medications, e) SMBG and using values for self-management decision making, f) preventing, detecting, and treating acute complications, g) preventing, detecting, and managing chronic complications, h) developing personal strategies to address psychosocial issues and concerns, and i) developing personal strategies to promote health and behavior change (Funnell et al., 2010). The culmination of researchers’ diligence has provided insight into web-enabled short messaging interventions that have statistical significance, aimed at improving diabetes self-management and A1C values. Usual care of the adult with diabetes type 2 consists of all of the above recommendations, delivered in quarterly 15 minute face-to-face visits. The innovation described by the review of this evidence is the use of web-enable technology and SMS interventions to deliver that usual care in an asynchronous manner.

**Web-enabled Technology**

Web-enabled technology, often referred to as mobile health (mhealth), is an ideal strategy to support an evidence-based diabetes self-management program. Web-enabled technologies encompass an array of devices currently used by many Americans: a) smartphones or mobile phones, b) netbooks, c) tablets, d) laptops, and e) desk top computers, to name a few. The use of web-enabled devices are an integral part of Americans’ lives. For example, the percentage of adult cell phone users in the United
States who access web-based features on their phone—sending or receiving emails, instant messaging, access of social networking sites, watching videos—rose from 31% in 2009 to 63% in 2013 (U.S. Dept. of HHS, 2014).

Patient portals, a secure component of electronic health records, provides patients and health care teams a platform to communicate via secure messaging service (SMS) from any web-enabled device. SMS allows for secure communication outside of regular office hours for clinical questions, appointment requests, medication refills and more. Since SMS is asynchronous, it has the potential to reduce call volumes, personnel or staffing burdens, and, subsequently costs (Wade-Vuturo et al., 2013). SMS use for patient communication is a component of meaningful use and linked to reimbursement and federal incentives for health care organizations (Wade-Vuturo et al., 2013). The federal mandate to implement and use SMS provides health care organizations with an ideal platform for the delivery of diabetes self-management education, asynchronously, delivered to any web-enabled device that patients choose, when they are ready and available to learn. This paper will examine the effectiveness of SMS use to deliver diabetes self-management education with a synthesis of the included evidence as it pertains to the ADA’s education component recommendations, the effect on A1C values, and finally by participants’ self-reported satisfaction with web-enabled interventions.

**SMS and Self-Management Education Components**

**Diabetes disease process.** Diabetes disease knowledge was measured in 6 of the 10 sources chosen for this project (Cotter et al., 2014; Fischer et al., 2012; Nes et al., 2012; Pal et al., 2010; U.S. Dept. of HHS, 2014; Wade-Venturo et al., 2013). Although the education delivery mechanism was SMS for the included studies, the content designs, outcomes, and measurement methodologies varied. For example, the studies each used different diabetes knowledge measurement tools. The systematic
review by Cotter et al. (2014) reviewed nine studies, two of which measured diabetes knowledge. One of the studies used a diabetes knowledge test titled “BASICS”. That study showed a 36.7 point increase in diabetes knowledge compared to the 6 point increase in the control group. The study could not correlate the increased knowledge to a change in behaviors. Cotter et al. (2014) did not reveal the knowledge measurement tool used in the second study.

A systematic review of influential factors in the self-management of diabetes cited a lack of appropriate, consistent, and understandable diabetes disease education as a barrier to effective diabetes self-management (Wilkinson, Whitehead & Richie, 2014). The researchers concluded that key educational content needed to be repeated frequently to create a sustainable knowledge base, referring to a scaffolding effect, building on previous knowledge with educational follow-ups. Additionally, information from all members of the health care team needed to be consistent as conflicting information is a barrier to comprehension and use of disease-specific education. One study design attempted to solve knowledge gaps by delivery of diabetes self-management education using a daily short-message platform (Nundy et al., 2012). The researchers’ intervention design included educational content that was tailored to individual participant needs based on their responses to intake questions. Disease education was based on participant diagnosis and allowed for two-way messaging to resolve content ambiguity or provide reinforcing information. The post-study focus group reported feeling “more in control” of their disease because they better understood the importance of daily care activities relating to the disease process (Nundy et al., 2012). Focus group participants, from a study on the feasibility of web-enabled diaries with two-way short-messaging ability between participants and health care team members,
reported feeling that their diabetes knowledge increased as a result of team member feedback that focused on content from their diaries (Nes et al., 2012).

This evidence suggests that providing diabetes disease education via SMS does improve the knowledge recall of study participants. However, correlating obtained knowledge to improvements in clinical outcomes is difficult due to methodological variation. Participants generally reported feeling more in control of their diabetes as a result of their new knowledge, which has the potential to impact face-to-face visits, lifestyle choices, and efforts to self-manage.

**Nutritional management education.** The NSDSME contends that interventions that target behavioral goals or objectives require patient-centered, action-oriented, and creative delivery methods (Funnell et al., 2010). Nutrition or dietary education was evaluated in 6 of the 11 sources used for this project (Cotter et al., 2014; Nes et al., 2012; Nundy et al., 2014; Pal et al., 2010; Yeager & Menachemi, 2011; U.S. Dept. of HHS, 2014). The methodologies of the interventions, again, were varied. In a systematic review by Cotter et al. (2014), five of the nine included studies measured dietary behaviors. Only one noted a statistical significance in dietary changes when compared to the control group. However, it is interesting to note that dietary improvements were seen in both intervention and control groups in the remaining studies, although they were not statistically significant.

The US Department of Health and Human Services’ (HHS) task force created an environmental scan titled “Using Health Text Messages to Improve Consumer Health, Knowledge, Behaviors, and Outcomes” (U.S. Dept. HHS, 2014). Five of the systematic reviews included in the environmental scan found statistical evidence supporting the use of health messaging for dietary management and weight loss, but did not publish the statistical analysis that may have been provided in the reviews.
Dietary management, strongly linked to behavior, can be a difficult concept for patients with diabetes. In a focus group from an SMS pilot study, participants indicated information provided to them via SMS as helpful, but they would like to receive more information focused on diet management stating that this was a very difficult area to control and felt more information and support would have a positive impact (Nes et al., 2012). Participants in the study conducted by Nundy et al. (2014) reported following a healthy eating plan post-study 5.2 days of the week compared to 4.5 days pre-study (p = 0.03). Pal et al. (2013), who conducted a Cochrane Review of 16 SMS studies, did not find any statistically significant evidence that interventions via SMS improved dietary management.

The ADA contends that nutrition therapy is an integral component of diabetes prevention, management, and self-management education (ADA, 2014). Although there was no overwhelming or consistent statistical findings on the effect of SMS intervention on dietary or nutritional efforts, the guidelines support the inclusion of this material in a diabetes education program.

**Physical activity education.** The “ADA Standards of Medical Care for Diabetes-2014” recommend that adults with diabetes should perform at least 150 minutes per week of moderate-intensity aerobic physical activity (50–70% of maximum heart rate) at least 3 days per week with no more than 2 consecutive days without exercise. Three of the 11 sources included in this project evaluated the effect of SMS intervention on physical activity behavior (Cotter et al., 2014; Nes et al., 2012; Pal et al., 2013).

In Cotter et al. (2014), five of the eight included studies found that participants had an increase in self-reported physical activity, but did not provide statistical data. Nes et al. (2012) conducted a study involving a web-based diary with feedback that included a sound file of mindfulness exercises designed to stimulate physical activity. Participants
who used the sound bites felt the stimuli to perform physical activity was effective, but few participants used the available file; the researchers did not provide data on how many used the files. All 11 of the participants in that study did, however, report an increase in their motivation to increase physical activity. In Pal et al. (2013), three studies showed statistically significant improvements in self-reported physical activity; one study found no improvement in self-reported physical activity on questionnaire replies. Some of the daily messages in the study conducted by Nundy et al. (2014) contained educational information about the impact that exercise has on the SMBG value, but did not measure physical activity as an outcome.

The ADA has recommended that physical activity be a component of diabetes self-management teaching, and although the included evidence included in this project does not provide consistent statistical data on the use of SMS to deliver physical activity education, it should remain a component of any diabetic education program. In fact, physical activity education must be included as a component of DSME in order for the program to qualify for third party insurers and Medicare and Medicaid reimbursement (Funnell et al., 2010).

**Medication education.** Medication education and compliance is one of the most commonly measured outcomes in studies of web-enabled interventions (Cotter et al., 2014; Nundy et al., 2014; Wade-Venturo et al., 2013; U.S. Dept. of HHS, 2014). Nundy et al. (2014) measured days of medication adherence, which improved from 83% to 91% ($p = 0.003$) among participants in their study. Their study involved daily text messaging that contained educational content on the effect of medication compliance as well as medication reminders and prompts. However, their study was not designed to provide isolated results for independent intervention. Cotter et al. (2014) noted two of nine studies in their review measured medication adherence; neither found a statistically
significant effect from web-based interventions, such as education modules, goal setting, and web-based publicly available diabetes mellitus information. In their environmental scan, the U.S. Department of Health and Human Services (2014) found evidence across all chronic diseases, message reminders were effective for medication adherence, but more importantly, participants were more likely to seek advice from their health care team for adverse medication reactions or outcomes. However, it was not revealed how the researchers reached this conclusion. Participants in the survey study conducted by Wade-Venturo et al. (2013) felt that having SMS capability to communicate with a provider for medication questions or reactions helped them to continue to take medications as prescribed. Although not statistically measured, the patient perception reported in focus groups, surveys, and self-reporting was that SMS reminders and prompts for medication regimen adherence assists patients’ efforts to manage their medications with fewer missed doses and reduced complications from medication side-effects.

The use of SMS intervention for medication adherence can be done through education on how medication affects diabetes outcomes, as in the study conducted by Nundy et al. (2014) where educational SMS on medication adherence were sent. Use of SMS to send medication reminders as discussed in the DHHSs’ environmental scan has also demonstrated some improvement in medication adherence. Either method can be used as an independent intervention, or together for a more comprehensive approach.

**Self-monitored blood glucose education.** Self-monitored blood glucose (SMBG) values provide information necessary for both the health care provider and the patient to make care adjustments. The ADA recommends in their “Standards of Medical Care in Diabetes-2014” to educate patients about how to use SMBG data to adjust food intake, exercise, or pharmacological therapy to achieve specific goals, and to ensure
that patients receive ongoing instruction and regular evaluation of SMBG technique and their ability to use SMBG data to adjust therapy. The ADA contends that adherence to SMBG regimens has a positive effect on A1C values for the first six months, and plays a key role in adequate self-management (ADA, 2014).

Several resources reported positive effects of web-based interventions on SMBG values (Cotter et al., 2014; Fischer et al., 2011; Nes et al., 2012; Nundy et al., 2013; Nundy et al., 2014; U.S. Dept. of HHS, 2014). Cotter et al. (2014) noted that one of the nine studies reviewed measured SMBG testing, and noted a significant improvement ($p < .001$). In a focus group study by Nundy et al. (2013), participants were interviewed about how they felt about the 4-week study that utilized SMS intervention for management and education of diabetes. One participant reported that she was more aware of how she felt physically and how her SMBG value varied when feeling poorly. Another participant reported increased awareness of food intake and how various foods she ate affected her SMBG values. Nundy et al. (2014) reported that participants went from performing SMBG values 4.3 days per week to 4.9 days per week ($p = 0.03$). Their study consisted of educational messages regarding the importance of performing SMBG, as well as reminder messages. Fischer et al. (2012) noted that 66.4% of participants correctly sent SMBG values via SMS in response to a request compared to a previous 12% correct SMBG logs provided during their previous two face-to-face visits. Nes et al. (2012) noted that 9 of the 11 participants reported checking their blood glucose levels more often. The U.S. Dept. of HHS reported that SMS intervention had a positive impact on SMBG monitoring, but did not report statistical evidence. The included resource results suggest that the real-time communication component of SMS may improve SMBG adherence, as well as education on the importance of self-monitoring,
and how SMBG values can impact the decisions patients make in their attempts to self-manage their diabetes.

**Education to prevent acute and chronic complications.** According to the ADA, diabetes education is positively associated with use of primary and preventive services, and results in lower use of acute, inpatient hospital services. Patients who participate in diabetes education are more likely to follow best practice treatment recommendations, thereby preventing many acute and chronic complications (ADA, 2014).

Wilkinson et al. (2014) noted that slow response to patient clinical issues or questions negatively impacted patients’ ability to avoid acute and chronic complications. Web-enabled interventions have the ability to reach patients in “real-time,” which can improve health care team feedback times, increase awareness of undesirable self-management habits, increase recognition of poorly managed disease, and potentially avoid acute or chronic complications of disease (Nes et al., 2012). Nundy et al. (2014) measured the effect web-enabled interventions had on unplanned visits, noting a statistical difference of 1.33 less unplanned visits in a 6-month period ($p = 0.007$).

Although there is a paucity of evidence on the effect SMS has on adverse event prevention, the ADA guidelines have produced much evidence that education on this topic, such as recognizing when SMBG values are veering from normal ranges and proper assessment of feet to prevent ulcers or infections, is an essential part of diabetic self-management education. Education programs that follow the ADAs’ guidelines have a positive impact on adverse event prevention.

**Healthy behavior modification education.** In the “Standards of Medical Care in Diabetes-2014”, the ADA asserts that emotional well-being is an important part of diabetes care and self-management. Psychological and social problems can impair the
individual’s ability to carry out diabetes care tasks and therefore compromise health status. Web-enabled interventions have been shown to improve participants’ feelings of support, care and emotional well-being (Nes et al., 2012; Nundy et al., 2013; Wade-Vuturo et al., 2013; Cotter et al., 2014; Pal et al., 2013; U.S. Dept. of HHS, 2014). Nundy et al. (2013) conducted in-depth, individual, recorded interviews regarding subjects’ participation in a prior 4-week study using SMS intervention. Topic guides were created for the interviews, which consisted of open-ended questions. When asked about caring and support, participants reported the text messaging provided them with someone who cared about their outcomes. Nes et al. (2012) used the ADDQoL-19 (Audit of Diabetes Dependence Quality of Life) assessment tool to assess patient perception of how significant the impact of a diabetes diagnosis has on their quality of life, and the Problem Areas in Diabetes (PAID) assessment tool to measure diabetes-related distress. The researchers found improved scores in both assessment tools post-intervention, which indicates that patient felt less of a negative impact of having to live life with diabetes, and less diabetes-related distress as a result of the SMS intervention.

The NSDSME holds the position that development of strategies to address psychosocial issues and concerns, and health promotion and behavior change should be part of the education curriculum (Funnell et al., 2010). The lack of a supportive family, health care team, or community is perceived by patients to be a barrier to adequate self-management (Wilkinson et al., 2014). Educational material sent via SMS on a daily or weekly basis can provide the evidence-based information needed to prompt the adult with diabetes to make behavioral modifications (U.S. Dept. of HHS, 2014). Two-way messaging can provide interactive support at the time when patients need it.
Outcomes

Two primary techniques are available for health care providers and patients to assess the effectiveness of the management plan on glycemic control: A1C level and patient self-monitoring of blood glucose (SMBG), also called interstitial glucose (ADA, 2014).

A1C level. A1C reduction as a result of SMS intervention was a common finding in the literature. Eight studies or reviews specifically addressed A1C value as an outcome (Cotter et al., 2014; Liang et al., 2011; Nundy et al., 2012; Nes et al., 2012; Pal et al., 2013; U.S. Department of Health and Human Services, 2014; Wade-Venturo et al., 2013; Yeager and Menachemi, 2011), all showing statistically significant reductions A1C values.

Nundy et al. (2014) completed a study designed with two-directional, daily SMS intervention, demonstrated a reduction from A1C average of 7.9 to 7.2 (p = 0.01) in the intervention group. The control group had no change in A1C value. Pal et al. (2013) reviewed 16 randomized trials; the pooled effect on A1C values showed a slight, but significant improvement (-0.2%) in A1C level (p = 0.009). Liang et al. (2011) pooled A1C results from 22 randomized controlled trials and found a statistically significant reduction in A1C by a mean of 0.5% (95% CI). Wade-Venturo et al. (2013) reported that patient use of SMS to communicate with a provider for any reason was positively associated to a lower A1C value (p = 0.07), and use of SMS to schedule appointments was significantly associated with A1C reductions (p = 0.04).

The use of SMS intervention varied among all of the evidence included in this project, but have a demonstrated a consistently positive effect on A1C value, which correlates to lower average daily blood glucose levels.
**Patient Acceptance**

Rogers’ Diffusion of Innovation theory explains that in order for an innovation to be adopted, the adopter must feel compatibility with it, meaning that they perceive it to be consistent with their values, social needs, past experiences, and current needs (Sahin, 2006). This review contained 5 studies or reviews that measured patient satisfaction with the innovation, the usability of the program, and their overall experience (Fischer et al., 2012; Nes et al. 2012; Nundy et al., 2013; Nundy et al., 2014; Wade-Venturo et al., 2013). All five resources cited positive reactions by participants to the intervention of SMS. The most common consensus was ease of use. One participant in the study by Wade-Venturo et al. stated that the program and the use of SMS helped her to prepare for face-to-face visits. This participant now requests lab work before her appointment, and can see results through the patient portal. Participants from Fischer et al. felt that the intervention made them feel more ‘connected’ with their provider, improving their communication efforts. Four of the eight participants in that study appreciated the asynchronicity of the intervention. In the study conducted by Nundy et al. (2014), 73% of the participants in the treatment group were satisfied with the program and 77% said they would like to repeat it in the future. Focus groups in the study by Fischer et al. (2012) viewed the SMS favorably as did the focus groups from Nundy et al. (2013). They perceived the program, which was two-directional, expanded their communication and engagement with the healthcare system. In a survey study by Wade-Venturo et al., participants felt that using SMS to communicate with their provider elicited a faster response and that SMS was preferable for scheduling appointments and requesting medication refills. In the study by Nes et al., 10 of 11 participants felt the intervention was easy to use, supportive, meaningful and inspiring, and motivational.
The use of web-enabled technology, as discussed previously, has been largely adopted by Americans. The idea that a health intervention program that uses SMS as a delivery platform is acceptable to patients is plausible. The evidence for this project supports this notion.

**Best Practice Recommendation**

The ADA Standards of Medical Care in Diabetes-2014 recommends that patients with diabetes type 2 follow a plan of care that includes lifestyle changes (diet modification, regular exercise, smoking cessation), blood glucose control (A1C, SMBG), medication adherence, regular clinical appointments, and self-management support and education (ADA, 2014). Diabetes self-management support through SMS via web-enabled technology can provide the patient with a “pocket coach” to assist efforts to achieve these behavior modifications and clinical goals.

The ideal SMS intervention would have an EHR-compatible delivery platform, such as a HIPPA-secured patient portal that interacts with patient records and can be accessed by patients at any time from any device that they choose, from any location. The content of the SMS can be accessed, saved, and responded to in a two-way communication. The SMS content should consist of the components of diabetes self-management education: a) diabetes disease process, b) nutritional management, c) physical activity, d) medication adherence, e) SMBG, f) prevention of acute and chronic complications, and g) health behavior modification. Further considerations for the intervention design would be the frequency and length of the SMS program. The SMS should be frequent enough and the program duration long-enough to impart the necessary contents of diabetes self-management education, but not be so long or intrusive that participants lose interest.
Answering the Clinical Question

This EBP project aims to answer the question, "In the adult patient with diabetes type 2, can a four-week diabetes self-management education program delivered from a patient portal to a web-enabled device in an SMS platform improve the patient's self-reported self-care knowledge and behaviors and SMBG daily average compared to usual care?"
CHAPTER 3
IMPLEMENTATION OF PRACTICE CHANGE

The purpose of this EBP project was to design and implement a diabetes self-management education program with an innovative delivery platform that solved the time limitations of the antiquated face-to-face quarterly visit. The evidence-based practice of providing diabetes self-management education was achieved through the implementation of a 30-day Diabetes Self-Management Education Program (DSMEP) for adult patients with diabetes type 2, delivered in the form of daily short messaging from a patient portal to a personal web-based device. The goal of this EBP project was to positively affect patients’ self-care knowledge and behaviors, demonstrated by their pre- and post-test scores on the Diabetes Self-Management Questionnaire (DSMQ) (see Appendix A), and decrease their SMBG daily average compared to their pre-project daily blood glucose average, which was converted from their most recent A1C value using the A1C Derived Average Glucose (ADAG) Study Group’s conversion formula (Nathan et al., 2008).

This EBP project was guided by the Chronic Care Model (CCM), as recommended by the ADA Standards of Medical Care in Diabetes-2014 (ADA, 2014). The CCM emphasizes a health care delivery system that is designed to facilitate partnerships between patients and providers in order to improve chronic disease care and develop self-management skills (Siminerio, 2010). This project has sustainability for effective practice change with the use of: a) the CCM as a theoretical-based framework, b) an innovative and adoptable innovative delivery system, and c) implementation of care derived from evidence-based guidelines. This project provides not only a platform of care delivery for the patient with diabetes type 2, but for patients with other chronic
disease states, as well as those requiring transitional care (e.g. orthopedic post-op care, rehabilitative care, lifestyle modification).

**Setting**

The EBP project will be implemented at a family practice clinic located in Mishawaka, IN. The practice is a sub-system of a surgical and medical hospital that consists of one surgical hospital and five satellite family practices. The target office has one full-time physician, one full-time family nurse practitioner--the project leader--, three medical assistants, two front office staff, and one office manager. The clinic provides primary health care for patients throughout the lifespan. The providers are credentialed and participate with Medicare, Medicaid, and most third-party payers. Hours of operation are Monday through Friday, 8:00a.m. to 5:00p.m., with on-call service covering all after-hour needs.

Current clinical practice for the adult patient with diabetes type 2 is not historically consistent from provider to provider, but often loosely follows the current standards of care determined by the ADA. The implementation of ‘meaningful use’ has been the impetus to change, requiring providers to report achievement of disease related clinical criteria to Medicare. The typical care currently consists of identifying patient risks for development of diabetes, quarterly clinical examinations including glucose level or A1C value, management of pharmaceutical interventions, providing patient education literature regarding dietary and lifestyle modifications, and initiating referrals to a registered dietician or diabetes education class. There is typically a three month wait list for dietary referrals and/or available diabetes education programs, which is often not covered by third-party insurers.
Participants

The target population for this project is adults between the ages of 18 and 75 who have a diagnosis of diabetes type 2, have not been hospitalized in the previous six month period for diabetes or complications from diabetes, and have an A1C value of 6.5 or higher in the last three months. Most participants were patients from the family practice, but some were referred to the project by other providers. No plan of care changes were made for participants who were under the care of other providers, however, if their participation in the project provided data that suggests a care change was needed, participants were be asked to contact their health care provider, and any information that might assist their provider was be sent to them following HIPPA regulations. Additionally, participants needed to have access to a web-based device that was capable of receiving messages from the patient portal system used by the clinic (e.g., smartphone, feature phone, tablet, and lap top).

Outcomes

This project has two primary outcomes of interest. First, participants’ self-assessed ability to manage their diabetes type 2 was measured by their DSMQ scores pre- and post-project. The second primary outcome is the participants’ average daily blood glucose level pre-project, converted from their most recent A1C values using the ADA’s Standards of Medical Care in Diabetes-2014 conversion table, compared to the mean SMBG values over the 30-day project (American Diabetes Association, 2014). The group’s weekly mean SMBG values were also compared to their total 30-day mean average. Additionally, the project leader (the DNP student and clinic nurse practitioner), also qualitatively described the participant’s satisfaction with the delivery method and the DSMEP with the use of a participant satisfaction survey (see Appendix B).
**Intervention**

This EBP project employed an innovative delivery platform to improve the delivery efficacy of diabetes self-care information, support, and medical interventions. This capitalized on the target family practice clinic’s requirement, through ‘meaningful-use’ stage two, to utilize a patient portal system for improved communication between patients and their health care team. Participants received a minimum of two messages a day, more if two-way interaction was necessary based on SMBG values or other diabetes complications. The SMS originated from the project leader through the target system’s patient portal and was received by the participant on the web-enabled device of his/her choice. Messages consisted of one daily message containing educational information about diabetes, and a second daily message from either the prompt and reminder, assessment, feedback, tips, or encouragement categories, following a rotational pattern of every six days. Samples of message are provided in the following sections.

**Educational Messages**

Participants received one SMS message every day that provided educational information about diabetes, medications, nutrition, SMBG monitoring, or exercise. Messages were changed on a daily basis for the 30 days of enrollment (see Appendix C). Examples of these messages are as follows:

- SMBG monitoring: “A desired fasting SMBG reading ranges from 80-126.”
- Living with diabetes: “Did you know that stress can increase your blood sugars?”
Prompts and Reminders

These messages are designed to assist patients to develop habits of self-assessment and medication adherence (see Appendix D). For example:

- Medication: “Did you remember to take your medication as prescribed today?”
- Prompts: “Have you seen your doctor in the last three months?”

Assessments

Assessment messages are a request for information from the provider to the participant, and are designed to assess self-management behaviors (see Appendix E). Examples include:

- Medication: “In the last seven days, how many days did you take all of your scheduled medications? Do you need any refills?”
- SMBG Monitoring: “Did you test your blood sugar today? (Respond with yes or no.) “Was your SMBG level within range?” (Respond with value.) If it is clear to the project manager that SMBG readings demonstrate a pattern that is out of range, the participant will be called in for an office visit to evaluate and adjust the care plan as appropriate.

Feedback

These are messages designed to reinforce positive behaviors and provide education about negative behaviors and their outcomes (see Appendix F). For example:

- SMBG monitoring: “Great job on your SMBG schedule, keep up the good work!”
- Medication: “I see you missed several doses of your medication this week? Do you know why? Do you have timers set in your phone?”
Tips

Tips are designed to encourage adoption of positive behaviors (see Appendix G). For example:

- Nutrition: “You can’t eat it if you didn’t buy it. Keeping unhealthy foods out of your kitchen pantry reduces temptation.”
- Exercise: “The ADA recommends 150 minutes of exercise per week. Exercise reduces your SMBG levels for 72 hours.”

Encouragement

These messages are intended to increase participants’ perception of support in this program (see Appendix H). For example:

- SMBG levels: “Monitoring your blood glucose level isn’t just so your provider can adjust your meds, it’s so you can adjust your actions to produce better outcomes.”
- Psychosocial: “Everyone with diabetes gets down from time to time about it, it’s how you respond to your feelings that matters.”

Participants received a telephone call from the project manager at the end of the first week to address any technological issues, diabetes self-management questions, or any concerns with their participation in the project. They were then offered a call weekly thereafter via SMS. If they wanted a call, they returned the SMS asking to please be called.

Participants ended the 30-day project with a face-to-face visit with the project leader. During this visit the project leader retrieved participants’ SMBG 30-day logs, the completed DSMQ, which will be compared to the completed pre-project DSMQ. Participants were asked to complete a participant satisfaction survey to determine their satisfaction with the delivery platform and content of the DSMEP (see Appendix B).
Recruiting Participants

Participants were recruited from the target family practice by several means. First, posters were placed in patient waiting rooms, exam rooms, and bathrooms at the clinic. Next, the project leader delivered a dinner-style presentation at the clinic’s medical and surgical hospital to recruit any interested diabetic patients who may not have a primary care provider, or who receive care at one of the surgical hospitals’ other family practice clinics. The ‘Dinner and Discussion’ presentation was advertised in the local newspaper and an ad was placed on a billboard on a main street of the target community.

Participants were also recruited from the target clinic patient roster, by the project leader, as they were recognized to meet the project participant requirements during the course of daily clinic schedules. This process of screening occurred on a daily basis. The project leader had access to patient information and knowledge of potential participants as she functions as a primary care provider at the target clinic. The project leader, in anticipation of this EBP project, has been identifying potential participants through the course of their usual care.

Enrollment

Participant enrollment in the project was completed in weekly intervals with four start dates beginning October 22, 2014, October 29, 2014, November 5, and November 12, 2014. Participants who met eligibility requirements, and agreed to participate in the project were enrolled by the project leader during an “enrollment” face-to-face visit. The project participation consent form was explained by the project leader and any questions or clarifications about the project was answered at that time (see Appendix I). The project leader and participant signed the consent form; and a copy was provided. Participants completed a demographic form (Appendix J), and a pre-project DSMQ,
which provided baseline information about participants’ self-assessed perception of their ability to self-manage their diabetes type 2 (see Appendix A).

The participants’ pre-intervention weight and blood pressure was obtained by the project leader during the enrollment face-to-face visit. The data was used to develop a diabetes plan of care (standard care) to determine a nutritional and physical activity plan, and target goals for A1C, weight, and blood pressure (see Appendix K). The care plan helped to determine some of the SMS content in the feedback category. Participants were asked to keep a daily log of their SMBG (see appendix L). Finally, participants were, if they weren’t already, registered in the target clinics secure patient portal. This is a registration process that involves the participants’ email, and is done through the clinic’s EHR system. The system generated a portal invitation that was sent to the participants’ registered e-mail, and they were required to answer a security question and confirm participation. Once the participant accepted the invitation to the portal, a test message was generated by the project leader asking for a confirmation of receipt. The DSMEP began the day after enrollment, with the first message transmission at 8a.m.

Data Collection

Measures and their Reliability and Validity

The instruments used to collect data included the Demographics Sheet, pre- and post-project Diabetes Self-Management Questionnaires (DSMQ), the Participant Satisfaction Survey (PPSS), the participant SMBG 30-day log, and a retrospective view of participant’s latest pre-project A1C value. The DSMQ is a sum-scale instrument completed by the participant pre- and post-project, and the PPSS is a self-assessed likert-scale tool completed by the participant post-project. The SMBG log is a self-reported value of the participant’s daily blood glucose level completed by the participant and turned in at project completion. The A1C is a “look-back” CLIA-waived laboratory
value that provides retrospective average daily blood glucose values, and was provided either by the participant as a lab document, or was retrieved from the EHR by the project leader. The Demographics Sheet was completed by the participant on enrollment day.

**DSMQ.** The DSMQ questionnaire was developed and studied by Schmitt et al. (2013) to provide an instrument that could reliably correlate self-management skills with glycemic values. It is a psychometric assessment of 16 questions that provides a sum scale value to the participant's overall self-reported diabetes management skills. The questionnaire also provides four sub-scale scores covering the participant’s perceived skills in glucose management (Items 1, 4, 6, 10, 12), dietary control (items 2, 5, 9, 13), physical activity (items 8, 11, 15), and health care use (3, 7, 14). Seven of the questions are formulated positively, nine inversely (see Appendix A). This questionnaire was chosen because it was developed to assess self-care behaviors known to affect the measure of A1C values (Schmitt et al., 2013). Schmitt found reliability testing revealed good internal consistency of the “Sum Scale” and acceptable consistencies of the subscales. Cronbach’s α co-efficients of the subscales were 0.77 for ‘Glucose Management’, 0.77 for ‘Dietary Control’, 0.76 for ‘Physical Activity’, and 0.60 for ‘Health-care Use’. For ‘Sum Scale’ an α co-efficient of 0.84 was observed.

**Patient satisfaction survey.** The PPSS is a likert-scale survey that provides the participant’s satisfaction with the project, its delivery methods, as well as the content of the DSMEP. It was created by the project leader for the sole purpose of participants’ evaluation of this project (see Appendix B).

**SMBG log.** The participant SMBG logs are a component of standard care and was used to collect the participant’s daily SMBG values over the 30-day program. This type of tool is used in clinical management of diabetes to provide the health care
provider with data on which to base clinical treatment decisions. It is a key component to being able to self-manage diabetes type 2 (Funnell et al., 2010)(see Appendix L).

**Data Measurement and Analysis**

Participants completed the DSMQ prior to the start of the 30-day program and at program completion. This questionnaire is a psychometric scale that is scored as a ‘sum scale’ as well as four ‘subscale’ areas: a) glucose management, b) dietary control, c) physical activity, and d) health-care use. The project leader compared the group pre-project ‘sum score’ and ‘sub-scores’ to their post-project scores by a statistical test of means (paired \( t \)-test) with a significance level of \( p \) of \( \geq 0.05 \) (two-tailed). The project leader converted the participants’ pre-project A1C values to an average daily blood glucose value, and compared to the group SMBG average over the 30 day project using a statistical test of means (\( t \)-test) with a \( p \) of \( \geq 0.05 \). The final statistical comparison is a RM-ANOVA comparison of the group’s four weekly SMBG averages to their total 30-day average. This was to determine any possible relationship between degree of improvement of weekly SBMG values and point of time in educational program. For example, did groups achieve the greatest improvement during week three, or week four? This data could have future implications on length of programs, timing of content, and saturation of information (see Appendix A).

**Management of Data**

The intervention for this project utilizes the clinic’s patient portal. Much of the data will be entered directly into participants’ secure medical chart. Since one of the aims is to determine the feasibility of a 4-week diabetes self-management development program, utilizing the existing portal of the clinic will increase sustainability and transferability to other chronic diseases or post-operative care. Participant data that is kept separate from the participants’ medical chart will not contain any identifying
information and will be maintained in a locked case in the project leader’s office located in the target clinic. All data collected during the 30-day program that is not self-contained within the EHR will be identified by a project number and kept secure as mentioned above, and destroyed at the completion of the project.

Protection of Human Subjects

This project is subject to all U.S. Department of Health and Human Services (HHS) regulatory and NIH policy requirements. The project leader completed the required course intended to allow investigators to fulfill the required education in the Protection of Human Research Subjects. Application for approval was made to the Valparaiso University Institutional Review Board (IRB). The IRB reviewed this project with all research statutes and regulations pursuant to Federal regulations, 45 CFR 46.101(b). This project, identified by the IRB as Project No. 15-019 was granted approval on September 26, 2014.
CHAPTER 4
FINDINGS

The purpose of this EBP project was to determine the effect of a 30-day diabetes self-management education program delivered from a patient portal to a web-enabled device in the form of SMS on adults with diabetes type 2. Statistical analysis was completed to compare baseline estimated average daily glucose values (eAG) to the 30-day daily SMBG average obtained throughout the duration of the program, and to compare the sum-scale and sub-scales of the pre-DSMQ to the post-DSMQ. Data analysis using SPSS 18 was completed performing paired sample t-tests to compare the baseline eAG to the 30-day SMBG average, and the pre- and post-DSMQ sum-scale and four subscales: a) glucose management b) dietary management, c) physical activity, c) health care use and engagement. A RM-ANOVA was performed to determine if there was a point in the program that had the most significant SMBG reduction.

Patient satisfaction was analyzed as well, calculating a sub-score from the PPPS of 5 questions that represent overall program satisfaction. Participant satisfaction with the length of the program was calculated as well using responses from a sub-scale of the PPPS.

Sample Size

Twenty-one participants were scheduled for, and attended, a face-to-face intake visit. Of the 21 patients who completed the program intake face-to-face process, 4 were unable to begin the program due to an inability to connect to the patient portal due to independent technology issues. Of the 17 participants who began the program, 16 completed the program by attending the conclusion face-to-face visit, which is when the post-DSMQ, the PPPS, and the SMBG 30-day log was obtained. Since post-intervention data were unable to be obtained on the participant who did not attend the conclusion
visit, data from that participant were not included in the sample. The sample size for this project is $N = 16$ (see Figure 4.1).

![Participant Flowchart](image)

**Figure 4.1. Participant Flowchart**

- **Participants scheduled for intake face-to-face** $n = 21$
  - Failed to begin program after face-to-face due to individual technology issues $n = 4$
  - Failed to complete program by not attending post program face-to-face $n = 1$
  - Completed entire 30-day DSME Program $N = 16$

**Characteristics**

The participants of the program were an accurate representation of the target clinic. Sixteen participants, 10 female and 6 male with a mean age of 49.9 years ($sd = 12.17$, range 20-66), completed the program. Thirteen of the participants were Caucasian (81.3%), 2 were Hispanic (12.5%), and 1 was African American (6.3%). Their mean length of diabetes type 2 diagnosis was 8.9 years ($sd = 7.56$, range 1-21).
The majority of participants (87.5%) reported at least one co-morbid condition, while only 2 reported no co-morbidities (12.5%) (see Figure 4.2). Hypertension and dyslipidemia were the two most common reported co-morbid conditions (37.5% each). Participant characteristics obtained during the program intake face-to-face meeting also provided information on education and marital status (see Table 4.1).
Figure 4.2. Participant Reported Co-Morbidities
Table 4.1

*Participant Demographic Data (N = 16)*

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<th>Characteristics</th>
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</thead>
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<td>Gender</td>
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</tr>
<tr>
<td>Male</td>
<td>6</td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>13</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2</td>
</tr>
<tr>
<td>African American</td>
<td>1</td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>10</td>
</tr>
<tr>
<td>Gay/Lesbian Partner</td>
<td>1</td>
</tr>
<tr>
<td>Single</td>
<td>2</td>
</tr>
<tr>
<td>Divorced</td>
<td>2</td>
</tr>
<tr>
<td>Widowed</td>
<td>1</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>High School</td>
<td>9</td>
</tr>
<tr>
<td>Associate Degree</td>
<td>1</td>
</tr>
<tr>
<td>Bachelor Degree</td>
<td>4</td>
</tr>
<tr>
<td>Graduate Degree</td>
<td>2</td>
</tr>
<tr>
<td>Mean Duration of Type 2 Diabetes (SD)</td>
<td>8.9 yrs. ( sd 7.56)</td>
</tr>
<tr>
<td>Co-Morbidities</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td>COPD</td>
<td>2</td>
</tr>
<tr>
<td>HTN</td>
<td>6</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>6</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>5</td>
</tr>
<tr>
<td>Auto-immune Conditions</td>
<td>1</td>
</tr>
<tr>
<td>Depression/Anxiety</td>
<td>5</td>
</tr>
</tbody>
</table>
Changes in Primary Outcomes

To assess the effect a 30-day DSME program has on daily blood glucose levels and self-reported diabetes self-management skills, paired sample $t$-tests were done to determine the differences between pre- and post-intervention average daily blood glucose levels and DSMQ’s scores (see Table 4.2). Pre-intervention data were collected at the face-to-face intake visit. Participants were asked to provide their last A1C laboratory result, or it was retrieved from their EHR by the project manager. Participants also completed a pre-program DSMQ at that time. Post-intervention blood glucose data were collected from a daily SMBG log completed during the 30-day program by the participants, with a mean average calculated at program conclusion. A RM-ANOVA was calculated to determine intervention effects at different points in time (see table 4.3). Post-hoc analyses were performed using protected dependent $t$-tests methodology. These analyses provided information about when statistically significant effects on daily average blood glucose occurred.

Blood Glucose Results

Blood glucose measures were obtained from participants’ ($N = 16$) pre-program A1C levels obtained prior to program intake. A1C values were converted to an estimated average glucose (eAG) value using a formula developed by the A1C Average Glucose (ADAG) Study Group ($AG_{mg/dl} = 28.7 \times A1C – 46.7$, $R^2 = 0.84$, $p < 0.0001$) (Nathan et al., 2008). This conversion allowed for more meaningful and accurate comparisons of the DSME program’s effect on daily glucose values. The post-program daily glucose values were obtained from the daily self-monitored blood glucose logs recorded by the participants ($N = 16$). The pre-intervention mean glucose value was 193.8 ($sd = 38.58$), and the post-program mean glucose value was 151.9 ($sd = 28.07$). A paired $t$-test was
Table 4.2.

**Paired Sample t-Test for Blood Glucose Value and Pre- and Post-DSMQ (N = 16)**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pre</th>
<th>Post</th>
<th>M Diff (sd)</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average blood glucose</td>
<td>193.81 (38.58)</td>
<td>151.96 (28.02)</td>
<td>-41.85 (4.395)</td>
<td>15</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>DSMQ Sum Total</td>
<td>6.54 (1.02)</td>
<td>7.33 (1.33)</td>
<td>.794 (1.41)</td>
<td>--2.238</td>
<td>15</td>
<td>.041</td>
</tr>
<tr>
<td>Subscale Glucose Management</td>
<td>7.08 (1.77)</td>
<td>8.50 (1.38)</td>
<td>1.42 (2.25)</td>
<td>-2.512</td>
<td>15</td>
<td>.024</td>
</tr>
<tr>
<td>Subscale Dietary</td>
<td>4.90 (1.58)</td>
<td>5.83 (2.09)</td>
<td>.94 (2.04)</td>
<td>-1.840</td>
<td>15</td>
<td>.086</td>
</tr>
<tr>
<td>Subscale Physical Activity</td>
<td>6.60 (1.31)</td>
<td>6.74 (1.79)</td>
<td>.139 (1.90)</td>
<td>-.293</td>
<td>15</td>
<td>.774</td>
</tr>
<tr>
<td>Subscale Health use</td>
<td>8.40 (1.67)</td>
<td>8.26 (2.18)</td>
<td>-.139 (1.46)</td>
<td>.382</td>
<td>15</td>
<td>.708</td>
</tr>
</tbody>
</table>
Table 4.3

*Post-Hoc t-tests with Means and Standard Deviations for Blood Glucose Values Over Time*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (sd)</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Blood Glucose</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline- Week 1</td>
<td>-42.45 (44.45)</td>
<td>3.819</td>
<td>15</td>
<td>.002</td>
</tr>
<tr>
<td>Baseline</td>
<td>193.81 (38.57)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week1</td>
<td>151.36 (29.55)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week1- Week 2</td>
<td>-.6909 (25.38)</td>
<td>.109</td>
<td>15</td>
<td>.915</td>
</tr>
<tr>
<td>Week1</td>
<td>151.36 (29.55)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week2</td>
<td>150.67 (36.06)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 2- Week 3</td>
<td>2.831 (26.225)</td>
<td>-.432</td>
<td>15</td>
<td>.672</td>
</tr>
<tr>
<td>Week2</td>
<td>150.67 (36.06)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week3</td>
<td>153.50 (29.66)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week 3- Week 4</td>
<td>-1.33 (21.344)</td>
<td>.251</td>
<td>15</td>
<td>.806</td>
</tr>
<tr>
<td>Week3</td>
<td>153.50 (29.66)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Week4</td>
<td>152.16 (33.50)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

calculated to compare the mean pre-program value to the mean post-program value. A statistically significant decrease in the eAG value was found \( t (15) = 4.395, p < .001 \).

To assess for significant eAG changes across the 30-day time span, a one-way repeated measures ANOVA was calculated comparing the weekly mean blood glucose values of participants at five different times: baseline, week 1, week 2, week 3, and week 4. A significant effect was found \( F (4, 60) = 10.5, p < .001 \). Follow-up protected *t*-tests revealed that values decreased significantly from baseline \( m = 193.8, sd = 38.6 \) to
week 1 ($m = 151.4$, $sd = 29.6$). No significant effect was found between week 1 and
week 2 ($m = 150.7$, $sd = 36.1$), week 2 and week 3 ($m = 153.5$, $sd = 29.7$), or week 3
and week 4 ($m = 152.2$, $sd = 33.5$).

**DSMQ Results**

Participants ($N = 16$) completed the DSMQ at the intake face-to-face visit, and
again at the conclusion face-to-face visit (see Appendix A). The DSMQ scale scores
were calculated as a sum of items and then transformed to a scale ranging from 0-10
(raw score/ theoretical maximum score)*10). For example, the sum scale theoretical
maximum score is 48 (total of all 16 questions answered at top score of 3), which is then
divided in to the raw score (actual participant score), and then multiplied by 10. A
transformed score of 10 represented the highest self-rating score possible. This process
was repeated for the sub-scales. Nine of the questions were formulated inversely and
scoring them involved reversing score value so that higher values correspond with more
effective self-care. Paired sample $t$-tests were calculated to compare the mean pre-
intervention DSMQ sum scale ($m = 6.54$, $sd = 1.02$) to the post-intervention DSMQ sum
scale ($m = 7.33$, $sd = 1.33$). This improvement was statistically significant ($t (15) = -2.24$,
$p = 0.041$).

Paired sample $t$-tests were calculated to compare the pre- and post-intervention
DSMQ sub-scales. The subscale category for glucose monitoring skills pre-intervention
scores ($m = 7.08$, $sd = 1.77$) was compared to the post-intervention glucose monitoring
($m = 8.50$, $sd = 1.39$); statistical significance found ($t (15) = -2.51$, $p = 0.024$). The
subscale category for dietary control pre-intervention scores ($m = 4.90$, $sd = 1.58$) were
compared to post-intervention dietary control ($m = 5.83$, $sd = 2.09$), no significance
found ($t (15) = -1.84$, $p = 0.086$). The pre-intervention physical activity ($m = 6.60$, $sd =
1.31$) to post-intervention physical ($m = 6.74$, $sd = 1.79$), no significance found ($t (15) =$
Finally, the pre-intervention healthcare use ($m = 8.40, sd = 1.67$) to post-intervention healthcare use ($m = 8.26, sd = 2.18$), no statistical significance found ($t(15) = .382, p = .708$).

**Patient Satisfaction Results**

All participants ($N = 16$) completed a likert-style patient satisfaction survey at the conclusion face-to-face visit (see Appendix B). The PPPS consisted of 8 questions. Five of the questions were related to participants’ overall satisfaction, including satisfaction with the program, its contents, usability, and applicability to diabetes self-management. The scale ranges from 0 (disagree/dissatisfied) to 4 (Agree/satisfied). The PPPS mean overall satisfaction score was 3.50 ($sd = 0.89$) (see Table 4.4).

The first two questions of the PPPS directly reported the participants’ belief that the material in the program was helpful to them in the management of their diabetes ($m = 3.56, sd = 0.63$), and that the delivery of the program to their web-enabled device made their participation possible ($m = 3.63, sd = 0.86$) (see figures 4.3 and 4.4).

Table 4.4

**Post-Project Participant Survey Mean by Content ($N = 16$)**

<table>
<thead>
<tr>
<th>I found the content of this diabetes educational program helpful in the management of my diabetes.</th>
<th>Having the program content delivered to my phone or other web-based device made it possible for me to participate.</th>
<th>The length of this program was appropriate for the amount of information given.</th>
<th>This program is very user friendly.</th>
<th>I am overall satisfied with this program.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>3.5625</td>
<td>3.6250</td>
<td>3.0625</td>
<td>3.3750</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>.62915</td>
<td>.88506</td>
<td>1.38894</td>
<td>1.14746</td>
</tr>
<tr>
<td>Range</td>
<td>2.00</td>
<td>3.00</td>
<td>4.00</td>
<td>4.00</td>
</tr>
</tbody>
</table>
Figure 4.3 PPPS Question 1 (Responses N = 16)

I found the content of this diabetes educational program helpful in the management of my diabetes.

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Figure 4.4 PPPS Question 2 (Responses N = 16)

Having the program content delivered to my phone or other web-based device made it possible for me to participate.
The remaining 3 questions of the PPPS pertained to program length, content, and the weekly phone call. Participants were asked if they felt the program was too long for its purpose; 87.5% reported they disagreed it was too long (see Figure 4.5). They were also asked if they thought the program was too short for its purpose. They were split at 50% each agreeing and disagreeing (see Figure 4.6). Participants were also asked if they thought the program length was appropriate for the amount of information given; 87.5% reported they agreed it was appropriate (see Figure 4.7). The participants were offered a weekly phone call to clarify any information or questions about the content of the program, or about their diabetes self-management. Only 37.5% of the participants mostly agreed, somewhat agreed, or agreed they needed a weekly phone call (see Figure 4.8).
Figure 4.5. PPPS Question 4

The length of this program is too long for its purpose.

Figure 4.6. PPPS Question 5

The length of this program is too short for its purpose.
Figure 4.7. PPPS Question 6
The length of this program was appropriate for the amount of information given.

Figure 4.8. PPPS Question 3
I needed the weekly phone call to clarify information.
CHAPTER 5
DISCUSSION

The purpose of this EBP was to determine the effect of a 30-day diabetes self-management education program delivered from a patient portal to web-enabled technology in the form of SMS’s on daily average blood glucose levels and self-reported diabetes management skills of adults with diabetes type 2. This chapter provides: a) explanation of the EBP projects findings, b) comparison of outcomes to literature findings, c) evaluation of the application of the CCM as the theoretical framework for this EBP, and d) discussion of the Theory of Innovation as the framework for this EBP project. Finally, this chapter includes the EBP project’s strengths and weaknesses and implications for advanced practice nursing as well as future research.

Explanation of Findings

SMBG results. The primary focus of this EBP project was to determine the effect of a 30-day DSMEP on the average daily blood glucose level of adult patients with diabetes type 2. The participants (N = 16) baseline estimated average glucose (eAG) was determined by obtaining patients’ last reported A1C value of no more than 30-days old, and converting it to a pre-DSMEP estimated average glucose (eAG) value using the A1C Derived Average Glucose Study Group (ADAG) formula (AG mg/dl = 28.7 X A1C – 46.7= eAG) (Nathan et al., 2008). According to the ADA, the use of this conversion allows patients and providers to have meaningful discussions about their SMBG values compared to their A1C values, and allows for better comparison of the two (American Diabetes Association, 2015). That eAG value was compared to the 30-day mean of the participants’ SMBG logs. The SMBG logs consisted of a daily SMBG value of varied times, occurring once daily over the 30-day DSMEP. It is important to note that those logs were kept from day 1 of the intervention, the first day of educational messaging, and
occurred daily throughout the 30-day program. It is for that reason that a RM-ANOVA was completed using weekly SMBG means, to determine at what point in the DSMEP the most significant eAG reduction occurred.

This EBP project produced a statistically significant reduction ($t(15) = 4.395, p < .001$) in the participants’ pre-DSMEP eAG ($193.8$, $sd = 38.58$) compared to their post-DSMEP SMBG values ($151.9$, $sd = 28.07$). This is consistent with findings in the supporting literature. Eight of the 11 included resources measured or addressed A1C values (Cotter et al., 2014; Liang et al., 2011; Nes et al., 2012; Nundy et al., 2014; Pal et al., 2013; U.S. DHHS, 2014; Wade-Venturo et al., 2013; Yeager & Menachemi, 2011), 7 of which reported statistically significant improvement in A1C values. The single study that did not report a statistically significant improvement in A1C with SMS as an intervention suggested a positive trend (Nes et al., 2012).

A RM-ANOVA calculated the SMBG mean at five different times throughout the DSEMP: a) baseline, b) week 1 mean, c) week 2 mean, d) week 3 mean, and e) week 4 mean. It is of interest to note that the most significant reduction occurred between the baseline eAG and the week 1 mean, with the SMBG decrease leveling off and remaining largely the same for the following three weeks. This finding is consistent with the findings from one resource for this EBP. In the meta-analysis by Liang et al. (2011), researchers determined that the longer duration of the intervention, the smaller the significance of A1C improvement. There was a lack of research comparing time of intervention to degree of A1C or SMBG value improvement. This EBP project compared time of intervention against SMBG means to determine if there might be a point of saturation of information when the SMBG value improvement peaks. In retrospect, the most efficient way of comparing knowledge saturation to SMBG improvement would be to repeat the DSMQ at the same weekly intervals as the SMBG mean.
**DSMQ results.** A secondary purpose of this EBP project was to determine if the 30-day education program improved self-care skills as measured by the DSMQ. Secondary outcomes involved participants' self-reported diabetes self-care skills, measured by pre-intervention and post-intervention scores of the DSMQ. The DSMQ's were computed in a sum-scale and sub-scale manner. Developers designed this tool to assess self-care behaviors—dietary control, physical activity, SMBG testing consistency, health care use—that have a positive correlation to glycemic control, noting that a weak association between a self-care assessment instrument and A1C values constitutes major limitations for research (Schmitt et al., 2013). When scored as a full psychometric assessment sum scale (all 16 questions), participants had a statistically significant improvement in their self-care scores. There are four subscales of the DSMQ designed to assess self-care skills in: a) glucose management, b) dietary control, c) physical activity, and d) health-care use.

**DSMQ SMBG management skills.** Participants had a statistically significant improvement in scores on the subscale assessment for glucose management. SMBG pre-Intervention scores ($m = 7.08$, $sd = 1.77$), post- ($m = 8.50$, $sd = 1.39$), with a mean difference of 1.42, which is statistically significant ($t (15) = -2.51$, $p = 0.024$).

In this category, participants are asked if they check and record their SMBG carefully, take their medications as scheduled, or forget to do those activities. Results for dietary control and physical activity, although not statistically significant, were improved from pre- to post-intervention. The dietary category questions related to the types of foods participants chose, behavior of sweets binging, or adherence to dietary recommendations. Physical activity questions prompted participants for physical exercise patterns and behaviors. Participants’ scores in healthcare use did not show any improvement. The resources used for this EBP project supports that self-education
programs delivered to web-enabled devices improves participant-reported self-management skills. This is consistent with the findings of this EBP with the exception of health care use. Additionally, the primary findings of a statistically significant reduction in participants’ mean SMBG values is consistent with the DSMQ developers’ findings of a significant positive correlation between their instrument and A1C values (Schmitt et al., 2013).

Eight of the eleven included resources for this paper reported self-management outcomes pertaining to the above categories (Cotter et al., 2014; Fischer et al., 2012; Nes et al., 2012; Nundy at al., 2014; Nundy et al., 2013; Pal et al., 2013; Wade-Venturo et al., 2013; U.S. DHHS, 2014). SMBG skills, which had a statistically significant improvement in this EBP, were reported in five of the eight resources (Fischer et al., 2012; Nes et al., 2012; Nundy at al., 2014; Nundy et al., 2013; U.S. DHHS, 2014). These researchers found that participants reported performing SMBG testing more often, improving their self-management. For example, in the study by Nes et al. (2012), 9 of 11 participants reported that they check their SMBG more often, and in the study by Nundy et al. (2013), one participant found that consistent self-monitoring of her blood glucose enabled her to better evaluate where she went wrong in her diet if her SMBG levels were elevated stating that, “Now that I regularly check my SMBG, I am more aware of what I eat and how it affects my SMBG values. If my SMBG levels are high, I look at my food diary to see where I went wrong.” In another study by Nundy et al. (2014), participants reported checking their SMBG values 4.9 days per week compared to 4.3 days per week (\( p = 0.03 \)) before the intervention.

In this EBP project, participants were asked to keep a daily record of their SMBG values. They were also given reminders to check their SMBG via SMS. The daily messages contained educational information about monitoring, interpreting, and
intervening based on their SMBG values. For example, during the week focused on physical activity, participants were educated on the effects of exercise on their SMBG values. During the week focused on nutrition, they received a message about sugar alcohols and the effect they have on SMBG values.

**DSMQ dietary changes.** Self-reported dietary control knowledge scores improved in this EBP project, dietary pre-Intervention \((m = 4.90, \text{sd} = 1.58)\), post- \((m = 5.83, \text{sd} = 2.09)\), with a mean score improvement of 0.94 \((\text{sd} = 2.04)\), and although mean results were not statistically significant, 8 of the 16 participants had improved post-intervention dietary scores. Dietary outcomes were reported in 4 of the 11 resources in this paper (Cotter et al., 2014; Nes et al., 2012; Nundy et al., 2014; Pal et al., 2013). All participants \((N = 10)\) in one study with a 3-month design consisting of three daily entries reported feeling more motivated to follow their dietary plan, exercise, and check their SMBG levels more often; although that motivation translated into a reduction in their mean A1C, it was not statistically significant (Nes et al., 2012). Participants in a study conducted by Nundy et al. (2014) self-reported that the intervention improved adherence to a dietary plan \((4.5 \text{ days per week pre-intervention to } 5.2 \text{ days per week post-intervention, } (p = 0.03)\). One systematic review (Pal et al., 2013) consisted of 16 trials, 6 of which looked at self-management of diet. Five of the six studies reported statistically significant improvements in dietary behaviors. Three studies were similar enough to be combined in a meta-analysis finding a statistically significant improvement in the dietary change mean difference with web-based interventions \((\text{SMD} = -0.29 \text{ (95% CI)}\). All three of those studies were 12 months in duration, which may have been the reason for the statistical difference compared to this EBP projects 4-week duration.

**DSMQ physical activity.** Self-reported management of physical activity scores improved in this EBP from pre-Intervention \((m = 6.60, \text{sd} = 1.31)\) to post- \((m = 6.74, \text{sd} = 2.09)\)
= 1.79), with a mean improvement in scores of 0.14 (sd = 1.90). Physical activity knowledge and behaviors were measured in three of the included resources (Cotter et al., 2014; Nes et al., 2012; Pal et al., 2013). In the systematic review conducted by Cotter et al. (2014), researchers reported that eight of the nine studies examined physical activity self-management. Of those eight, five reported an increase in physical activity. All eleven of the participants in the 3-month study by Nes et al. (2012) felt more motivated to exercise as a result of web-based diabetes education. In the Cochrane review by Pal et al. (2013), three studies found an improvement of self-reported physical activity. In all three resources, improvements in self-reported physical activity were found as a result of web-based interventions. Self-reported physical activity improved in this EBP project, but as in the literature, there was not a statistically significant difference. This EBP project was implemented in October and continued until the end of December, possibly accounting for the improvement without statistical significance. The project was implemented in a mid-west state at a time when weather can be unfavorable for outdoor activities. There were no studies available that correlated weather or climate with physical activity behaviors.

**DSMQ Health care use.** Health care use is the one category in which results of this EBP project showed no improvement. Healthcare use pre-intervention mean was 8.40 (sd = 1.67) and post-intervention mean was 8.26 (sd = 2.18) with a mean score reduction of 0.14 (sd = 1.46). However, improvements were reported in four of the eleven resources used for this project (Fischer et al., 2012; Nundy at al., 2013; Wade-Venturo et al., 2013; U.S. DHHS, 2014). The environmental scan by the U.S. DHHS (2014), consisting of seven systematic reviews, included four reviews that measured health care use in relationship to self-management. Three of those four reviews demonstrated improved attendance rates for clinic visits when SMS reminders were
sent, compared to no reminders. In a survey study by Wade-Venturo et al. (2013), use of SMS to schedule appointments positively correlated with lowered A1C values ($p = 0.04$). Finally, in Fischer et al. (2012), participants perceived an improvement in communication with and access to their PCP. All of these behaviors—appropriate appointment scheduling, reduced no shows or cancellations, initiating communications with PCP or office staff with status changes or for information—have all been positively associated with improved A1C values. This EBP project design did not provide appointment scheduling, however, messaging content did include a prompts and reminders category, which encouraged timely dental and eye exams, as well as education on when to seek the advice of their PCP for disease-related problems. One possible explanation for the lack of improvement in the health care use category for this EBP project is the relatively high scores in this topic on the pre-intervention DSMQ ($m = 8.40$, $sd = 1.67$). The pre-intervention mean for health care use was already at a desired level.

**Post-Project Participant Survey results.** Additional findings pertained to participant satisfaction with the 30-day DSMEP. The PPPS consisted of eight questions, five of which reported overall satisfaction with the program. Participants ($N = 16$) overall satisfaction with the program content, usability, and applicability to their self-management was reported as $m = 3.42$ ($sd = 0.84$) (0 = disagree/dissatisfied, 4 = agree/satisfied). Participants were also asked three additional questions: Did they feel the program was either too long for the amount of information presented, did they feel the program was too short for the amount of information presented, and did they feel they needed the weekly phone call to understand or clarify any of the SMS content they received during that week. The majority of participant’s answer to the weekly phone call question was no, they did not feel they needed it to clarify message content, as it was presented in an easily understood format. Seventy-five percent of the participants did not
feel the program was too long, and they were evenly split agreeing or disagreeing that it was too short. This indicates that participants felt they would benefit from a longer program. Although the PPPS did not require participants to elaborate on their reasons for wanting the program longer or shorter, responses from participants in the evidence for this project provide possible explanations. For example, Fischer et al. (2012) reported participants felt comfortable with the intervention, wanted it to continue, and felt it helped them be "more connected" to their PCP. Participants in Nundy et al. (2014) felt that the messages helped them with their self-care. This suggests that having frequent interaction with a healthcare team, a PCP, or a ‘coach’, helps patients be more mindful of and confident in their daily life choices, explaining their desire to continue with the program longer. In fact, of the six studies that addressed participant satisfaction with a SMS intervention, all reported satisfaction to varying degrees (Fischer et al., 2012; Nes et al., 2012; Nundy at al., 2014; Nundy at al., 2013; Pal et al., 2013; Wade-Venturo et al., 2013).

Findings from the evidence are consistent with the findings of this EBP project: SMS as an intervention can improve SMBG values and self-management of diabetes skills, and is delivered in a way that patients can relate to, use easily, and see a value in.

The Chronic Care Model as a Project Framework

The ADA has recommended the use of the Chronic Care Model (CCM) as a strategy for improving diabetes care (ADA, 2014). The CCM promotes evidence-based health care system changes necessary to manage the patient with chronic disease (Stellefson, Dipnarine, & Stopka, 2013). The CCM provides a framework that facilitates self-management and communication between care team, patient, and community. There are six components within the CCM: a) health system, b) community, c) self-management support, d) decision support, e) clinical information systems (CIS), and f)
delivery system design (Siminerio, 2010). All six pillars of the CCM played an integral role in guiding this EBP project.

The CCM’s health system pillar requires that the practice or organization provides structure and commitment to implementation of the project or innovation, be willing to adapt their system as needed, and plan for adoption of the new practice/policy. The target system’s mission statement, and follow-through support that they were a good choice as an EBP project site. They were responsive and assisted with problem solving when technological issues arose.

The CCM’s community pillar helped guide some of the projects message content. The community pillar pertains to resources available to patients, whether that be family, friends, local services, fitness clubs, health care services, available shopping, etc. To be successful in self-care management, one must know their community resources and how and when to access them. For example, one of the messages sent on day 4 explains that most pharmaceutical companies have programs to assist with the cost of medications. On day 2, message content reminds participants to see their dentist every six months.

The self-management support pillar of the CCM was central to this project. Self-management support is aimed at helping patients acquire the self-care skills and knowledge needed to manage their chronic disease on a day to day basis. Self-management includes, but is not limited to, appropriate dietary choices, physical activity, good social habits, medication adherence, self-assessment, and monitoring of health status (Siminerio, 2010). The messages were developed into categories containing information promoting the idea of self-care management. For example, on day 20 participants are taught that if their blood sugar is low, they should consume 15 grams of carbohydrates which is equivalent to 6-8 life savers, 15 skittles, or a ½ cup of fruit juice.
Decision support was also a crucial pillar for the development of this project. The SMS had a two-way communication design, allowing participants to respond to the nurse practitioner’s/project manager’s messages, or initiate a message of their own asking for direction based on SMBG values or for medication adjustment guidance. Much of the SMS content provided education about self-care decisions. For example, day 12 message content teaches that if the SMBG value is low before exercising, consume a snack of 15-30 grams of carbohydrates before the planned activity.

Determining the platform for delivery of the DSMEP was guided by the CIS pillar of the CCM. The success of SMS intervention requires that the delivery platform is interactive between multiple modalities, fostering communication between patients and health care teams (Siminerio, 2010). The CIS for this project had to be one that was already in use by the target health system, or one that the target system was willing to adopt. The CIS in use by the target clinic is equipped with a patient portal, meeting the requirements not only for this project, but for meaningful use, whose launch coincided with project implementation. The current CIS’s capability to meet this EBP projects requirements meant there was more likely sustainability for the program after the EBP projects completion.

The final pillar, delivery system design, also guided project design decisions. The design has to be sustainable, doable, and user-friendly. Using a CIS that was already in place meant that a lot of the technical details had already been addressed. Choosing a web-enabled device as a receiving platform meant that participants had already adopted that technology into their daily life, likely improving their involvement in and sustainability of the EBP project.

The strengths of the CCM as a framework for creating a system that delivers innovative, evidence-based care, and in particular for use with this EBP project’s
innovative technological SMS intervention are: a) all six pillars were applicable to the
design of the project, b) it can apply to other chronic disease management programs
using the same platform, c) it relies on technology to put evidence-based guidelines into
daily practice, which supports its use with technological interventions, and, d) it facilitates
communication between patient and provider, which is applicable to alternate ways of
exchanging information whether that be education, disease management, medication
adherence, or appointment setting through the patient portal in the form of SMS.

The main weakness of the CCM is that it is a relatively young theory and many
health care workers are not familiar with it, thus when projects or programs need to be
altered to improve efficacy, unfamiliarity in following the CCM framework can
compromise any efforts to make improvements. Although not specifically used by the
researchers in this EBP project evidence pool, the ADA recommends the CCM as an
ideal framework for an SMS via web-based technology intervention to enhance the self-
management of patients with diabetes. Unfamiliarity can be easily overcome with staff
education of the CCM and the importance of its use in developing EBP programs.

**Rogers’ Diffusion of Innovation Theory as Implementation Framework**

Rogers’ DOI is commonly used as the theoretical framework for technological
interventions. Rogers defines diffusion as the way in which an innovation is
communicated over a period of time to society (Sahin, 2006). Rogers’ DOI was an
appropriate theoretical framework for this project because it provided rationale for
making design choices that were believed to be easily adopted. There are five attributes
that influence the adoption rate of innovations: a) relative advantage, b) compatibility, c)
complexity, d) trialability, and e) observability.

The delivery of self-management education using SMS via patient portal to a web-
enabled device had to be perceived by participants as a better way to receive needed
information. Not only did asynchronous learning have to have an advantage over traditional face-to-face education, but it had to be delivered in a way that was acceptable and easy to use with technology that patients have already adopted. The newest concept of this EBP project for participants to adopt was the initiation of their patient portal accounts. Once they were walked through that process, all remaining interaction used skills—messaging, logging in to web devices, mobile interaction—that the participants already had prior to this project. The EBP project had compatibility with participants’ current knowledge of and lifestyle with technology and the planned intervention without complexities that would be difficult to overcome. Because the intervention utilizes SMS via web-enabled devices that participants already use on a daily basis, the trialability component of Rogers’ DOI theory had been satisfied. Trialability is the “test drive” of the innovation. Adopters need to be able to experiment with the innovation, try it, and modify it if needed. The observability is the witnessing of positive results with the innovation. Participants were able to see the results as their SMBG levels decreased and their self-care confidence increased.

**EBP Project Strengths and Weaknesses**

The health system’s implementation of ‘meaningful use stage 2’ requirements occurred concurrently with this EBP implementation. This could have been both a strength and weakness. There were technological issues with the use of the patient portal that had to be overcome during EBP implementation, however, resolving these issues resulted in a smoother meaningful use implementation. At times, the emphasis for resolving technical issues was directed towards achievement of meaningful use implementation, however, that technology had to function the same way for both this EBP project and ‘meaningful use’. Resolving ‘meaningful use’ technical issues resolved any technical issues of this EBP project simultaneously, which made the concurrent
implementations a strength. Simultaneous implementation could have potentially directed all IT and administrative resources towards ‘meaningful use’ only since there were financial implications of not meeting the requirements. In fact, the design phase of this EBP project revealed some of the technical issues with the patient portal prior to ‘meaningful use’ implementation, allowing a timely resolution of the issues before going live with ‘meaningful use’.

The design of this project was its main strength. The use of web-enabled technologies like smartphones, tablets, and desktops, which have already been widely adopted for personal use as a way to deliver much needed diabetes self-management education, demonstrates a good use of technology for purposes not yet applied. A second strength of this project was implementing it in a health system that has a mission and commitment to implement innovative, patient-centered care. This commitment of the target health system administration allowed for efficient trouble shooting, and access to resources that might not otherwise have been available or affordable for a small EBP project such as: a) advertisement, b) IT team support, c) access to CIS administrators, d) free use of existing CIS software and technology, and e) support from other providers within the system. Finally, it is a design strength to deliver needed education to a population that is motivated to seek information, participate and learn. A study by Yang et al. (2010) looked at motivations for health information seeking and clinical trial enrollment. The study found optimistic feelings and normative beliefs had a great impact on one’s decision to participate in trials, and affected their information seeking and processing. Patients who tend to feel optimistic about their ability to manage their care with more information are those who typically enroll in clinical trials. Therefore, the participants of this EBP project, as evidenced by existing research, should have been optimistic and motivated to improve their self-management skills beyond participants
who may be enrolled without volunteering as a part of their disease management. Therefore, automatic enrollment of all diabetic patients in a DSMEP may not result in the same degree of SMBG value improvement due to removing the optimism and motivation of the trial volunteer.

One weakness of this project was the information system administrator’s lack of understanding of the patient portal software’s capability. A contracted company, the administrators were implementing meaningful use stage 2 for several clinics throughout the target community. They often had to check with the software creators to resolve technical issues that occurred during implementation. Additionally, the project lost four potential participants due to incompatibility between their web-service providers and the portal. Both of these weaknesses may be due less project design and more to software functionality.

This project manager recognizes that there may have been some selection bias in the EBP project. Participation was open to anyone who fit the inclusion criteria; it was advertised to the community via a billboard, the newspaper, a ‘dinner and discussion’ presentation, and through other PCP’s within the target health systems clinics. However, many of the participants came from the project manager’s own family practice clinic, increasing the potential to encourage participation to patients who were more likely to participate eagerly and give 100% effort to it. There was also potential that reduction in the mean daily blood glucose levels were the result of participant eagerness or motivation to make a change due to the fact that the project manager was also the PCP for the majority of participants (n = 12). As a result, they may have felt pressured to improve their SMBG values, follow dietary guidelines, exercise, and respond to messaging. It is worthy to note though, that in order to affect true behavioral changes, one must be motivated, and that this scenario, although not ideal for original research, is
more true to the actual relationship between patient and provider. The reduction in glucose values could also be attributed to a “looking glass” effect. Knowing that they were being contacted daily may have made them feel supervised and caused them to pay greater attention to their care. Another limitation is the lack of long-term follow-up to see if SMBG improvements continue or regress.

This EBP innovation does require future modifications. The CIS has the capability to schedule future message delivery so that staff does not have to log on daily to send all DSMEP messages, however, this feature is not currently activated. Also, because the EBP project design was two-way messaging, there is the potential for PCP’s to declare that their time is already too sparse, and that responding to patient messages will be too time-consuming. This argument has been addressed by Medicare and Medicaid, who have, through ‘meaningful use’ requirements, mandated that providers or their representatives will communicate with their patients via a patient portal and messaging. Providers who do not comply with this requirement will be at risk of being fined. Support staff, such as MA’s, nurses, or educators are appropriate alternatives to providers to respond to patient messages. In order to assure sustainability for this program, clinic administrators will have to examine ‘work flow’ to determine ‘who’ will respond to ‘what types’ of questions. This type of work flow study is similar to the decisions that are made when determining who is responsible for phone communications or patient calls. The benefit of asynchronous messaging is that personnel are not tethered to a phone during clinic hours, but can begin response to a message, stop to give instructions to a patient in the clinic, and go back to the message without leaving a patient on hold or having to call them back. Having purposeful two-way interaction with patients during an educational program offers the potential to satisfy the ‘meaningful use’ requirements and improve patients’ self-management skills.
The target health system administrative staff (founder, CEO, COO, IT Director) believes that this EBP project will not only work for a DSMEP, but for other chronic disease illness education programs as well as post-operative programs for spinal surgery patients. The administrative staff have identified, as a result of this EBP project, some of the limitations of their current CIS capabilities (i.e., inactivated auto-generated messaging, future capability messaging, and patient-portal malfunctions) and are working with the information network administrators to make improvements. Health care systems are traditionally not eager adopters of technology compared to the mainstream. It’s not uncommon for a health care team members to balk at using CIS’s at work, yet go home with cell phones, mobile internet, and devices with software that manages every aspect of their life.

**Future Implications**

This EBP was designed utilizing the evidence-based process to implement a short-messaging service delivered from a patient portal to a web-enabled device aimed at improving the ability of adult patients to self-manage their diabetes type 2, ultimately improving clinical outcomes. Implementation of EBP projects occurs because of a need to change or improve standards of care or the methodology. This project and its findings have the potential to impact the way in which DSMEP’s are delivered, having future implications for: a) clinical practice, b) theory, c) research, and d) education.

**Clinical Practice**

The current approach to the management of diabetes includes a patient-provider face-to-face visit every 3 to 6 months, wherein patients are given a plan of care, diabetic education, moral support, and a chance to ask questions: all in a 15-20 minute time slot. Health care systems are not adequately responsive to a patient’s efforts to self-manage (Nundy et al., 2012). The advanced practice nurse coordinating and/or providing primary
or specialty care to patients with chronic diseases are ideal stewards of innovative delivery programs, as their profession has a strong foundation in education, patient-centered care, and theory, and their role is typically one that delivers preventive and primary care. It does not take much observation to realize that the mainstream population has moved into a mainly technological web-based lifestyle. Technological innovations for private use have been eagerly adopted, yet health care systems seem to be adoption laggards. APN's can use the platform of this EBP project and adapt it to almost any form of patient education and capture their patients’ attention, interest, and time, affecting chronic care health outcomes in the process. The outcomes of this EBP project suggests this type of innovation is doable and potentially, sustainable. Adoption of web-enabled interventions in clinical practice, using platforms that patients have already eagerly adopted, can have a significant impact on chronic disease care and outcomes.

**Theory**

The CCM is a relatively young theory having only been in use in health care since 2001. Even so, the American Diabetes Association (ADA) Standards of Care has recommended its use as a strategy for improving diabetes care (ADA, 2014). Using the CCM as a framework for future EBP projects will increase the familiarity with this theory. Understanding the theoretical basis for care methodology may improve its efficacy, and improve efforts to implement changes to current standards of care or guidelines. Nursing as a profession has a strong theoretical base for conduct and care delivery. Approaching future care design with theoretical frameworks and EBP models should strengthen future efforts to improve patient outcomes.

**Research**
Although this EBP project produced a statistically significant reduction in mean daily blood glucose values after a 30-day DSMEP, the sustainability of that effect has not been documented. Further research needs to be done to determine if daily blood glucose values remain reduced for periods of time after programs have ended, or if patients revert back to old habits once the SMS has stopped. Secondly, A1C reduction is the marker for good diabetes control, so research that correlates improved self-management skills from SMS intervention to a statistically significant reduction in A1C is needed. Research that examines various aspects of program design, such as intervention length, SMS frequency, communication direction, and education content—should be done comparing various methods to A1C outcomes. There is the potential for future research to determine if multiple methods of education delivery are more effective that SMS alone, such as video messaging, skype interaction, etc.

Education

This project has great promise for the way health care providers deliver education in the future. Approaching patients in a place and at a time that is convenient for them should optimize their efforts to learn. Optimizing the little face-to-face time providers have with patients, focusing on physical assessments, chief complaints, and problem identification, will allow providers to be more proactive in their care delivery. Taking standardized education out of the exam room and sending it to patients’ web-enabled devices makes that possible. Taking health care into the social media and web-enabled technology arena would require that advanced nursing programs prepare NP’s for the ethical and moral issues related to interaction and communication with patients through those technologies.
Conclusions

In summary, the purpose of this EBP project was to design and implement a diabetes self-management education program with an innovative delivery platform that solves the time limitations of the antiquated face-to-face quarterly visit. The EBP involved the implementation of a 30-day DSMEP for adult patients with diabetes type 2, delivered in the form of daily short messaging from a patient portal to a personal web-based device. The goal of this EBP project was to decrease participants’ SMBG daily average compared to the pre-project daily blood glucose average and positively affect patients’ self-care knowledge and behaviors, demonstrated by their pre- and post-intervention scores on the DSMQ.

Results of this EBP included a statistically significant reduction in participants’ mean daily blood glucose level. Participants’ self-management skills showed a statistically significant improvement between pre- and post-intervention in the overall self-care and glucose management categories, and showed slight improvement in dietary management and physical activity skills. Participants entered the DSMEP with an existing high score for health care use, so improvement in this category was not expected. Participants reported that the program content was applicable to their diabetes self-management efforts and that the use of SMS enabled them to participate in education, removing the barriers of traditional diabetes self-management education programs such as a) time constraints, b) willingness to participate, and c) application to the daily aspects of self-care (Wilkinson et al., 2014). In addition to improving SMBG values and self-management skills, this EBP has the potential to improve patients’ perception of social support, modify their health behaviors, and improve their interaction with health systems, thereby increasing their overall self-efficacy.
REFERENCES


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Ms. Holcomb graduated from Lake Michigan College with a Licensed Practical Nursing certificate in 1998 and her Associate of Science in Nursing in 2002. She worked in a variety of hospital and long-term care settings before returning to earn her Bachelor of Science in Nursing degree from Bethel College in 2004. Ms. Holcomb developed her leadership skills as a patient care coordinator for a hospice organization and then found her passion in a family practice clinic as the clinical manager. This experience led Ms. Holcomb to pursue her Master of Science in Nursing from the University of Saint Francis. She received her MSN in 2008, becoming an AANP-certified family nurse practitioner. Ms. Holcomb has developed advanced skills in the management of diabetes. She has completed post-graduate certificate work at the University of Southern Indiana in Advanced Diabetes Management. Ms. Holcomb plans to become board certified in advanced diabetes management (BC-ADM) aiming to develop evidence-based technologies designed to support adults with diabetes in their self-management efforts.

Ms. Holcomb is a member of Phi Theta Kappa, Sigma Theta Tau International-Nu Omnicron chapter, AANP and CAPNI. She is employed by Unity Medical and Surgical Center, practicing at Unity Family Practice on Fulmer Road.
ACRONYM LIST

ACA: Affordable Care Act
ADA: American Diabetes Association
ADAG Study Group: A1C Derived Average Glucose
A1C: Glycosylated hemoglobin
CCM: Chronic Care Model
CIS: Clinical Information System
CDM: Chronic Disease Management
DSME: Diabetes Self-Management Education
DSMEP: Diabetes Self-Management Education Program
DSMQ: Disease Self-Management Questionnaire
eAG: Estimated Average Glucose
EBP: Evidence-Based Practice
EHR: Electronic Health Records
Health IT: Health Information Technology
RM-ANOVA: Repeated Measures Analysis of Variance
SMBG: Self-Monitored Blood Glucose
SMS: Short Messaging Service
# Appendix A

## Diabetes Self-Management Questionnaire

The following statements describe self-care activities related to your diabetes. Thinking about your self-care over the last 8 weeks, please specify the extent to which each statement applies to you.

<table>
<thead>
<tr>
<th></th>
<th>Applies to me very much</th>
<th>Applies to me to a considerable degree</th>
<th>Applies to me to some degree</th>
<th>Does not apply to me at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I check my blood sugar levels with care and attention.</td>
<td>□ 3</td>
<td>□ 2</td>
<td>□ 1</td>
<td>□ 0</td>
</tr>
<tr>
<td>2. The food I eat makes it easy to achieve optimal blood sugar levels.</td>
<td>□ 3</td>
<td>□ 2</td>
<td>□ 1</td>
<td>□ 0</td>
</tr>
<tr>
<td>3. I keep all clinical appointments recommended for my diabetes treatment.</td>
<td>□ 3</td>
<td>□ 2</td>
<td>□ 1</td>
<td>□ 0</td>
</tr>
</tbody>
</table>
| 4. I take my diabetes medication as prescribed (e.g. insulin, tablets).
   or □ I am not required to take any diabetes medication for my treatment. | □ 3 | □ 2 | □ 1 | □ 0 |
| 5. Occasionally I eat lots of sweets or other foods rich in carbohydrates. | □ 0 | □ 1 | □ 2 | □ 3 |
| 6. I record my self-monitored blood glucose levels regularly (daily). | □ 3 | □ 2 | □ 1 | □ 0 |
| 7. I tend to avoid diabetes-related clinical appointments. | □ 0 | □ 1 | □ 2 | □ 3 |
| 8. I do regular physical activity to achieve optimal blood sugar levels. | □ 3 | □ 2 | □ 1 | □ 0 |
| 9. I strictly follow the dietary recommendations given by my provider or diabetes specialist. | □ 3 | □ 2 | □ 1 | □ 0 |
| 10. I do not check my self-monitored blood glucose levels frequently enough as would be required for achieving optimal blood glucose control. | □ 0 | □ 1 | □ 2 | □ 3 |
| 11. I avoid physical activity although it would improve my diabetes. | □ 0 | □ 1 | □ 2 | □ 3 |
| 12. I tend to forget to take or I skip my diabetes medication (e.g. insulin, tablets).
   or □ I am not required to take any diabetes medication for my treatment. | □ 0 | □ 1 | □ 2 | □ 3 |
| 13. Sometimes I have real food binges (not caused by hypoglycemia). | □ 0 | □ 1 | □ 2 | □ 3 |
| 14. Regarding my diabetes care, I should see my medical practitioner(s) more often. | □ 0 | □ 1 | □ 2 | □ 3 |
| 15. I tend to skip planned physical activity. | □ 0 | □ 1 | □ 2 | □ 3 |
| 16. My diabetes self-care is poor. | □ 0 | □ 1 | □ 2 | □ 3 |

## Appendix B
### Post-Project Participant Survey

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree</th>
<th>Mostly Agree</th>
<th>Somewhat Agree</th>
<th>Mostly Disagree</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I found the content of this diabetes educational program helpful in the management of my diabetes.</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2. Having the program content delivered to my cell phone or other web-based device made it possible for me to participate.</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>3. I needed the weekly phone call to clarify information.</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>4. The length of this program is too long for its purpose.</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5. The length of this program is too short for its purpose.</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>6. The length of this program was appropriate for the amount of information given.</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>7. This program is very user-friendly.</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>8. I am overall satisfied with this program.</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Day</td>
<td>Message:</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>-----</td>
<td>----------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td><strong>Diabetes Information:</strong>&lt;br&gt;And ideal SMBG fasting blood glucose value ranges from 80-126.</td>
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<tr>
<td>2</td>
<td>Beta cells, from the pancreas, make and release a hormone called insulin.</td>
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<tr>
<td>3</td>
<td>When you eat the pancreas releases another hormone called GLP-1.</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>GLP-1 helps the beta cells to release insulin when blood sugar is too high.</td>
<td></td>
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<tr>
<td>5</td>
<td>Insulin made by the pancreas may not be used efficiently by cells in the body.</td>
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<tr>
<td>6</td>
<td>Many people with Diabetes type 2 have lost 50% of their beta cell function by the time they are diagnosed.</td>
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</tr>
<tr>
<td>7</td>
<td>Diabetes can negatively affect the eyes, kidneys, feet, skin, and nerves over time.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td><strong>Physical Activity:</strong>&lt;br&gt;The American Diabetes Association recommends 150 minutes of physical exercise a week for improved glycemic control.</td>
<td></td>
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<tr>
<td>9</td>
<td>To calculate your heart rate target subtract your age from 220, then, 220-age x 0.65= 65% of target heart rate, or 220-age x 0.95= for 95% of target heart rate.</td>
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<td></td>
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</tr>
<tr>
<td>10</td>
<td>Physical activity can result in low blood sugar, always carry a source of carbohydrates with you.</td>
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<tr>
<td>11</td>
<td>Aim to keep your blood glucose level in the range of 100 to 150 while exercising.</td>
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<td></td>
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<tr>
<td>12</td>
<td>If your blood glucose is below 100 before you exercise eat a snack of 15 to 30 grams of carbohydrates before you begin.</td>
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<tr>
<td>13</td>
<td>Strength training burns glucose as fuel, raises metabolism, and helps build muscle (e.g. lifting weights, resistance bands, Pilates).</td>
<td></td>
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<tr>
<td>14</td>
<td>An exercise session can lower your SMBG values for up to 72 hours.</td>
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</tr>
<tr>
<td>15</td>
<td><strong>Sick Days:</strong>&lt;br&gt;Did you know that stress can increase your blood sugar?</td>
<td></td>
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<tr>
<td>16</td>
<td>If you are too ill to eat regular food drink a liquid or eat a snack of 10 to 15 grams of carbohydrates every one to two hours (e.g. 4 oz. regular gelatin, 4 oz. applesauce, 8 oz. sport drink).</td>
<td></td>
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<tr>
<td>17</td>
<td>Take your diabetic medications as prescribed even when you are ill.</td>
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<td></td>
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</tr>
<tr>
<td>18</td>
<td>Numbness or tingling around your mouth and lips can be a sign of hypoglycemia. “Diabetes burnout” can occur as a result of the day to day management of your diabetes.</td>
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<td></td>
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</tr>
<tr>
<td>19</td>
<td>If you notice you feel less desire to maintain your care, or are angry or depressed, call your provider for an appointment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>If your SMBG level is low, take 15 grams of carbohydrates (e.g. 6-8 life savers, 15 Skittles, ½ cup fruit juice).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Nurture yourself spiritually, emotionally, and mentally. Be your own best friend.</td>
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<tr>
<td>22</td>
<td><strong>Nutrition:</strong>&lt;br&gt;For an adult who does 150 minutes of activity weekly, eat 15 calories for every pound of weight (e.g. 160 lb. somewhat active adult should consume 2,400 calories to maintain weight).</td>
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<td>23</td>
<td>An 1800 calorie diet should contain 209 total daily carbs, 8 from starches, 3 from fruits, 2 from dairy products, and 4 from vegetables. It should also contain 7 oz. of meats and 7 servings of fats.</td>
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<td>24</td>
<td>Sugar alcohols are used in some sugar-free candies, gum, and desserts. They can cause your SMBG level to rise and cause extreme stomach irritation. Use cautiously.</td>
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<td>25</td>
<td>The ADA recommends adults eat 25-30 grams of fiber daily.</td>
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<tr>
<td>26</td>
<td>Diabetics should not fast to lose weight.</td>
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<tr>
<td>27</td>
<td>There are three types of carbohydrates; 1) sugars, 2) starches, and 3) fibers.</td>
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<td>28</td>
<td>A meal high in unhealthy fats can interfere with insulin action and affect SMBG values.</td>
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<td>29</td>
<td><strong>Other:</strong>&lt;br&gt;Smoking makes diabetes control more difficult.</td>
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<td>30</td>
<td>Adults with diabetes type 2 should have a dental exam every 6 months.</td>
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</tbody>
</table>
Appendix D
Prompts and Reminders Short Messages

Once Every Six Days Short Message
Category: Prompts and Reminders

<table>
<thead>
<tr>
<th>Day</th>
<th>Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Did you remember to take your prescribed medication today?</td>
</tr>
<tr>
<td>6</td>
<td>Have you been logging your SMBG values?</td>
</tr>
<tr>
<td>11</td>
<td>Have you seen the eye doctor this year?</td>
</tr>
<tr>
<td>16</td>
<td>Have you checked your feet for open areas or dry skin or cracks?</td>
</tr>
<tr>
<td>21</td>
<td>Have you been logging your SMBG values?</td>
</tr>
<tr>
<td>26</td>
<td>Did you receive your flu vaccine this year?</td>
</tr>
</tbody>
</table>