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Text Message Intervention for Latino Adults To Improve Diabetes Outcomes in an Urban Free Clinic Setting

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by

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Approval Page

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Abstract

Introduction**:** This text message intervention sought to help patients at a free clinic in the Southeastern U.S. that have uncontrolled diabetes (DM) (A1C > or = 7) improve their DM clinical and behavioral outcomes, and thereby help them to live healthier, more hopeful and productive lives as they deal daily with this chronic illness. Eight weeks of educational text messages were sent to help improve DM care and outcomes.

Method**:** Free clinic patient Latino adults with DM (n=25) pre-post one group design.

Results**:** Statistically significant results ($p < .05$) were seen in three (SKILLD, p=.001, DSES, p = .000, and SDSCA, p = .042) of the four tools/surveys administered. A1C improvements were significant from the pre-intervention (M = 9.10, SD = 1.51) and the trended post-intervention values/results (M=8.26, SD = 1.29, t [21] = 2.79, p = .0110).

Discussion**:** Does personalized communication, education and follow up for patients at the free clinic improve diabetes knowledge, self-efficacy and self-care? This text message intervention shows great promise to improve outcomes for diabetes self-management.

Keywords: diabetes, Latino, text message, free clinic, self-efficacy

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SECTION I

Problem Recognition

Identified Need

Diabetes and pre-diabetes are problems in the world, in the Unites States (US), in North Carolina (NC), in Charlotte, and in the Latino free clinic patient population. Diabetes is either the lack of enough insulin production in the body (type 1) or inability to use the insulin produced/resistance to the insulin produced (type 2). The World Health Organization (WHO) indicates that the prevalence of diabetes has been rising more rapidly around the world in middle and low income countries, and it is estimated that diabetes will be the 7th leading cause of death by 2030 (WHO, 2016). Diabetes is now the 7th leading cause of death in the US and the increasing prevalence is considered an epidemic (Centers for Disease Control [CDC], 2016). The CDC estimates that by 2050 one in three US adults will have diabetes (CDC, 2016). Major complications of uncontrolled diabetes are heart attacks, strokes, blindness, amputations, end-stage kidney disease, and deaths due to high blood sugar (CDC, 2016).

Diabetes is a problem in North Carolina and is the 7th leading cause of death in NC. In North Carolina there are 750,000 people (one in ten) diagnosed with diabetes, and an estimated 280,000 have pre-diabetes. As of 2015, 9.6 % of North Carolinians are diagnosed with diabetes (CDC, 2017).

In Mecklenburg County, NC, 8.5% of the population is diagnosed with diabetes (CDC, 2013), and it is the ninth leading cause of death (Mecklenburg County Government, 2017). Two of the top four issues identified as priorities by Mecklenburg County residents are chronic disease prevention and access to care (Mecklenburg County

Government, 2017a), and both of these are directly related to diabetes. In 2000, six percent of the population of Mecklenburg County was of Hispanic origin, and by 2014, the percentage was almost double-at 13% (Pew Research Center, 2017a). Between 2000 and 2012, the Hispanic race had an increase of 149%, the highest rate of growth of any race in the county (Lancaster-Sandlin, 2013, p. 35).

The DNP project setting is a free clinic in Mecklenburg County, North Carolina, and is one of the few that specifically serves the Spanish-speaking population. Eight free or low cost clinics serve the approximately one million residents of Mecklenburg County (Lancaster-Sandlin, 2013, p.15). In 2012, 16.5% of Mecklenburg County was uninsured and 8.3% of the population had limited English proficiency (Lancaster-Sandlin, 2013, p. 42). Diabetes is a problem at one of the free clinics in Charlotte that serves about 2,000 mainly Spanish-speaking patients. Approximately 200 of the clinic patients have diabetes.

Problem Statement

1. Latino adults with diabetes at the free clinic have poor diabetes control.
2. Diabetes control in the Latino patient is poor because of increased risk due to ethnicity/race, less access to care, low health literacy and other barriers.
3. The staff at the free clinic do not have the resources to provide face-to-face educational and social support to their patients with diabetes.

Literature Review for Best Practice

A database search was conducted to review the literature. A University library Bulldog One search simultaneously searched multiple databases with the search terms diabetes and text message and diabetes and short message service (SMS): Cumulative

Index of Nursing and Allied Health (CINAHL) Plus, PsycINFO, MEDLINE, Library, Information Science & Technology Abstracts, Science Direct, Family and Society Studies Worldwide, and the Directory of Open Access Journals. Articles from various publishers were obtained: JMIR publications, Biomed Central, Elsevier Science, Wiley-Blackwell, Springer Science and Business Media, and Mary Ann Liebert, Inc. Articles were located from the last 10 years (2007-2017) that were full-text and peer reviewed. A total of 103 articles were located for diabetes and text message, and 14 articles were retrieved for the search terms of diabetes and short message service (SMS). Twenty-five duplicate articles were removed. The remaining articles (92) were reviewed for relevance for the topic of diabetes and text messaging/SMS and nine additional articles were retrieved from reference lists. Five relevant systematic reviews were retrieved from the Cochrane database of systematic reviews with the terms diabetes (four) and mobile phone (one).

Diabetes Standards of Care

The American Diabetes Association (ADA) publishes a yearly update of the Standards of Medical Care in Diabetes. The first chapter in the ADA Standards of Medical Care in Diabetes (2017) gives guidance for the DNP project and interventions at the free clinic. The free clinic setting is a safety net for those who do not have insurance and cannot get care at other clinics or locations. The diabetes standards have four recommendations that directly apply to the free clinic population group. The title of the first chapter is Promoting Health and Reducing Disparities in Populations and the four recommendations in this chapter are:

1. Treatment decisions should be timely, rely on evidence-based guidelines, and be made collaboratively with patients based on individual preferences, prognoses, and comorbidities. B
2. Providers should consider the burden of treatment and self-efficacy of patients when recommending treatments. E
3. Treatment plans should align with the Chronic Care Model, emphasizing productive interactions between a prepared proactive practice team and an informed activated patient. A
4. When feasible, care systems should support team-based care, community involvement, patient registries, and decision support tools to meet patient needs. B (ADA, 2017, p. 6).

The ADA Standards of Care levels of evidence are graded A=Randomized Controlled Trial (RCT), B=Well conducted cohort studies, C= Poorly controlled or uncontrolled studies, E= Expert consensus or clinical experience (ADA, 2017, p. 2). The American Diabetes Association, the American Association of Diabetes Educators (AADE), and the Academy of Nutrition and Dietetics have a joint position statement for diabetes self-management education (Powers et al., 2015), and these standards contain the elements necessary to be included in a text messaging intervention for improvement of diabetes outcomes. These recommendations will be followed as part of this DNP project text message intervention at the free clinic with Spanish-speaking patients with uncontrolled diabetes. A text message intervention will help the clinic to meet the four recommendations from the first chapter of the ADA 2017 Standards of Medical Care in Diabetes.

Diabetes Self-Care and Self-Management

People with diabetes do more than 95% of their own self-care (Funnell & Anderson, 2000). For those persons on oral diabetes medications that check their blood sugar once daily, it is estimated that it takes around 143 minutes per day for completing diabetes self-care behaviors/tasks (Russell, Suh, & Safford, 2005). Physiological (glycemic control) and behavioral (diet, physical activity, blood glucose self-monitoring, and medication adherence) outcomes are key outcomes for diabetes self-management and self-care. Therefore, interventions directed at improving self-care are of vital importance. Standards of care for diabetes explain that persons with diabetes should see their provider every three months for a check on their progress with their diabetes and have a goal to improve their diabetes management as reflected in hemoglobin A1C (A1C). Keeping diabetes-related lab tests (glucose, A1C, lipid panels, etc.) within normal range helps to decrease the possibility of microvascular complications (retinopathy, nephropathy, and neuropathy) and macrovascular complications (heart disease, stroke, peripheral vascular disease) of diabetes (ADA, 2017). Diabetes self-management education (DSME) is the recommended education for efficacious self-care (ADA, 2017; Powers et al., 2015; Saffari, Ghanizadeh, & Koenig, 2014). The ADA identifies lifestyle management as the foundation of diabetes care, and says that lifestyle management includes "DSME and diabetes self-management support, nutrition therapy, physical activity, smoking cessation counseling, and psychosocial care" (ADA, 2017, p. 33). For optimal outcomes, the person with diabetes needs to know how to balance many self-care tasks such as using a glucometer, taking medications, giving insulin injections, following a diabetic diet, exercising and doing daily foot care. Newer technologies (Connelly, Kirk, Masthoff, &

MacRury, 2013) such as mobile phone apps (Cadburnay et al., 2015), text messages/short message service (SMS) and computerized web-based sites (Cassimatis et al., 2015; Yu et al., 2014) have been able to reach more people with individualized, culturally appropriate, health literacy sensitive diabetes education.

Health information technologies (including mobile phone interventions through text messaging/SMS) showed improvements in diabetes self-management in multiple systematic reviews and meta-analyses (Liang et al., 2011; Orr & King, 2015; Pal et al., 2013; Harrison, Stadler, Ismail, Amiel, & Herrmann-Werner, 2014; Saffari et al., 2014), and noted that these technologies are a cost-effective way to deliver DSME and diabetes self-management training (Fitzner, Heckinger, Tulas, Specker, & McKoy, 2014; Krishna, Boren, & Balas, 2009). Improved self-efficacy, A1C, positive behavior change, and improved diabetes self-management through mobile phone interventions were noted by Holtz and Lauckner (2012). Appointment attendance improvement and improvement in clinical and behavioral outcomes through text messaging in patients with diabetes were the focus of Nuti et al. (2015) and Gurol-Urganci, De Jongh, Vodopivec-Jamsek, Atun, and Car (2013).

Diabetes and Latinos/Hispanics

Minorities have a higher chance of having diabetes. Hispanics or Latinos are terms used to denote an ethnic group from the Spanish-speaking countries of Spain, Mexico, Central and South America (Gonzalez-Barrera & Lopez, 2015). Latino refers to those from Mexico, Central and South America, versus those that trace their ancestry directly from Spain (Hispanics). Both terms are used interchangeably in this paper. Hispanics are almost twice as likely to be diagnosed with diabetes as compared to non-

Hispanic whites (CDC, 2016). Hispanics have a 12.1% chance of having diabetes versus 7.4% for non-Hispanic whites (CDC, 2017). The US Census Bureau (2015) projects that by 2060 about one fourth (29%) of the US population will be Hispanic or Latino. The 2010 US Census identified Hispanics or Latinos as the largest minority in the US (US Census Bureau, 2010). In North Carolina 9% of the population of the state is of Hispanic origin (Pew Research Center, 2017b). Interventions are a necessity to improve the health of this ethnic group.

Text Messaging and Mobile Phone Technology

The push for electronic health records has escalated the use of technology in chronic disease management with diabetes (Health IT Buzz, 2011). As early as 2008, text messaging was identified has having great utility in health care (Terry, 2008). Text messaging was identified in 2011 by the National Institutes of Health (NIH) as an area that needed to be more fully utilized in diabetes management (Health IT Buzz, 2011). Mobile health has been used for health promotion and disease prevention and treatment compliance with diabetes and other chronic diseases (U.S. Department of Health and Human Services, 2014).

Mobile phones are ubiquitous in society. There are over 165,000 health related apps for mobile phones (Misra, 2015). Mobile health or m-Health is using the smartphone for the purposes of improving healthcare (Cadburnay et al., 2015). M-Health is “the delivery of healthcare services via mobile communication devices" (Healthcare Information and Management Systems Society, 2017). Text messaging/short message service (SMS) on mobile phones is widely used and is an effective platform for chronic disease management to improve health outcomes. Text messaging is connected to

positive impacts on chronic disease management (Hamine, Gerth-Guyette, Faulx, Green, & Ginsburg, 2015) and encouragement for healthy lifestyle changes. Telehealth phone calls have been used for many years for disease prevention, health promotion and disease management.

Text messaging has been found to be a low cost intervention in developing countries with those who have a mobile phone, that otherwise may not have access to health care (World Health Organization, 2011). Short message service (SMS) is the term most frequently used for text messaging in many countries outside of the US. One systematic review and meta-analysis concluded that the SMS interventions were more effective in low income than high-income countries (Arambepola et al., 2016). Articles about effective SMS interventions are based in Iran (Fatehi, Malekzadeh, Akhavimirab, Rashidi, & Afkhami-Ardekani, 2010; Peimani et al., 2016; Zolfaghari, Mousavifar, Pedram, & Haghani, 2012), Bangladesh (Fottrell et al., 2016), Bolivia (Piette et al., 2014), India (Pfammatter et al., 2016; Shetty, Chamukuttan, Nanditha, Raj, & Ramachandran, 2011), Pakistan (Siddiqui et al., 2015), Congo, Cambodia, and the Philippines (Van Olmen et al., 2013), Hong Kong, China (Wong et al., 2013, 2016), Turkey (Sezgin & Cinar, 2013), UK (Barley et al., 2014), South Africa (Bobrow et al., 2014), and New Zealand (Dobson et al., 2016). All of these studies demonstrated that people in low-income countries highly benefitted from SMS/text messages to promote self-efficacy and improved self-care and self-management of diabetes. One could extrapolate that the SMS messages would also highly benefit people of low income living in the US.

The Pew Research Center (2017b) reports that racial and ethnic minorities (African Americans and Latinos) are prone to use smartphones for health information and educational information. Mobile apps that take into account health literacy levels are needed for persons with diabetes (Cadburnay et al., 2015).

SECTION II

Needs Assessment

Expanded Literature Review of Text Message Interventions for Best Practice

Systematic Review or Meta-Analysis

Twenty-four systematic reviews or meta-analyses (level I evidence) from 2007 to 2017 were located that included the search terms of diabetes and text message/SMS. Systematic reviews validate the use of SMS/text messaging to improve diabetes outcomes. One of the reviews focused on chronic diseases to assess the impact text messaging played to improve adherence and outcomes for diabetes, hypertension, COPD, asthma, HIV and other chronic diseases (Hamine et al., 2015). Positive healthy behavior change and improved quality of life for persons with diabetes through text messaging/SMS was addressed by Fjeldsoe, Marshall, and Miller (2009), Cole-Lewis and Kershaw (2010), Orr and King (2015), Fitzner et al. (2014), Arambepola et al. (2016), and Krishna et al. (2009). Sarabi, Sadoughi, Orak, and Bahaadinbeigy (2016) and Farmer et al. (2016) noted that medication adherence can be improved by mobile phone text messaging with people that suffer from chronic diseases, and specifically with those who are diagnosed with diabetes.

Cochrane Library systematic reviews validate effective interventions in diabetes management. One review explains the positive benefits on blood sugar control by computer, internet, and mobile device based interventions for diabetes self-management for adults with type 2 diabetes (Pal et al., 2013). Culturally appropriate education is needed for improved outcomes in people in ethnic minority groups with type 2 diabetes (Attridge, Creamer, Ramsden, Cannings-John, & Hawthorne, 2014), and this includes

education given through text messages. A Cochrane systematic review by Renders et al. (2000) indicated that nurses play an important role in patient-oriented interventions used in primary care, outpatient and community settings to improve the management of diabetes. Shi (2013) indicates that mobile phone messages do facilitate the self-management of chronic diseases.

Besides the Cochrane systematic reviews, there were over a dozen other systematic reviews or meta-analysis articles that explained the positive impact of SMS/text message interventions on diabetes outcomes. Two systematic reviews from 2009 discussed the use of cell phones and text messaging. Krishna et al. (2009), based out of Missouri, concluded, "cell phone voice and SMS can help improve health outcomes and care processes" (p. 231). Fjeldsoe et al. (2009), from Australia, concluded that "SMS-delivered interventions have positive short-term behavioral outcomes" (p. 165).

A meta-analysis from 2011 looked at the effect of mobile phone interventions for diabetes and their effect on glycemic control. Of the 22 trials included in the analysis, 12 were studies of both SMS and internet, and eight looked at SMS alone or SMS combined with other technology interventions (e.g. Bluetooth, glucose monitoring devices), and two compared mobile phone interventions and internet-based care. The conclusion was that there was "strong evidence that mobile phone intervention(s) led to statistically significant improvement(s) in glycaemic control and self-management in diabetes care, especially for Type 2 diabetes patients" (Liang et al., 2011, p. 455).

A systematic review by Holtz and Lauckner (2012) looked at diabetes management via mobile phones. In the 21 studies analyzed, improvements were noted in self-efficacy, A1C levels, and self-management behaviors. The study concluded that the

articles “showed promise in using mobile phones to help people with diabetes manage their condition effectively” (p. 175).

Systematic reviews about diabetes and technology published in 2014 were from England, Iran, and the US. The systematic review from England looked at 26 studies and looked at patient satisfaction and concluded that “high satisfaction was seen with almost all devices and correlated strongly with ease of use and improved diabetes management” (Harrison et al., 2014, p. 771). A systematic review and meta-analysis from Iran identified 10 studies that dealt with health education via text messaging, and concluded that “diabetic self-management education through text messaging has a considerable effect on glycemic control” among those with type 2 diabetes (Saffari et al., 2014, p. 283). A systematic review by authors from Chicago, Illinois, summarized that “the literature suggests that telehealth technology serves as an important platform for the delivery of diabetes self-management education and training and offers tools that help people learn, self-monitor and change their behavior” (Fitzner et al., 2014, p. 1890). In relation to those patients with diabetes that have “poor access to care or social barriers that constrain their access, telemedicine can be a particularly effective tool” (Fitzner et al., 2014, p. 1891).

A literature review of text messages in health care reported that 77% of the studies showed improved quantitative or physiological (e.g. A1C, weight) and qualitative (e.g. behavioral and lifestyle changes) outcomes (Kannisto, Koivunen, & Valimaki, 2014). Text messages were the sole intervention in 73% (44 of 60) of studies. The two most common groups to have a text message intervention in this report were HIV/AIDS (9 of 60) and diabetes (8 of 60) (Kannisto et al., 2014).

Systematic or literature reviews or meta-analyses were completed in 2015: from the United States (Nuti et al., 2015; Hamine et al., 2015); from the United Kingdom (Farmer et al., 2016); and from Australia (Orr & King, 2015). Nuti et al. (2015), from Boston, Massachusetts, looked at the impact of interventions on appointment and clinical outcomes in 77 different articles for people with diabetes. This literature review, that included SMS reminders, concluded that "simple phone and letter reminders for scheduling or prompting of the date and time of an appointment to more complex web-based multidisciplinary programs with patient self-management can have a positive impact on clinical and behavioral outcomes for diabetes patients" (Nuti et al., 2015, p. 1).

Hamine et al. (2015) looked at 107 articles with mHealth (mobile health) interventions on chronic disease management and found that SMS was "the most commonly used mAdherence tool" in about one half of the studies (42/107). MHealth interventions were evaluated for usability, feasibility and acceptability, and "automated reminders, text messages with educational and motivational content, healthy living challenges and wireless transmission of data contributed to increased self-care awareness and knowledge about chronic diseases" (Hamine et al., 2015, p. 7). This study concluded that:

> Vulnerable, hard-to-reach, or otherwise high-risk patient populations were the t target audiences for several mAdherence interventions. There is a clear recognition that mHealth tools have the potential to impact patients who are less inclined to engage traditional health service, mAdherence offers a way to address barriers to care and to reduce health disparities (Hamine et al, 2015, p. 9).

A systematic review and meta-analysis from 2015 from the United Kingdom looked at 11 trials that had interventions for medication adherence. The three trials that were based exclusively on text messaging showed improved medication adherence, but the statistical significance was not clearly shown (Farmer et al., 2016). In Australia, a meta-analysis of 38 randomized controlled trials focused exclusively on text/SMS messages. The meta-analysis concluded that the "effect of SMS messaging is robust, regardless of population characteristics or healthy behavior targeted. SMS messaging is a simple, cost-effective intervention that can be automated and can reach any mobile phone owner" (Orr & King, 2015, p.1).

A systematic review from the United Kingdom looked at the impact of messaging to promote lifestyle changes for people with type 2 diabetes. Of the 15 trials and 15 interventions included, nine were one-way text messages and six were two-way text messages. There was a difference of -0.53% in the A1C in the intervention as compared to the control groups (Arambepola et al., 2016). Faruque et al. (2017) conducted a systematic review and meta-analysis of 111 randomized trials that discussed telemedicine interventions. This systematic review concluded that use of web portals or text messaging showed the greatest improvement in A1C.

A systematic review extolled the positive impacts and statistical significance of text message interventions for improvement in clinical and behavioral outcomes with chronic diseases (Fjeldsoe et al., 2009) and specifically with improvements in A1C with diabetes (Nuti et al., 2015; Liang et al., 2011; Saffari, et al., 2014). Very few of the studies evaluated in the systematic reviews showed that a small number of studies had the

usual care group show greater improvements in A1C than the intervention groups (Faruque et al., 2017).

Randomized Controlled Trials of Diabetes and Text Message/SMS Interventions

Randomized controlled trials (RCT) have shown that mobile phones are useful to improve diabetes self-management behaviors and outcomes (Buis et al., 2013). Over 25 RCTs that have diabetes and text message/SMS interventions were located in the Bulldog One database search. All studies include A1C as an outcome measure.

Randomized controlled trials (level II evidence) and pilot studies using text messages/SMS support positive impacts on chronic diseases (Atarodi, RahmaniBeilondi, RahmaniBeilondi, Bondar, & Bagheri, 2013; Bobrow et al., 2014; Kamal et al., 2015; Kozak et al., 2017). Text messaging has also been used effectively with teens with type 1 diabetes (Franklin, Waller, Pagliari, & Greene, 2006; Franklin, Greene, Waller, Greene, & Pagliari, 2008; Han et al., 2015; Herbert, Owen, Pascarella, & Streisand, 2013; Herbert, Collier, Stern, Monaghan, & Streisand, 2016; Markowitz, Harrington, & Laffel, 2013; Newton, Wiltshire, & Elley, 2009; Vaala et al., 2015); with adults with type 1 diabetes to improve A1C (Kirwan, Vandelanotte, Fenning, & Duncan, 2013); and with gestational diabetes (Friedman, Niznik, Bolden, & Yee, 2016). Great improvement in diabetes outcomes and almost 100% patient satisfaction has been noted in nearly all studies with text message interventions.

Many systematic reviews referenced one of the earliest and best-designed diabetes and text messaging RCTs that was conducted by Kim and colleagues in Korea. Kim, Kim and Ahn (2006) conducted a quasi-experimental study and then Kim and Jeong (2007) followed up with an RCT in Korea that was led solely by PhD-prepared nurses. Both of

these studies using text messages showed improvement in glucose control. In a 12 week quasi-experimental study in 2006, Kim used a one group pre-test and post-test cohort (n=33) to see if participant input of information to an internet program and SMS would improve A1C and self-management activity adherence in adults with diabetes. The nurses sent weekly texts to educate on diet, exercise, medications, and blood glucose monitoring. A physician was consulted with blood glucose results and then medications adjustments were communicated back to the participants, with the goal of maintaining A1C levels less than 7%. There was a mean decrease of 1.1% in the A1C (p=0.006) and adherence improvements with an increase in diabetic medication taking (p=0.032), completion of 30 minutes of exercise (p=0.036) and foot care adherence (p=0.030). The pre- post-test was reliable with a Cronbach α of .87 (Kim et al., 2006).

Kim and Jeong (2007) conducted a follow-up 12 week RCT to investigate the effectiveness of an educational intervention using cell phone texts/SMS and internet to improve A1C levels and two hour post meal glucose. The intervention group (n=25) improved more (A1C decreased 1.15%) than the control group (n=25) (A1C decreased 0.07%) over the 12 week period (p=0.005). Two hour post-meal glucose also improved in the intervention group (p<0.5) as compared to a non-significant change in the control group. This study showed effectiveness in nurse educational interventions to improve A1C and two hour post meal glucose levels; and showed that text/SMS can be used as an effective means of providing education about diabetes via cell phone (Kim & Jeong, 2007; Kim, 2007). In 2007 these nurses conducted a RCT SMS type 2 diabetes intervention that showed that “an SMS of cellular phone intervention by a nurse can

reduce HbA1c and 2HPMG for six months in type-2 diabetic patients" (Kim & Jeong, 2007, p. 1082).

Kim et al. (2007) used an internet management system to send automatic texts/SMS based on a knowledge matrix algorithm system for 12 weeks to intervention group participants (n=35) versus usual care control group (n=36) in Korea. The participants were given a device that was a glucometer/pedometer and this device connected to the participant's cell phone and sent data automatically to the study website. The participants entered foods eaten and exercise information into the website. The knowledge matrix texts were then sent to the intervention group participants via text/SMS based on three topics: blood glucose testing, diet and exercise and generated automatic clinical recommendations based on the knowledge matrix. A1C levels were significantly decreased in the intervention group (0.72+ or – 0.80) versus control group (0.15 + or – 0.85%) in the study (p=0.005). Fasting and post-prandial glucose levels were also significantly decreased in the intervention group (p=0.005) versus control group (p=0.06). This study suggests that internet-based monitoring and computerized generated texts may be more effective than usual care of diabetes (Kim et al., 2007).

Diabetes self-care improvement from increased physical activity was addressed in a daily personalized text messaging RCT conducted over four months at four healthcare centers that are connected to the Massachusetts General Hospital (Agboola et al., 2016). The intervention group (n=64) had significantly higher monthly step counts (p= .03) as compared to the control group (n=62). The A1C decreased by 0.07% in the intervention group as compared to the control group. Twenty-six of the participants primarily spoke Spanish, and 31 of the 126 participants identified their race as Hispanic. The study

concluded that “Personalized text messaging can be used to improve outcomes in patients with T2DM” (Agboola et al., 2016, p. 1). The feasibility and development of a text messaging and pedometer program to promote physical activity for those at high risk to develop diabetes (A1C 6.0 to 6.4) was conducted in the U.K. (Morton et al., 2015). The PRomotion Of Physical activity through structured Education with differing Levels of ongoing Support for those at high risk of type 2 diabetes (PROPELS) text message program RCT is a four year study now being executed that is a multi-centered trial with follow up at 12 and 48 months (Yates et al., 2015) and plans to look at the long-term effectiveness of a structured text message program on prevention of development of diabetes and the cost-effectiveness of the intervention (Yates et al., 2015).

Health information technology was used to improve diabetes care outcomes in Utah (Capooza et al., 2015, p. 90). Capooza et al. (2015) explained how text messaging was used as a personalized behavioral intervention. Participants included 93 (n=58 intervention, n=35 control) adults with inadequately controlled type 2 diabetes from 18 primary care clinics in three counties. Aims of the study included improving care of a large patient population while decreasing cost and engaging patients with a low cost alternative to in-person nurse case management. Depending on the web-based enrollment options chosen, the intervention group received one to seven diabetes-related texts daily. Because they were unable to reply to the welcome text message in the Care4Life text-messaging program, only two Spanish speakers of six enrolled were able to complete the program. Hemoglobin A1C decreased for both groups from baseline levels. An exit survey reported high satisfaction of all participants (mean score of 27.8 out of 32). Text

messaging was shown to be an effective intervention to improve diabetes outcomes (Capooza et al., 2015).

Diabetes medication adherence has been evaluated through a pharmacist-led text message intervention. Gatwood et al. (2016) sent daily tailored texts (based on the Health Belief Model or Self-Determination Theory) for three months to the intervention group (n=23), versus standard care in the control group (n=20). Both groups improved in their medication adherence with no statistical significance in improvement between the groups. Gatwood notes that areas of future opportunity are improving medication adherence and increasing knowledge and motivation through text messages (J. Gatwood, personal communication, April 27, 2017).

World Health Organization (WHO) strategic plans from 2011 put mobile phone technologies as a way to improve health in developing countries around the world (WHO, 2011). Improvements in diabetes knowledge were assessed in a RCT study conducted in Iran (Fatehi et al., 2010). A knowledge questionnaire developed by two endocrinologists and a health education specialist was given pre and post intervention. At the end of the study 100% of the intervention group (n=43) believed the texts increased their knowledge and 75% felt the messages led to daily diet choice changes and 79% thought they had better blood sugar control and all of them wanted to continue to receive the text messages. The mean score of correct answers on the knowledge questionnaire was statistically significant ($p<0.001$), whereas the control group (n=38) scored worse on the post-test than the pre-test. The authors concluded that texts/SMS are an "effective means of conveying information to the patients with diabetes who own a mobile phone. Further

studies are suggested to check whether this improvement in knowledge will lead to change in their attitude and/or practice" (Fatehi et al., 2010, p. 27).

Another RCT in Iran (Goodarzi, Ebrahimzadeh, Rabi, Saedipoor, & Jafarabadi, 2012) demonstrated the positive impact of texts/SMS on lab values and diabetes knowledge, attitudes, practice, and self-efficacy of adults with type 2 diabetes. For three months the experimental group (n=43) received four text messages weekly on the topics of diet, exercise, and medication adherence. The control group (n=38) received usual care. A pre-post questionnaire of 30 questions was noted to be valid (CVI > 80% and CVR >99%) and reliable (Cronbach α=.75). The experimental group improved significantly in A1C (p=0.024), LDL (p=0.019), cholesterol (p=0.002), BUN (p<=0.001), micro albumin (p<=0.001), knowledge (p<=0.001), practice (p<=0.001) and self-efficacy (p<=0.001) (Goodarzi et al., 2012).

A study in Bangladesh (Islam et al., 2015) used A1C as the primary outcome measure and medication adherence as a secondary focus of the RCT. In this six-month study 236 adults taking oral medications for type 2 diabetes were randomized into the SMS intervention or standard care groups. Hemoglobin A1C decreased more in the intervention group -0.85 (least squares mean) versus -0.18 in the control group (p< 0.0001), and medication adherence improved in both groups. Texts/SMS were shown to be a low-cost alternative to improve diabetes care (Islam et al., 2015).

Van Olmen et al. (2013) supported the premise that the majority of diabetes self-management happens between scheduled appointments with providers, so technology to improve communication with healthcare personnel is essential to empower patients to improve their diabetes self-management. The TEXT4DSM study (n=480) was conducted

in three developing countries (Democratic Republic of Congo, Cambodia, and the Philippines). Assessments of A1C, B/P, height, weight, and waist circumference were measured at baseline, at one year and at two years. Text messages were sent to intervention group participants on nine dimensions of diabetes disease management: diabetes explanation, healthy eating, physical activity, monitoring, medications, foot care, tobacco and alcohol control, patient record keeping, and problem solving/patient empowerment. Three questionnaires/tools were used to measure dimensions of diabetes care: Diabetes Care Profile, Patient Enablement Score and the Patient Assessment of Chronic Illness Care (Van Olmen et al., 2013). The results of this two-year RCT were published in March, 2017 and revealed that even though the proportion of participants with controlled A1C was 2.8% more improved in the intervention group than the control group, the result was not statistically significant. Results were mixed (A1C improved in Cambodia, but did not improve in DR Congo). Other RCTs that showed improvement in A1C were of a much shorter duration. The study concluded that it is possible that text messaging may not improve diabetes self-management over longer periods of time, as indicated by the mixed results of this study (Van Olmen et al., 2017).

Pilot Studies and other Relevant Text Message Studies and Information

Short Message Service/text messaging has been used in diabetes management with insulin titration (Celik et al., 2015; Levy et al., 2015), promotion of physical activity (Agboola et al., 2016; Berra, Rippe, & Manson, 2015; Morton et al., 2015; Ramirez, Shinyi, & Beale, 2016; Yates et al., 2015), weight management (Kozak et al., 2017), lifestyle changes (Arambepola et al., 2016; Mundi, Lorentz, Grothe, Kellogg, & Collazo-Clavell, 2015), diabetes self-management education (DSME) with English (Rosal et al.,

2012) and Spanish speakers (Burner, Menchine, Kubicek, Robles, & Arora, 2014), diabetes knowledge (Fatehi et al., 2010), medication non-adherence (Nelson, Mulvaney, Gebretsadik, Johnson, & Osborn, 2016b; Nelson, Mulvaney, Johnson, & Osborn, 2017; Sarabi et al., 2016; Shetty et al., 2011; Vervloet et al., 2014), and self-efficacy (Buis et al., 2013; Burner et al., 2014). Use of text messaging programs has increased requests for certified diabetes educator coaching to improve glycemic control (Pulizzi et al., 2016).

A pilot study on diabetes self-management was conducted over three months by researchers at the Yale Prevention Research Center (Faridi et al., 2008). The Novel Interactive Cell-phone technology for Health Enhancement (NICHE) study design was sending daily tailored text messages to the intervention group (n=15) versus no texts in the control group (n=15). A1C improved in the intervention group (0.1, SD=0.3%, p=0.1534) and deteriorated in the control group (0.3, SD=1.0%, p=0.3813). Self-efficacy scores improved significantly in the intervention group (-0.5, SD=0.6, p=0.0080) versus the control group (0.0, SD=1.0, p=0.9060). Tools used in the study were the Yale Physical Activity Scale (YPAS) for physical activity, and the Diabetes Self-efficacy Scale (DSES) to assess self-efficacy, and the Summary of Diabetes Self-care Activities (SDSCA) tool to assess diabetes self-management (Faridi et al., 2008).

Automated text messages were sent for four weeks to try to improve diabetes self-management in an exploratory study (n=51) in Spain, Italy, and the Czech Republic in Europe (Fioravanti, Fico, Salvi, García-Betances, & Arredondo, 2015). The intervention group (n=26) received automated messages from a mobile device called “METABO” versus the control group (n=25) that received standard care. The automated system responded based on the patient’s feedback. The aim of the study was to improve

medication adherence and improve diabetes self-management via texts on medication adherence, food intake and physical activity. The survey results showed that the system was well accepted and medication adherence improved over the four-week study (Fioravanti et al., 2015).

Research studies in Iran show improvements in diabetes outcomes. A quasi-experimental descriptive survey of SMS effects on health and quality of life of people with type 2 diabetes was conducted for eight months at a hospital in Iran. An SF-26 quality of life questionnaire was completed on both the intervention (n=40) and control (n=40) groups pre and post SMS education texts that were sent three times a week, and showed improved quality of life (p=0.00). (Atarodi et al., 2013). A three month feasibility study (n=150) in Iran showed texts/SMS can be effective in improving A1C and diabetes self-care (Peimani et al., 2016). The tailored text intervention group (n=50) had improved fasting blood sugar (p=<0.001) and decreased mean BMI (p=0.003) results. The non-tailored text message group (n=50) had improved fasting blood sugar (p=0.002) and decreased mean BMI (p= 0.026). The control group (n=50) had an increased BMI (p=0.045). In the three groups of 50 (tailored SMS, non-tailored SMS and control) the change in A1C was not significant (Peimani et al., 2016). Improvements in A1C were seen in a three month SMS text (-0.93% change in A1C, p=0.001) and nurse telephone follow up (-1.01% change in A1C, p=0.001) study in Iran (Zolfaghari, Mousavifar, & Pedram, 2009).

Feasibility studies in the Middle East in Iraq and Bahrain show the positive impact and cost-effectiveness of texts/SMS on diabetes education and self-management. Diabetes knowledge scores (Diabetes Knowledge Test, Michigan Diabetes Research and

Training Center) improved for study participants in Iraq (n=42) from 8.6 (SD=1.5) at baseline to 9.9 (SD =1.4) at six months (p=0.002), and A1C decreased from 9.3% (SD=1.3%) to 8.6% (SD=1.2%). A1C correlated with the knowledge test post intervention (r= -0.341, p=0.027). All Iraqi study participants were satisfied with the texts and wanted them to continue post-study (Haddad et al., 2014). A small study was conducted in Bahrain (intervention group=12, control group =12) to determine the effectiveness of mobile phone SMS and diabetes management. They concluded that the intervention group had a significantly greater reduction in A1C (1.16%, p=0.001) and all considered texts to be highly satisfactory and acceptable to the patients (Hussein, Hasan & Jaradat, 2011).

Texts/SMS were used between endocrinology clinic visits in Bahrain to try to help improve glycemic control with patients with elevated A1C levels (Hussein et al., 2011). The intervention group (n=12) had the cell phone numbers of the physician and diabetes educator for SMS support between clinic visits, versus the control group (n=22). At the three month office follow up visit the intervention group had a significantly greater reduction (1.16% lower) in A1C (p=0.001) as compared to the control group. The texts were effective in lowering A1C and were well accepted by patients (Hussein et al., 2011).

Scotland effectively used a software-based program called “Florence” or “Flo” that sent SMS/texts to help people living with chronic conditions more effectively self-manage their disease (diabetes, hypertension, COPD, and Asperger’s syndrome). A descriptive qualitative study completed by 33 nurses and 37 patients over six months showed 97% of patients found it easy to use their phone, 94% of patients felt that Flo helped them manage their chronic condition better, and 84% of staff felt that Flo helped

patients better manage their own health and well-being (Cund, Birch-Jones, Kay, & Connolly, 2015).

In Australia a Cardiac Diabetes Self-Management Program (CDSMP) used four instruments (Summary of Diabetes Self-Care Activities [SDSCA], Diabetes Management Self- efficacy Scale [DMSES], quality of life measured by Brief Profile of Mood States [POMS], Diabetes Knowledge Questions [DKQ])to assess pre and post text message intervention outcomes. The study showed significant improvements in the experimental group in self-efficacy, and non-significant improvements for both groups in knowledge, self-care behavior, fatigue and depressed levels. Participants said less volume of written educational materials from the hospital for diabetes and cardiac management would be beneficial and would actually increase the usage of information given (Wu, Chang, Courtney, & Ramis, 2012).

In New Zealand, a three-month qualitative study looked at the usability and acceptability of a diabetes text message self-management support program called Self-Management Support for Blood Glucose (SMS4BG). All participants (n=42) reported the program to be useful and appropriate to culture and age levels. A1C showed a significant decrease from baseline to follow up (p=0.001) for those (n=26 or 62% of participants) who had follow up A1C results available (Dobson et al., 2015).

Low-income diverse minority patients (n=20) in a pilot study at a Federally Qualified Health Center (FQHC) in Nashville, Tennessee identified 34 barriers to diabetes medication adherence that were distilled down to 17 categories of tailored texts and interactive voice response (IVR) calls to use in the MED Messaging for Diabetes Intervention (Osborn & Mulvaney, 2013). Nelson et al. (2016b) and Nelson et al. (2017)

then used the tailored texts in a mixed methods mHealth intervention in the same FQHC for three months. Daily text messages that addressed one of their three highest ranked barriers (out of 17 categories) and weekly IVR calls were used (n=60) to provide medication adherence feedback, encouragement and questions to encourage problem solving (Nelson et al., 2017). Medication adherence improved at one and at two months but not at three months (Nelson et al., 2016b). A1C was stable between the intervention group (n=52) and a matched control group (n=104) at the end of the three months (Nelson et al., 2016b). Qualitative results showed participants were favorable to both texts and IVR calls, but valued the texts more highly than the calls. The intervention to improve diabetes self-care was seen as favorable to provide new information about diabetes medications, emotional support, and reminders to take medications (Nelson et al., 2017).

In California, medication adherence improved with targeted diabetes education text messaging for 514 members of a total of 2017 members of a diabetes program. Text messages prompted 7.4% of program participants (n=38) to contact an available Certified Diabetes Educator (CDE) for a personalized coaching session, versus only 4% of members who contacted the CDE that did not participate in the text message program (Pulizzi et al., 2016).

A chronic care model (CCM) was used in Chicago in a mobile health institutional initiative (Nundy et al., 2012). The ADA Standards of Care (2017) consider the CCM to be a level A for the best evidence-based practice for promoting health and reducing disparities in populations. Nurses sent six topics of automated text messages for personalized diabetes self-management support and care coordination for patients that

were members of the University of Chicago Health Plan (Nundy et al., 2012). The texts message types were educational, prompts, tips, encouragement, and feedback and were sent via CareSmarts mHealth software. The diabetes text message program was well-received and provided self-management support and was especially effective with racial and ethnic minorities and low-income patients.

The following year Nundy, Dick, Solomon, and Peek (2013) did a qualitative study with 18 African American health plan participants that had completed a four-week text message program. The texts were based on the Rosenstock Health Belief Model, Bandura Self-Efficacy Theory and Barrera Social Support Theory. The study participants perceived the behavioral theory based automated messages positively impacted diabetes self-management (Nundy et al., 2013). Interviews were conducted with the participants and qualitative information showed that the text message program "reduced the denial of diabetes and reinforced the importance of self-management…through multiple behavioral constructs including health beliefs, self-efficacy, and social support" (Nundy et al., 2013, p. 125).

Nundy et al. (2014b) used a mixed methods observational study to evaluate how mobile phone diabetes programs affect behavior change. The hypothesis was that the text messaging, remote nursing and automated, interactive text intervention would show improvements in self-efficacy, social support, health beliefs, and self-care. Participant (n=67) improvements were noted in five of six domains of self–care (medication taking, glucose monitoring, foot care, exercise, and healthy eating) and in one or more aspects of self-efficacy, social support and health beliefs. Nundy et al. (2014b) concluded that "theory-driven mobile phone intervention led to improvements in diabetes self-care and

…self-efficacy, social support, and health beliefs" (Nundy et al., 2014b, p. 818). A mobile phone text messaging program improved glycemic control pre-post program (p=0.01), improved patient satisfaction with overall care (p=0.04) and saved money (8.8% or $32,388) over six months (Nundy et al., 2014a). This mobile phone text message program led to improved A1C results and decreased cost of healthcare ($812 per participant per six months). (Nundy et al., 2014b, p. 269). Nundy et al. (2014a) conducted a mixed methods study in 2012 to determine if a six-month text message intervention would improve diabetes self-efficacy, social support, health beliefs, and self-care. The results of the study showed that the text message intervention showed improvements in five of six domains of diabetes self-care (taking medications, monitoring blood glucose, foot care, exercise, and healthy eating), and showed improvements in self-efficacy, social support, and health beliefs. The study supported mobile health interventions that targeted behavior change (Nundy et al., 2014a).

Office and hospital follow up is needed for disease management. Gurol-Urganci et al. (2013) indicated in a Cochrane systematic review that improved outpatient follow up can be obtained through text messages. Since some low-income people without a primary care physician or insurance resort to the emergency room for their primary care needs, several studies showed improved DM care and management and a decrease in emergency room visits through text message follow ups (Burner et al., 2014; Ranney & Suffoletto, 2014; Tapp, White, Steuerwald, & Dulin, 2013).

Latinos/Hispanics and Impact of Text Message Interventions

The importance of culturally appropriate education for minority groups with diabetes was evaluated in a Cochrane review by Attridge et al. (2014). Low income

Latinos are less likely to receive DSME in Spanish, and they have worse diabetes self-care activities and behaviors (Chaet, Morshedi, Wells, Barnes & Valdez, 2016; Ramirez, Wu, & Beale, 2016). Lopez and Grant (2012) indicated there is a great need to use technology such as text messaging to provide education and promote self-care behaviors to reduce disparities with vulnerable minority populations. Texts messages were translated from the English Text4Walking program into Spanish to promote physical exercise (Buchholz, Sandi, Ingram, Welch, & Ocampo, 2015). Text messages in Spanish were used to promote physical activity with low-income Latino patients with diabetes in Los Angeles (Ramirez et al., 2016).

A Health Research Services Administration (HRSA) article from 2014 indicated that the racial group with the highest use of texting is the Hispanic population (87%), and 81% of all adults send and receive texts (U.S. Department of Health and Human Services, 2014). The article also explains that 88% of Hispanic adults own a cell phone and 60% of Hispanic adults own a smartphone (U.S. Department of Health and Human Services, 2014).

Three studies from California described the effect of text message interventions on Latinos (Arora, Peters, Burner, Lam, & Mechine, 2014; Burner et al., 2014, and Ramirez et al., 2016). Arora et al. (2014) reported on the RCT Trial to Examine Text Messaging for Emergency department (TExT-Med) trial (n=128). The A1C improvements were not statistically significant, but the intervention group improved more (1.05% decrease) than the control group (0.60% decrease). Emergency room use decreased more for the intervention group (35.9%) versus the control group (51.6%). Most (93.6%) enjoyed receiving the texts and 100% would recommend it to friends.

Medication adherence improved in the intervention group (1.1%) versus the control group (-0.3%). Overall quality of life improved for the intervention group.

A qualitative review of the TExT Med study showed that the text message intervention for improved diabetes self-management reported an intervention that was done after Latino patients were discharged from the emergency room (Burner et al., 2014). The six-month study sent text messages in Spanish two times a day with educational and motivational messages, medication reminders, trivia questions, and healthy living challenges. Burner et al. (2014) implemented the text intervention, based on the Health Belief Model, to decrease cost of additional emergency room visits and improve the health outcomes of Latinos with diabetes in the TExT-MED patient with Diabetes trial. The five focus groups (n=24) of mainly uninsured Latinos participants concluded that two types of texts were impactful and motivational: medication reminders and healthy living challenges. The texts were uni-directional and notes for improvement were for increased personalization of both message delivery and message content (Burner et al., 2014). All of the participants enjoyed the intervention and believed that the management of their diabetes improved. The low income Latinos were receptive to text messages to improve their diabetes self-management behaviors. Personalization of the text messages was noted as a way to augment the effectiveness of the text message intervention (Burner et al., 2014).

The CDC published a text message intervention article (Ramirez et al., 2016) about Latinos. The discrete choice experiment (n=125 Latinos) was used to ascertain the text message items important to low-income urban Latinos with diabetes and that could promote physical activity. Their aim was to determine what text-message features would

be important to this population and help to increase physical activity. Information noted that has applicability to urban Latinos in Charlotte, NC, is that they related that Latinos are less likely (than non-Latinos) to receive DSME. The article notes that barriers to DSME for this population are health system factors (poor access to healthcare and health education), provider factors (language, cultural, communication barriers), and patient factors (health literacy level, cultural beliefs) (Ramirez et al., 2016). Chen, Cheadle, Johnson, and Duran (2014) affirm that US data on racial and ethnic disparities in care show that Latinos are less likely to receive DSME than non-Latino Caucasians.

Lopez and Grant (2012) evaluated how to use health information technology (HIT) to eliminate health care disparities among Latinos with diabetes. Text messaging is noted as the most effective method of HIT. Texts decreased missed appointments and increased communication between patient and provider between office visits. It was noted that cell phone ownership is as common among those with low incomes as among the general population (Lopez & Grant, 2012).

A systematic review focused on Spanish language technology interventions. Forty-two studies were assessed and nine of the 42 looked specifically at diabetes interventions. Five of the 42 studies had mobile phone text messaging as the intervention. The article concluded that three needs were identified:

> First, while the increase in studies targeting the Latino population in the last decade is a promising advancement, future research is needed that focuses on Latino subpopulations previously overlooked. Second, preliminary steps have been taken to culturally tailor consumer health IT interventions for the US Spanish speaking Latino population; however, focus must expand beyond

> intervention content. Finally, the field should work to promote long-term evaluation of technology efficacy, moving beyond intermediary measures toward measures of health outcomes (Chaet, Morshedi, Wells, Barnes, & Valdez, 2016, p. 1).

A systematic review conducted by HRSA concluded that there is encouraging evidence that text messages can change behavior and improve health promotion, disease prevention, diabetes disease management and clinical outcomes in hard to reach groups and underserved populations (U.S. Department of Health and Human Services [USDHHS], 2014). Because of the "ubiquitous presence of cell phones, text messaging and other mHealth interventions can remove traditional geographic and economic barriers to access to health information and services" (USDHHS,2014, p. 27). The review notes there are higher rates of mobile phone ownership among African Americans and Hispanics as compared to Caucasians, and "interventions have the potential to improve health knowledge, behaviors, and outcomes and, ultimately, to reduce disparities" (USDHHS, 2014, p. 27). Telehealth interventions for diabetes self-management education increases access to care for people in underserved areas and should be individualized and linguistically and culturally tailored (Fitzner et al., 2014).

Uninsured Hispanic immigrants in Charlotte, NC were the focus of an evaluation of primary care delivery systems. Charlotte was noted by Tapp, Smith, Dixon, Ludden, and Dulin, (2013) to have had an increase of more than 1000% in the Hispanic population since 1980 (p. 19). Four different primary care delivery sites were named that had a focus on primary care delivery to Hispanics in Charlotte, NC. One location, a community free clinic with 2500 Hispanic patients, was mainly staffed with volunteer providers. The

clinic treats adults only and offers specialized care for patients with diabetes and heart disease. All of the patients lack insurance, and the majority of patients speak only Spanish (Tapp et al., 2013, p. 20). The other three locations that provide care to Hispanics in Charlotte are a low-overhead bilingual clinic, an Emergency Department, and a hospital-affiliated clinic. The article also notes that 85% of the community free clinic patients have a chronic disease (diabetes, depression, heart failure, asthma, or HIV) (Tapp et al., 2013, p. 21).

In summary, text messaging has been shown to be extremely effective with lower incomes/minorities. There is demonstrated satisfaction with receiving texts, with improvement in clinical (A1C), and behavioral outcomes. There is a lot of research with text messages and various options for ways to set up the text intervention and all were effective. Latinos/minorities use phones at even higher rates than those of higher income levels as their primary connection to the internet.

Sample/Population/Community

The DNP project site is a community free clinic in Mecklenburg County, North Carolina. Since 2004, it has served over 3,500 mainly Spanish-speaking individuals that are uninsured and provided more than 8,500 doctor visits. The clinic shows hope in action through health fairs, feeding the homeless, backpacks for kids, counseling services, clothing drives, fitness classes, and workforce training. The clinic estimates that they have around 200 patients with a diagnosis of diabetes of their 2,000 active patients. Since Latinos are twice as likely to have diabetes as non-Latino/Hispanic whites (CDC, 2016), and the free clinic serves mainly Latinos, efforts are needed that are directed towards improving the diabetes outcomes in the clinic patients with diagnosed diabetes.

For the free clinic to be able to receive funding from a grant, they need to greatly improve the A1C, blood pressure, and cholesterol levels of the clinic patients with diabetes. The free clinic patients with a diagnosis of diabetes are the focus of the DNP project intervention.

Setting

The free clinic is part of a community center. The mission and vision of the community center is "To Equip People to live healthy, hopeful, and productive lives." Besides the health clinic, the community center has a thrift store, a food pantry, and a homeless ministry. The clinic serves low-income, uninsured people, and provides adult primary care, diabetes and hypertension management, and health education programs. The free clinic is part of the National Association of Free and Charitable Clinics and the North Carolina Association of Free and Charitable Clinics.

The project PICOT (Problem/Patient/Population, Intervention/Indicator, Comparison, Outcome. and Time) statement for the DNP project is shown in Figure 1.

P	With Latino/Spanish speaking patients with uncontrolled diabetes (A1C > or = 7) in an urban Free Clinic setting
I	How does the use of a text message intervention
C	Compared with usual care
O	Affect diabetes physiological and behavioral markers, knowledge, self-care and self-efficacy
T	Over the eight week intervention

Figure 1. DNP Project PICOT Statement

Sponsors and Stakeholders

The executive director of the free clinic is the practice partner/sponsor for this DNP project. The free clinic wants to be a place of hope and has four focuses: the free clinic, a clothing thrift store, a food pantry, and a homeless ministry. The practice-learning environment is the free clinic. The internal stakeholders are the free clinic advisory board, clinic staff and volunteers, and the patients with diabetes that come to the clinic for healthcare. The external stakeholders are Mecklenburg County, which provides funding through the Community Service Grant (Mecklenburg County Government, 2017b), Spanish-speaking residents of Mecklenburg County, the National Association of Free Clinics, and community partners. Personnel at the clinic were available for help and consultation for the DNP project text message intervention.

Organizational Assessment Including SWOT Analysis

A SWOT analysis generated the following findings:

Strengths:

- The free clinic that provides care to the uninsured residents of Mecklenburg County.
- The clinic serves mainly Spanish speaking individuals.
- The clinic staff is committed to whatever project the project leader planned to do and were very supportive the project and the project leader
- Project leader worked at the free clinic since August, 2013 as Spanish speaking diabetes educator
- The clinic is part of a church, so project leader was free to share/show the

Christian faith.

- Project leader is a Spanish speaking Certified Diabetes Educator (CDE)
- Project leader is fluent in written and spoken Spanish
- The Hispanic/Latino population has an increased risk of having DM as compared to non-Hispanic whites (per CDC) and project leader gift mix can help this population
- One DNP intervention committee member is connected to both UNCC and the clinic.
- One committee member and project leader has had a close relationship since Masters Research at UNCC. She is well acquainted with clinic and its executive director.
- Clinic Education Coordinator, has data for the clinic
- Clinic Executive Director is aware of the needs of her clinic.
- Clinic has other programs to improve the health of patients with diabetes (Gym and Zumba)
- Clinic has the Blue line tram parking deck right behind their location.
- Project leader is clinic volunteer and has access to the clinic Practice Fusion E.H.R.
- Project leader has access to the CareMessage text message platform that clinic uses.
- Project leader has established relationships with many patients there from prior diabetes education with them.
- Four Clinical Nurse Specialist DNP educators (from the project leader's full-time

work location) gave input and recommendations to the DNP project

- Project leader lives 10-15 min drive from the clinic.

Weaknesses:

- The patients with Diabetes at the free clinic do not all have optimal diabetes outcomes.
- The clinic may not receive funding from a major funding source if they do not improve the outcomes for their patients that come to the clinic that have a diagnosis of diabetes.
- Clinic is only open Tues-Thurs
- Practice Fusion E.H.R. does not have full capabilities to pull data.
- Post intervention A1C not resulted for all project participants in time to complete DNP paper prior to graduation date.

Opportunities:

- There are many possibilities for DM interventions that would help this patient population
- Improve the diabetes outcomes for patients with uncontrolled diabetes (A1C > 7- per data needed for Mecklenburg county grant)
- Opportunity to send personalized text messages to help improve the diabetes self-management, self-care, and self-efficacy for free clinic patients with diabetes.
- Clinic staff willing to help in any way.
- There are many different tools available in Spanish to evaluate diabetes knowledge, diabetes self-care and diabetes self-efficacy.
- The clinic needs to show improvement in the diabetes outcomes of all their clinic

patients that have diabetes.

- The clinic needs to do better diabetes education with all their clinic patients that have diabetes, and not only the 5-6 that project leader can do intensive diabetes self-management education in Spanish with each month; or not only with the ones that do motivational health coaching on Tuesday mornings with another clinic volunteer.
- Various groups want to use the clinic to provide diabetes programs at the clinic.

Threats:

- Several individuals/groups want to use clinic as site for Diabetes programs and interventions, so these programs cannot happen at the same time as the DNP project diabetes intervention, so as not to overlap or overwhelm the staff or patients.
- The CareMessage text message program already has a diabetes program that is part of the text messaging capability that the clinic now has and can use, so a focused text message intervention that is deemed important to the clinic was created in this DNP project.
- The clinic has recently been sending too many messages (overuse of the system) to patients (e.g. movie nights, announcements, invitation to Tomando Control), so patients have started opting out of the texts and this means they opt out of all texts.

Assessment of Available Resources

The free clinic has personnel that are available for help and consultation for the DNP project text message intervention. In January 2016, the clinic started using Practice

Fusion as the clinic Electronic Health Record (E.H.R.). In January 2017, the clinic started using CareMessage text messaging for "friendly reminders" (labs, appointments, tests) to patients. The CareMessage text messaging program has unlimited texts and a platform for either creating a text message program or use of the CareMessage 25 week diabetes program, so there is no additional cost to the clinic, since they are already using the CareMessage text message 501c3 company text messaging platform. All of the clinic permanent staff regularly uses the Practice Fusion and CareMessage programs. Both the Practice Fusion E.H.R. and CareMessage programs are web-based and can be accessed via internet connection at any location. There are on-site laptops and offices that can be used, if needed, to access the clinic Practice Fusion electronic health record and the CareMessge text message internet site. Practice Fusion was utilized to identify clinic patients with diagnosed diabetes and lab values that are recorded in the E.H.R.

Desired and Expected Outcomes

Elements of successful implementation of this project are described as improved A1C levels, diabetes knowledge, diabetes self-care, and diabetes self-efficacy of the patients with uncontrolled diabetes at the free clinic.

1. By the end of the eight-week DNP project text message intervention, Latino adults with diabetes at the free clinic will have improved diabetes control as evidenced by improved A1C.
2. By the end of the eight-week DNP project text message intervention, Latino adults with diabetes at the free clinic will have improved diabetes self-management as measured/evidenced by improved diabetes knowledge, self-care and self-efficacy tool scores.

Meeting the goal of improved A1C levels is necessary for the clinic to receive grant funding from the Mecklenburg County Government.

Team Selection

The team includes Sharon R. Allen, MSN, RN-BC, CDE, CNE, DNP project leader, and committee members. The University's Faculty DNP Project Chair is the Chair of Graduate Nursing Programs and Professor in the School of Nursing at the University. Committee members are two faculty members at UNC Charlotte (UNCC). The free clinic staff practice sponsors include the executive director and the clinic patient education coordinator.

The two PhD faculty members at UNC Charlotte have direct connections to the free clinic and to the Spanish-speaking population and are the two project committee members. One of these UNCC Faculty members is chairperson of the board of the free clinic/community center and he has worked closely with the clinic executive director. He is an expert in community health, having developed and led three separate medical school units dedicated to community health science research. He has experience leading large research teams, as the principal investigator on three multi-year federally-sponsored community-based clinical trials including: (1) improving care for the uninsured using community-based health navigators and enhanced primary care; (2) testing the effectiveness of a congregation-based approach for reducing cardiovascular disease (CVD) risk through lifestyle modification; and (3) testing the effectiveness of the Diabetes Prevention Program (DPP) curriculum for promoting weight loss in the community-based setting.

The other DNP project committee member is a UNC Charlotte School of Nursing associate professor. This nurse-scientist has focused her entire research trajectory with the Spanish-speaking population and has close ties with the free clinic executive director. She is a nurse-investigator who is actively involved in research promoting health and health care access for Latino immigrants with chronic diseases. She has experience and expertise developing interventions focused on behavior change and health promotion and conducts randomized controlled trials using community-based participatory research methods, and identification and analysis of social determinants of health, largely with Latino immigrant populations.

Cost/Benefit Analysis

The cost of diabetes care and management is staggering to society and to the individual with the disease. Improved diabetes outcomes decrease the overall cost of care for the person with diabetes. "Gaining control of HbgA1C levels in a population will decrease the cost of care through avoidance of long-term complications of diabetes. In addition, it may decrease the number of hypo/hyperglycemic visits to the emergency department" (Zaccagnini & White, 2017). If glycemic levels are improved, then complications of diabetes may be avoided or delayed and thereby decrease the financial and personal cost to the individual with diabetes and to society as a whole.

The CDC (2016) says, "More than 20% of health care spending is for people with diagnosed diabetes" (p. 1). CDC data indicates that the 2012 estimated diabetes costs in the United States are $ 245 billion: direct medical costs are $ 176 billion (medical goods and services), and indirect costs are $69 billion (disability, lost workdays, premature death). Average medical expenditures among people with diagnosed diabetes were 2.3

times higher than people without diabetes (CDC, 2014b, p. 2). Since diabetes disproportionately affects Hispanics and other minorities, and the free clinic patients are low-income and uninsured, the cost to the individual could potentially be higher than the CDC estimates. Alternatives to expensive medications are explored with providers and patients at the clinic. Many at the clinic, if they qualify, receive their medications from Med Assist.

The American Diabetes Association (2018) reported that in the US in 2017, $327 billion was spent on diagnosed diabetes expenses. Direct medical costs were $237 billion and reduced productivity costs $90 billion. From 2012 to 2017, the economic costs of diabetes increased 26%. "One of every four health care dollars is incurred by someone with diagnosed diabetes, and one of every seven health care dollars is spent directly treating diabetes and its complications" (American Diabetes Association, 2018).

The clinic already uses CareMessage (2017) to send texts as friendly reminders to patients, and the clinic has unlimited texts. The contract with the company is based on number of subscribers and not the number of texts sent, and they will not be charged more until they have over 3,000 people that are subscribed to text messaging. They currently have approximately 1,500 people who subscribed to this text message service. The clinic has two CareMessage super-users and all regular clinic staff knows how to use the program. CareMessage has a 25-week diabetes program available for the clinic to use and has open enrollment, and once a patient is enrolled, the CareMessage Company does the rest. However, the clinic would like to explore the level of diabetes knowledge, self-care and self-efficacy perceptions of the clinic patients through a DNP project tailored text message intervention prior to the possible use of the 25-week diabetes automated text

message program. Patients are individually consented to the CareMessage program by clinic staff. Patients could incur a cost for the texts depending on their phone service/carrier.

Physiological markers were used for program participants. The clinic sends their lab samples out to a laboratory for testing, but on-site equipment to test glycosylated Hemoglobin (hemoglobin A1C) is available at the clinic using the Alere Afinion AS100 Analyzer. Each Alere Afinion Hemoglobin A1C costs the clinic approximately $10 and the patient pays $5 for an A1C test. A baseline A1C and a post intervention A1C needed to be completed for patients at the clinic that took part in the intervention in either the intervention or the control group. The clinic does periodic A1Cs on their clinic patients every three months for the patients that have uncontrolled diabetes.

Scope of the Problem

Diabetes and pre-diabetes are problems in the Hispanic population in the world, in the US, in North Carolina, in Charlotte, and in the free clinic patient population. A text message intervention was conducted with patients with uncontrolled diabetes at the free clinic to help improve their behavioral and physiological diabetes outcomes and help the clinic to retain grant funding.

SECTION III

Goals, Objectives and Mission Statement

A text message intervention was conducted with the uncontrolled diabetes patients (Hemoglobin A1C [A1C] > or = 7) at the free clinic to help improve their diabetes behavioral and physiological outcomes and help the clinic to retain grant funding.

Goals

1. Provide personalized communication, education, and follow up for patients diagnosed with diabetes that are patients at the free clinic.
2. Improve diabetes outcomes, knowledge, self-care and self-efficacy in the intervention versus usual care group.

Process/Outcome Objectives

1. By the end of the DNP project text message intervention, Latino adults with diabetes at the free clinic will have improved diabetes control as evidenced by improved A1C.
2. By the end of the DNP project text message intervention, Latino adults with diabetes at the free clinic will have improved diabetes self-management as measured/evidenced by improved diabetes knowledge, self-care and self-efficacy tool scores.

Mission Statement

This text message intervention seeks to help patients that come to the free clinic that have uncontrolled diabetes (A1C > or = 7) improve their diabetes clinical and behavioral outcomes, and thereby help them to live healthier, more hopeful, and productive lives as they deal daily with this chronic illness.

SECTION IV

Theoretical Underpinnings

Theories of Nursing, Change, Education, or Other Disciplines

Social Cognitive Theory was the theoretical basis for many literature review articles examined for this DNP project (Cherrington, Wallston, & Rothman, 2010; Dobson et al., 2015; Faridi et al., 2008; Fjeldsoe et al., 2009; Nundy et al., 2013; Peimani et al., 2016; Peña-Purcell, Boggess, & Jimenez, 2011; Wu et al., 2012). Self-efficacy (confidence that you can accomplish something) is a key construct of Bandura's Social Cognitive Theory (1986, 1977a, 1977b) that is used to explain how a person's perceived competence or confidence in their own abilities will influence self-care behavior and self-management of diabetes. Low self-efficacy is associated with poor glycemic control (Cherrington et al., 2010). Every day individuals with diabetes manage seven self-care behaviors (healthy eating, being active, monitoring, taking medication, problem solving, healthy coping, and reducing risks (America Association of Diabetes Educators, (AADE), 2017). There is a relationship between self-efficacy, self-care, and improved (diabetes) outcomes (Bandura, 1977a, 1977b; Gleeson-Kreig, Bernal, & Woolley, 2002; Kamimura et al., 2014; Oh, Ahn, & Song, 2012; van der Bilj, Poelgeest-Eeltink, & Shortridge-Baggett, 1999).

Bandura (1977a) explained four sources of efficacy expectations: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal (p. 195). Later Bandura (1986) changed the terms for sources of self-efficacy to be enactive attainment, vicarious experiences, verbal persuasion, and physiological state. Enactive attainment deals with mastery of a skill (giving insulin injections, using a glucometer).

Vicarious experience refers to learning from role models (diabetes educators, physicians, and people with diabetes with good self-management skills). Verbal persuasion is motivating and coaching (Spanish text messages). Physiological states (anxiety, pain, hyperglycemia, and hypoglycemia) affect ability to perform self-care tasks (Bernal, Woolley, Schensal, & Dickinson, 2000). Motivation is part of self-regulatory processes that move behavior toward goals (Bandura, 1977b). Higher self-efficacy is associated with higher rates of adherence to diabetes self-care activities and behaviors (Senécal, Nouwen, & White, 2000) and better outcomes (Bandura, 1977a). The goal of using a behavior change theory is to encourage self-efficacy to be able to cope with a chronic illness (Butts & Rich, 2015).

Theory/Theories to Support Project Framework

The 2017 ADA Standards of Medical Care in Diabetes (2017) recommends that to promote health, "providers should consider the burden of treatment and self-efficacy of patients when recommending treatments" (p. 6). The American Association of Diabetes Educators (AADE) has identified seven essential self-care behaviors that every person with diabetes must do: healthy eating, being active, monitoring, taking medication, problem solving, healthy coping, and reducing risks (AADE, 2017). For the person with diabetes to perform the daily self-care tasks, they need the confidence that they can complete these tasks. This self-confidence to be able to complete necessary tasks has been called self-efficacy (Bandura, 1977a). High levels of self-efficacy (Goodarzi et al., 2012) are needed for the person with diabetes to perform optimal self-care diabetes-related tasks and behaviors.

Social Cognitive Theory and the concept of self-efficacy have been used to support randomized controlled trials and other studies with Hispanics (Alvarez, 2014; Bernal et al., 2000; Coffman, 2008; Fjeldsoe et al., 2009; Gleeson-Kreig et al., 2002; McCloskey & Flenniken, 2010; Sarkar, Fisher, & Schillinger, 2006; Vincent, McEwen, Hepworth, & Stump, 2014). Albert Bandura taught psychology at Stanford and Alvarez (2014) explained the use of Bandura's theory in the Stanford Spanish Diabetes Self-Management Program that used lay leaders to teach diabetes self-management. Bernal et al. (2000) demonstrated that self-efficacy was important in healthy eating and taking insulin injections. Coffman (2008) examined the relationship between diabetes tangible support, depression and diabetes self-efficacy with Hispanics of predominantly Puerto Rican descent and determined that those with low self-efficacy needed more support from others. Fjeldsoe et al. (2009) used Social Cognitive Theory to show that text message interventions have a positive short-term effect on behavior. Gleeson-Kerig et al. (2002) explained that Hispanics with higher social support and self-efficacy had better diabetes self-management. Self-efficacy was closely related to diabetes self-management in the qualitative study explaining the La VIDA (Lifestyle and Values Impact Diabetes Awareness) program with Spanish speakers in New Mexico (McCloskey & Flenniken, 2010). Sarkar et al. (2006) validated that self-efficacy is connected to good diabetes self-management with Latinos and other ethnically diverse groups with limited health literacy. Vincent et al. (2014) used strategies to enhance self-efficacy in a culturally tailored intervention with Mexican-Americans in Arizona.

Text messages are both informational and motivational. Texts can encourage someone that they can learn and change their behavior to improve their clinical outcomes. Through sending informational text messages patients can gain confidence (self-efficacy) in knowing information and then be encouraged to act on these messages to change behavior and improve their diabetes behavioral and clinical outcomes. See Figure 2 for the Conceptual-Theoretical-Empirical (CTE) diagram for this DNP Project.

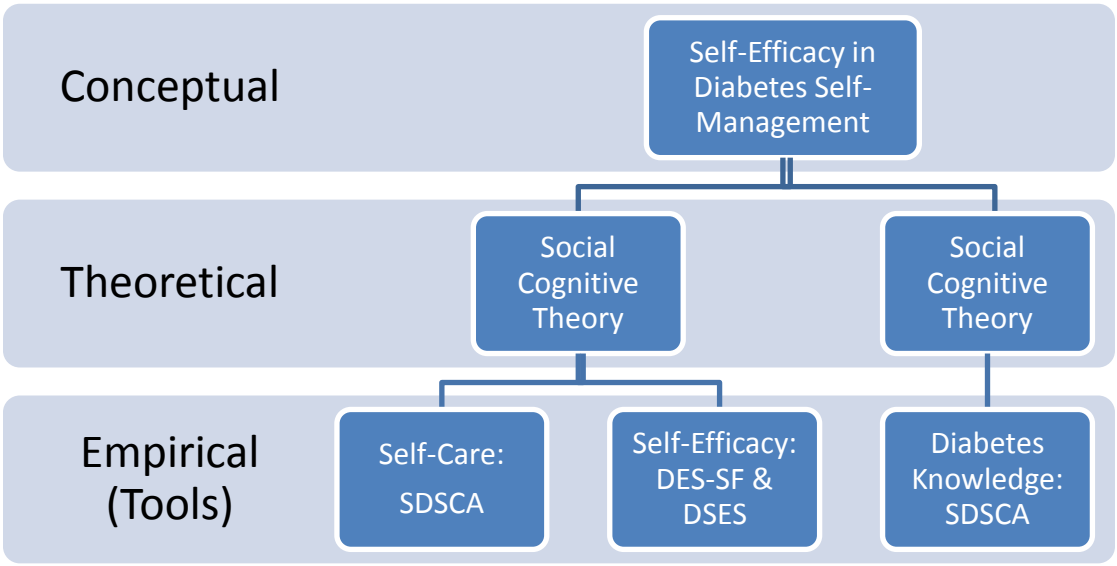


Figure 2. Conceptual-Theoretical-Empirical (CTE) Diagram for DNP Project

SECTION V

Work Planning/ Planned Methods

Plan for Evaluation of Project

1. Elements of successful implementation of this project are described as improved A1C levels, diabetes knowledge, diabetes self-care and diabetes self-efficacy of the patients at the free clinic with uncontrolled diabetes.
2. By the end of the eight-week DNP text message intervention, Latino adults with diabetes at free clinic will have improved A1C levels and diabetes control.
3. By the end of the DNP project text message intervention, Latino adults with diabetes at free clinic will have improved diabetes self-management as measured/evidenced by improved diabetes knowledge, self-care and self-efficacy tool scores.
4. Meeting the goals of improved A1C levels is necessary for the clinic to receive grant funding from the main funding source.

Project Proposal

Participants were free clinic patients. The study was explained to the participants, and they were asked to read and sign an informed consent form. Study staff verified eligibility (Hemoglobin A1C> or = 7) to participate in the study. The following procedure for obtaining consent (in English/Spanish) was followed:

a. The particpants were invited to participate in the study.
b. Each section of the consent form was reviewed with the participant.

c. If he/she agreed to participate, the participant was asked to sign the consent. One signed copy was given to the participant and the other copy became part of the confidential record.
d. Once consent was obtained, the participant became part of the DNP project.
e. If a potential participant declined to participate, they were thanked for their time and were not included in the study.
f. The consent form was separated from the data and stored in a locked area.
g. The participant was notified that they may choose to stop the study at any time and would suffer no retribution.
h. If consent was obtained and a participant was later deemed ineligible, then the consent was kept for descriptive purposes.

After obtaining written consent, four tools/surveys were administered at that same time by the DNP researcher. Then the text message eight-week intervention was implemented:

a. Texts were sent bi-weekly to the subjects for eight weeks.
b. Texts were sent to the phone number given to the free clinic during the intake as a new patient (after CareMessage implementation Jan 2017), or to the phone number indicated as the phone that receives texts (for patients at the clinic prior to Jan 2016).
c. Texts were sent to the patients twice a week. Some of the texts were information (unidirectional) and others required a response from the study participants (bidirectional).

d. Texts were sent from the app.caremessage.com web address to the study participants in the form of an "outreach" (term used in CareMessage for a group text).
e. A text group was created in app.caremessage.org of all phone numbers of participants who consented to be part of this study.

The DNP project-administrator has volunteered as the Spanish-speaking diabetes educator since August 2013, and has signed the clinic volunteer waivers and has been granted use of CareMessage texts (clinic started using Jan 2017) and the E.H.R. People Fluent (clinic started using in January 2016), both as a clinic volunteer and as a DNP student.

Plan for Evaluation of Project

1. Elements of successful implementation of this project are described as improved A1C levels, diabetes knowledge, diabetes self-care, and diabetes self-efficacy of the patients at the free clinic with uncontrolled diabetes.
2. By the end of the eight-week DNP text message intervention, Latino adults with diabetes at free clinic will have improved A1C levels and diabetes control.
3. By the end of the DNP project text message intervention, Latino adults with diabetes at free clinic will have improved diabetes self-management as measured/evidenced by improved diabetes knowledge, self-care, and self-efficacy tool scores.
4. Meeting the goals of improved A1C levels is necessary for the clinic to receive grant funding from the Mecklenburg County Government.

Project Management Tools

There are three project management tools included in this section (Zaccagnini & White, 2017). Figure 3 is a program evaluation review technique (PERT) chart. Figure 4 is a work breakdown and milestones diagram. Figure 5 is a Gantt chart and timeline of the project.

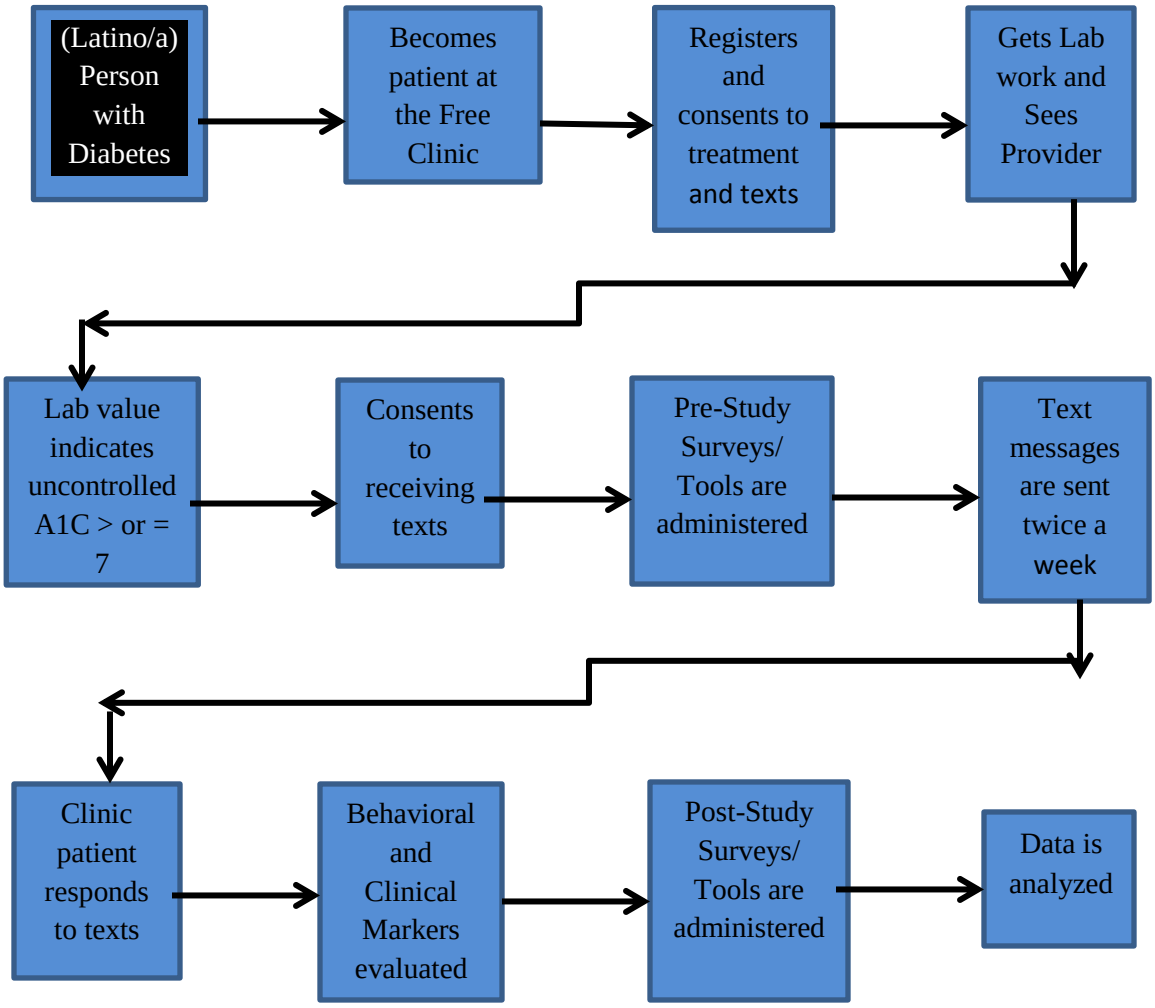


Figure 3. PERT Chart

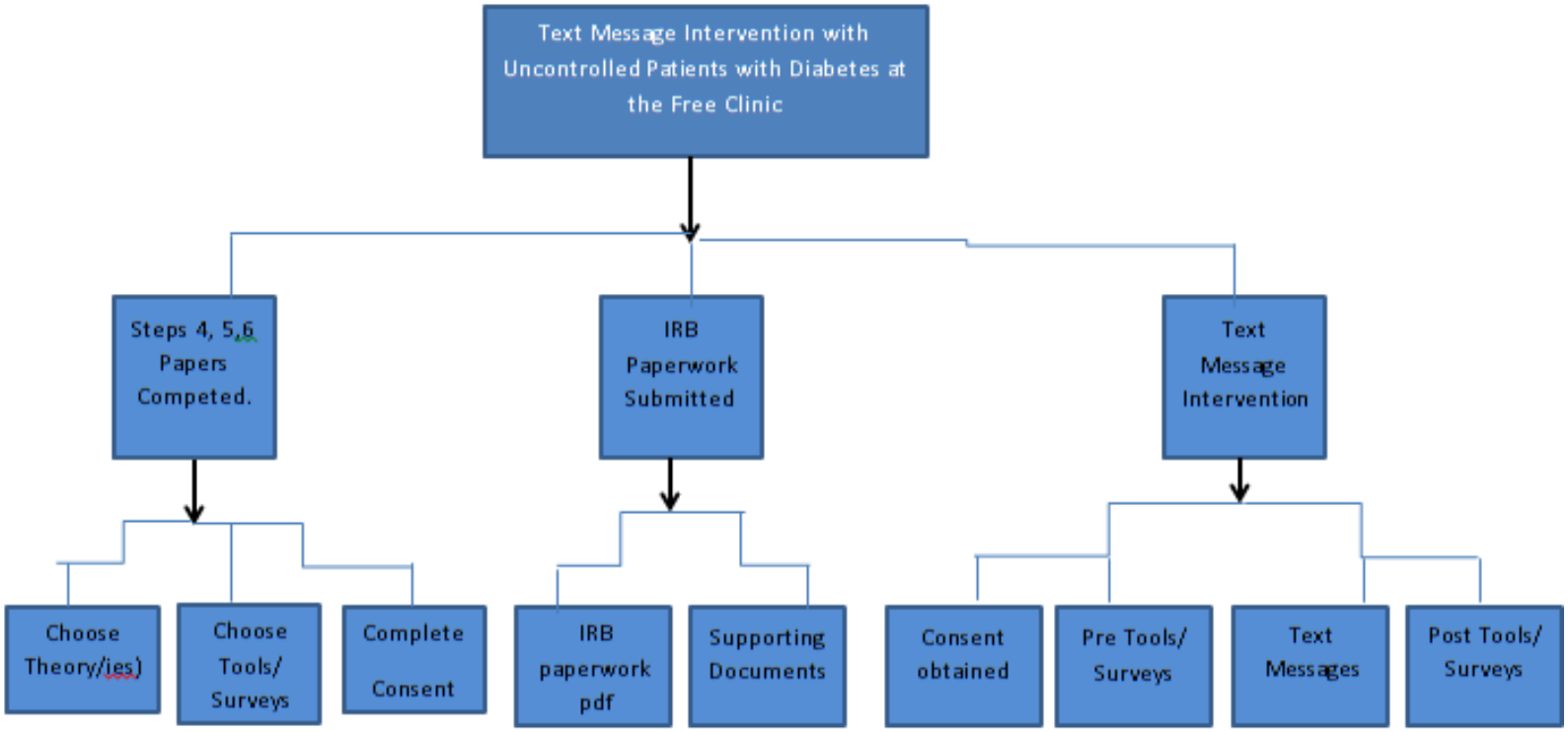


Figure 4. Work Breakdown and Milestones

GANTT Chart and Timeline

Task	June 2017	July 2017	Aug 2017	Sept 2017	Oct 2017	Nov 2017	Dec 2017	Jan 2018	Feb 2018	Mar 2018	Apr 2018	May 2018
Steps 1-3 papers completed in Spring 2017												
Choose Theory/ies as basis for DNP project												
Write Step 4 Theoretical Underpinnings Paper												
Prepare GANTT chart, Milestones, Budget												
Write Step 5 Work Planning Paper												
Choose Tools to measure outcomes												
Develop Logic Model and PDSA												
Write Step 6 Evaluation Planning Paper												
Write DNP Project Proposal												
DNP project proposal approval form												
Write IRB and other documents												
Turn in IRB and other documents by July 24 and submit IRB revision if needed.												
Prepare Texts to be used for the Text Message Intervention												
Explain study to office staff												
IRB APPROVED AND STUDY BEGINS												
Go to clinic every Tuesday all day and help them with DM pts. Filling out tools Pre-Intervention												
Tuesdays at clinic during Text Message Intervention/Implementation												
Daily text message monitoring of participants remotely in Care Message and People Fluent EHR												
Complete Tools with clinic DM patients Post-Intervention												
Step 8 Interpretation of Data												
Step 9 Utilization and Reporting of Results												
Draft of DNP Project Paper												
Final DNP Project Paper												
Draft of DNP Project Presentation												
Final DNP Project Presentation												

Figure 5. Gantt Chart and Timeline

Budget

Direct Costs: (1) Labor: $0-DNP project to be completed by student with appropriate clinic staff assisting with their normal duties (receptionist, medical office assistant, clinic educator, CareMessage Super-User, etc.); (2) Materials and supplies: $ 0- Cost of printing Consent forms- clinic and student have printers that can be used and $ 0- Cost of printing tools to be administered- clinic and student have printers that can be used; and (3) A1C tests- $10 per test pre-intervention and $10 per test post-intervention: costs normally assumed by clinic and $5 co-pay for each test by patients. These are normal tests administered by the clinic, so will not be an added cost for this study.

Indirect Costs: (1) Business space $0- use of clinic rooms; (2) Internet Access-$0- use clinic Wi-Fi or home Wi-Fi; (3) Internal Communications- $0 for telephone calls on clinic line; and (4) Electronic Health Record- $0 to use web-based E.H.R. People Fluent.

SECTION VI

Evaluation Planning

Evaluation Plan

A text message/SMS intervention has long term sustainability at the free clinic. Once a text messaging tool/intervention is in place, it should improve care and decrease A1C levels of those patients at the clinic that have diabetes. Once a tailored text messaging tool is set up, then it could be handed off to clinic staff/students/volunteers to use to continue to message the clinic clients with personalized messages and education appropriate to them. The evaluation plan includes a logic model (see Figure 6), tools to be used in the study (see Table 1) and a Plan Do Study Act (PDSA) quality improvement model (see Figure 7). The tools will be administered pre and post intervention to the clinic patients with uncontrolled diabetes (A1C > or = 7) that consent to be part of the text message intervention. The PDSA template for this project is modified from a healthcare system template where the DNP student works (Carolinas Healthcare System).

The logic model has inputs and resources needed to implement and evaluate the project. Personnel resources include the DNP project leader that is a Certified Diabetes Educator (CDE) and fluent Spanish speaker, the clinic executive director, the clinic education coordinator, and the clinic staff (receptionist, CareMessage super users, nursing assistant, and the clinic NP provider). The facility and organizational input is the free clinic which is part of a community center. Equipment and technology resources include the electronic health record People Fluent, the CareMessage text message program used by the clinic and patient cell phones. There is no charge to the DNP student for the use of CareMessage for the text message intervention.

Logic model constraints include the budget (no cost for use of People Fluent or Care Message texts), physical space of the clinic, the time frame for the fall 2017 implementation and the existing culture of the uninsured Spanish speaking clients with diabetes. Processes and activities include the events (pre and post test tools); training (use of tools, creating texts as outreaches); education (use of CareMessage to send and respond to texts); media and technology of the CareMessage Program; development of processes (texts- how many and type- unidirectional or bidirectional); the intervention (educational texts); and the evaluation plan (pre and post surveys/tools and Hemoglobin A1C pre and post).

Logic model outputs include anywhere from 40 to 200 participants (depending on how many consent to be part of the intervention) with an A1C of greater than 7. The amount of education will be bi-weekly texts. The number of hours of service will occur on Tuesdays when the clinic is open from 8a.m. to 6 p.m. The only other possible participation is the involvement of the PhD volunteer that does motivational interviewing at the clinic on Tuesday mornings.

Outcomes are short term, long term and impact outcomes. The short term outcomes include improvement in diabetes knowledge, diabetes self-care and diabetes self-efficacy. The clinical short term goal is improved A1C numbers. Long term goals include improvements in behavioral, motivational and clinical outcomes. Long term results of change would be improved diabetes glucose control, improved diabetes knowledge, improved diabetes self-care and improved diabetes self-efficacy. The ultimate goal would be improvement in the Hemoglobin A1C numbers so that at least

60% of the clinic population would be controlled in their diabetes self-management with an A1C less than 7.

Logic Model Development

See Figure 6 for the Project Logic Model.

				Outcomes		
Input/ Resources Needed to Implement and Evaluate project	Constraints	Processes/Activities	Outputs/Participation	Short Term	Long Term (1 year or more)	Impact
Personnel/People: Sharon Leader, DNP student, CDE, Spanish Speaker; Clinic Exec. Director; Clinic Education Coordinator; Clinic staff-Receptionist; CareMessage Super-users Clinic Providers- NP & others Volunteers Facility/ Organizational Free Clinic Equipment/ Technology People Fluent, CareMessage Text Messaging system; Patient cell phones. Time- Fall 2017 Materials-texts Finances-No charge for Care Message use.	Budget No cost for use of People Fluent or CareMessage texts Physical Space Law, Regulations, Local Policy Clinic space can be used Time Frame Fall intervention Existing Culture Uninsured Spanish Speaking clients with Diabetes	Events Pre & Post Tools Training Use of Tools Creating Texts as Outreaches Education Use of Care Message to send and respond to texts Media/Technology CareMessage Texts Meetings No meetings- texts sent Development of Processes Design of program-Texts- how many per week and unidirectional or bidirectional? Intervention-texts Evaluation Plan Pre & Post Tools Hemoglobin A1C pre and post	# participants 200 with A1C>7 # Amount of education Delivered Biweekly texts # Number of Hours of Service Tuesdays Fall 2017 # any other activities Involvement of volunteer doing motivational interviewing?	Knowledge Improvement Pre and Post scores on DM knowledge test/ tool Self-Care/skill Improvement Pre and Post scores on DM Self-Care tool Self-Efficacy Improvement/ improved level of functioning Pre and Post scores on DM Self-Care tool A1C improved Goal to improve A1C in patients with A1C>7	Behavioral Improvement Improved DM self-care Motivational Improvement Improved DM self-efficacy to do self-care Individuals Patients at the free clinic with Uncontrolled DM (A1C>7) will improve their DM management over the long term Clinic/Community R15 grant and other DM programs as follow up (Care Message 25 wk. program); Clinic NP future DNP project at the clinic	Long Term Results of Change Improved diabetes glucose control, diabetes knowledge, diabetes self-care and diabetes self-efficacy

Figure 6. Project Logic Model

Quality Improvement Methods Plan Do Study Act (PDSA)

The PDSA template for this project (Figure 7) shows that the Plan includes the problem:

1. Latino adults with diabetes at free clinic have poor diabetes control.
2. Diabetes control in the Latino patient is poor because of increased risk due to ethnicity/race, less access to care, low health literacy, and other barriers.
3. The staff at free clinic does not have the resources to provide face-to-face educational and social support to their diabetic patients.

The Plan includes that the aim or goals of this project are to:

1. Provide personalized communication, education, and follow up for patients diagnosed with diabetes that are patients at the free clinic.
2. Improve diabetes outcomes, knowledge, self-care and self-efficacy in the intervention versus usual care group.

The team includes Sharon R. Allen, MSN, RN-BC, CDE, CNE, DNP project leader; the University's faculty chair, two UNCC faculty committee members and free clinic staff.

To Do the improvement, changes will need to be made, so the intervention answers the question: What Changes do you plan to make?

1. Diabetes and pre-diabetes are problems in the Hispanic population in the world, in the U.S., in North Carolina, in Charlotte, and in the free clinic patient population.
2. A text message intervention will be conducted with the uncontrolled diabetes patients at the free clinic to help improve their diabetes behavioral and physiological outcomes and help the clinic to retain grant funding.

To Study and examine data, the results will include graphs and data. To be able to receive grant funding, this clinic has two goals related to their care of patients with chronic diseases:

Goal 1: 60% of diabetic patients to have a Hemoglobin A1C (A1C) of less than 7 (based on 175 patients with diabetes). For quarter two of 2017 the clinic was at 33% of this goal.

Goal 2: 65% of patients with Hypertension and Diabetes are to have a cholesterol level at goal (<200) (based on 425 patients). For quarter two of 2017 the clinic is at 41% of this goal. Lessons learned from the literature are included under the study section of the diagram.

The final step in the PDSA is to Act to sustain performance and spread change:

1. By the end of the DNP project text message intervention, Latino adults with diabetes at the free clinic will have improved diabetes control as evidenced by improved A1C.
2. By the end of the DNP project text message intervention, Latino adults with diabetes at the free clinic will have improved diabetes self-management as measured/evidenced by improved diabetes knowledge, self-care, and self-efficacy tool scores.

This text message intervention seeks to help patients that come to the free clinic that have uncontrolled diabetes (A1C > 7) improve their diabetes clinical and behavioral outcomes, and thereby help them to live healthier, more hopeful and productive lives as they deal daily with this chronic illness.

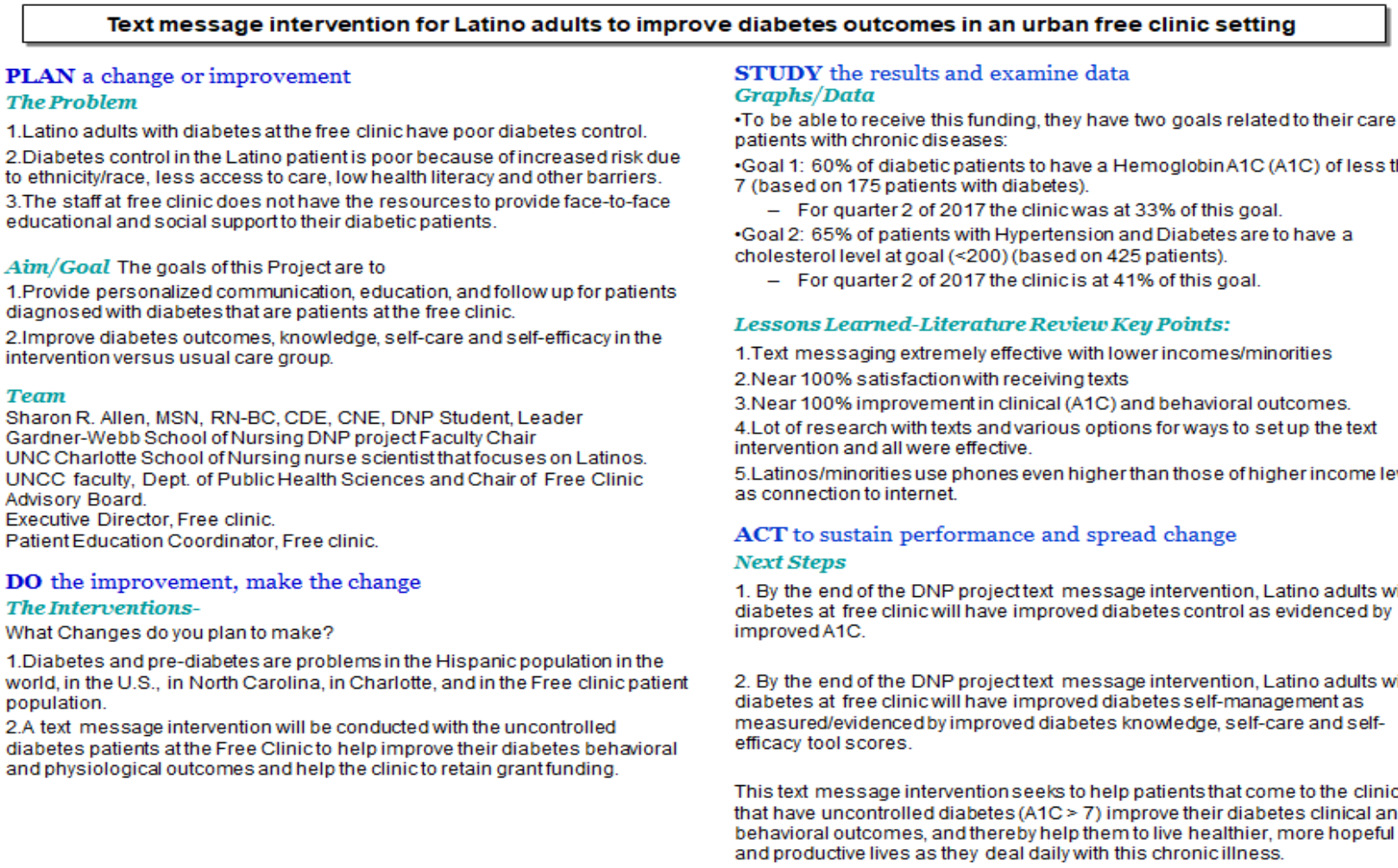


Figure 7: Plan, Do, Study, Act Model for DNP Project

Project Tools/Surveys for Pre and Post Tests to Measure Outcomes

Tools were used to measure diabetes clinical and behavioral outcomes. Tools were selected based on appropriateness for the setting, feasibility for use, reliability and validity, responsiveness to measure outcomes over time, and acceptability to the clinic staff and patient population at the clinic (Zaccagnini & White, 2017, pp. 476-477).

Pre and post-tests were used to assess diabetes knowledge, diabetes self-care, and diabetes self-efficacy. People with diabetes have to know information about diabetes to apply to their lives. People with diabetes have to do 90-95% of their own self-care so evaluating this part of their diabetes self-management is important. Self-efficacy is an evaluation of their confidence to be able to perform the self-care needed to manage this chronic condition. Four tools (see Table 1) were used for this DNP project: the Spoken Knowledge in Low Literacy in Diabetes (SKILLD) tool, the Summary of Diabetes Self-Care Activities (SDSCA) tool, the Diabetes Self-Efficacy Scale (DSES), and the Diabetes Empowerment Scale Short Form (DES-SF) tool. The Flesch-Kincaid Grade Level calculated for the four tools was 5.8, and a Flesch Reading Ease level of 76.0.

Table 1

Diabetes Tools (English and Spanish Versions)

TOOL	Abbreviation	Knowledge	Self-Care	Self-Efficacy
Spoken Knowledge in Low Literacy in Diabetes Scale	SKILLD	YES		
Summary of Diabetes Self-Care Activities	SDSCA		YES	
Diabetes Empowerment Scale -SF (short form)	DES, DES-SF			YES
Diabetes Self-Efficacy Scale	DSES			YES

For diabetes knowledge, the Spoken Knowledge in Low Literacy in Diabetes (SKILLD) tool was used. The English tool was developed and evaluated at the University of North Carolina in Chapel Hill at an academic internal medicine practice (Rothman et al., 2005) with low literacy African Americans. Nursing faculty (Garcia, Zuniga, Reynolds, Cairampoma, & Sumlin, 2015) at the University of Texas, Austin, modified the English version of the SKILLD and developed the Spanish version for use with low literacy Mexican Americans. Since a large percentage of Spanish-speaking patients at the free clinic are from Mexican origin, this tool is appropriate for use in this population and setting to evaluate the diabetes knowledge of this Spanish-speaking group. The SKILLD tool is a verbally administered test composed of 10 open-ended questions that have an additional probing question for all 10 questions. The questions cover high and low blood sugar, foot examination, eye exam, blood sugar level norms, A1C, exercise, and diabetes complications. An answer key indicates which answers would be correct.

The English version demonstrated high internal consistency (0.72). The SKILLD English tool was derived from validated scales of diabetes knowledge (Diabetes Knowledge Test from the Michigan Diabetes Research Center, 2017). The Spanish version demonstrated moderate internal consistency (Cronbach's alpha .64), but showed high interrater reliability and content and construct validity (Garcia at al., 2015).

Diabetes self-care was evaluated pre and post intervention using the Summary of Diabetes Self-Care Activities Scale (SDSCA). The English version of the SDSCA was developed by Toobert, Hampson and Glasgow (2000), and they evaluated results from seven studies where the SDSCA tool was used. Toobert et al., (2000) concluded that the tool had "adequate internal and test-retest reliability and evidence of validity and sensitivity to change" (p. 946). The Spanish version was developed by nursing faculty at the University of Tucson (Vincent, McEwen, & Pasvogel, 2008) and then further adapted for use in Spain by Caro-Bautista et al. (2016). Vincent et al. (2008) related that the Spanish version is valid and reliable. The Spanish SDSCA test-retest correlations ranged from .51 to 1.00 and had an internal consistency (Cronbach α) of .68, and is considered to have conceptual and content equivalency with the English version (Vincent et al., 2008). The tool covers self-care behaviors essential to be completed by persons with diabetes: diet, exercise, blood sugar testing, foot care, smoking (cessation), medications and self-care recommendations. Nursing instructors and researchers Caro-Bautista, Martin-Santos, and Morales-Ascencio (2013) completed a systematic review of psychometric properties of tools that evaluate self-care in people with type 2 diabetes. For the SDSCA Caro-Bautista et al. (2013) gave a positive rating for content validity for the SDSCA, a negative rating for reliability and a positive rating for responsiveness.

Self-efficacy is needed to accomplish diabetes self-management. It is the confidence to think you can effectively self-manage diabetes. Self-efficacy is based on Bandura's Social Cognitive Theory. Many self-efficacy scales have been developed, but the ones that are available in English and Spanish that fit the population and setting of this study are the Diabetes Self-Efficacy Scale (DSES) and the Spanish Version (DSES-S) and the Diabetes Empowerment Scale (DES). Ritter, Lorig, and Laurent (2016) from Stanford University examined the characteristics of both the English and Spanish versions of the DSES and DSES-S and found them to have internal consistency reliabilities across different sample groups and convergent validity. This tool is eight questions and each question starts with the words "how confident do you feel that you can…" (Ritter et al., 2016, p. 170). The score is one for "not at all confident" to 10 for "totally confident". For the DSES, Caro-Bautista et al. (2013) gave an indeterminate rating for content validity, no information for reliability and no information for responsiveness.

Self-efficacy is the basis of diabetes self-management. The Diabetes Empowerment Scale Short Form (DES-SF) tool is located on the Michigan Diabetes Research Center (2017) website, and was developed by Anderson et al. (1994), Anderson et al., (1995), Anderson, Fitzgerald, Funnell, & Fest, (1997), Anderson, Funnell, Fitzgerald, & Marrero, (2000), Anderson et al. (2001), Anderson, Fitzgerald, Gruppen, Funnell, & Oh, (2003). The tool is made of eight questions that measure psychosocial self-efficacy and the answers are on a five point Likert scale (1 = strongly disagree to 5 = strongly agree) (Michigan Diabetes Research Center, 2017). It has a high internal consistency (Cronbach α of 0.84 and 0.85) (Anderson et al., 2003). For the DES, Caro-

Bautista et al. (2013) gave a positive rating for content validity, a positive rating for reliability, no information for responsiveness, and a positive rating for theoretical ground. The question wording and tool length (eight questions) and the content of the tool seem to be a good match for the free clinic setting.

SECTION VII

Implementation

IRB Approval, Consent, and Tools

Institutional Review Board (IRB) approvals were received from the University and the free clinic. Informed consent was received from 36 participants to be part of the text message intervention at the project study location. After completing informed consent, each participant completed four tools/surveys administered by the project leader. The tools/surveys administered were the Spoken Knowledge in Low Literacy in Diabetes Scale (SKILLD) with 11 open-ended questions; the Diabetes Empowerment Scale Short Form (DES-SF) with eight questions and a Likert scale; the Diabetes Self-Efficacy Scale (DSES) with eight questions and a 10 point scale; and the Summary of Diabetes Self-Care Activities Measure (SDSCA) with 12 questions and a response scale of zero to seven days a week for self-care activities. The SKILLD tool/survey was administered orally and the other three surveys were completed by showing the questions to participants while the project leader read questions to participants. The project leader wrote and filled in the participant answers to the survey questions, which ensured that all questions were answered by participants.

Threats and Barriers

Participants were able to opt out of receiving the texts at any point in time by texting the word “STOP” or “ALTO”. However, no participants ever requested to stop receiving the texts.

A1C post study result time frame was a threat to project completion/success. The project intervention was November and December, 2017. The A1C is a three-month

blood sugar average; therefore, the valid post-intervention A1C participant results would be three months after the end of the intervention (from March through May 2018). Patients will continue to be assessed for A1C levels by clinic staff.

The clinic has around 200 clinic patients that had an A1C result (> 7) that qualified for inclusion in the project. In September 2017, a clinic volunteer (student from nearby university) set up 94 appointments in Spanish for inclusion in the study and 69 did not come to the scheduled appointments (see Figure 8). Eleven participants were added that were at the clinic on a Tuesday in October for an appointment with the Nurse Practitioner (NP) and she referred them to be part of the diabetes text message intervention. The potential study participants missed their appointment for twelve reasons. (Table 2)

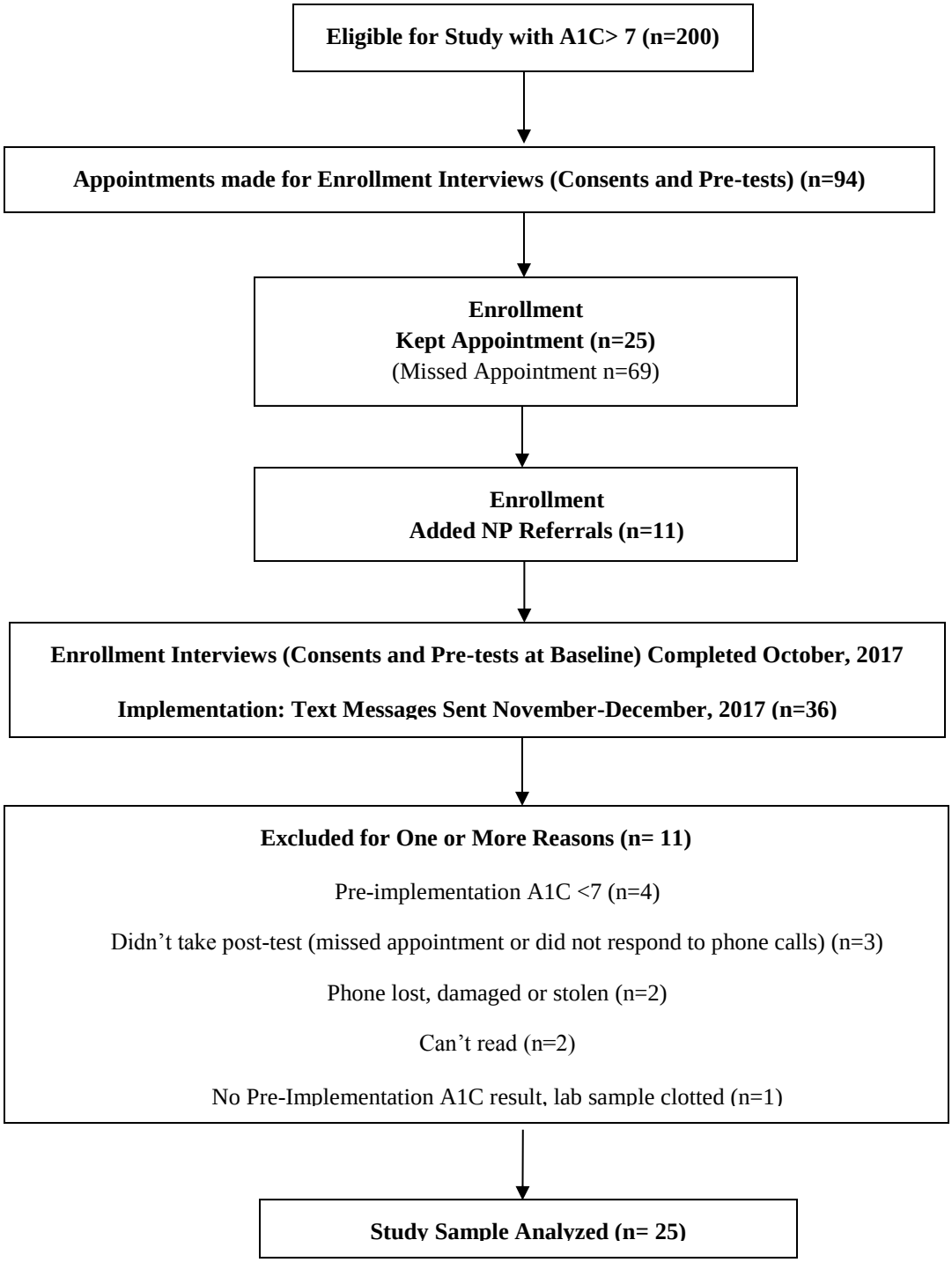
Table 2

Reasons Patients Did Not Come to Scheduled Enrollment Interview Appointments

Reason Number	Reason Did not Come to Appointment	How Many?
1	No answer to phone call morning of appointment. Left voicemail reminder, still didn't come	11
2	Forgot	8
3	Had to work	7
4	Said coming- No show	6
5	Another day better	5
6	Receptionist said not coming	4
7	No ride- Transportation	3
8	Out of Town	3
9	Another MD appointment (neurologist)	1
10	Family problems	1
11	Thought appointment was on the next day	1
12	Unknown	19
	Total Participants that did not come to Scheduled DNP Project Enrollment Interview Appointments	69

Of the 36 participants that consented, 11 had to be excluded from the study (see Figure 8). Four participants had to be excluded for pre-intervention A1C results less than 7 (one of them was the one that lost their phone). Three participants did not complete the post-tests so were excluded from the study. Two participants lost their phones (damaged, stolen) in the first weeks of the text message intervention and did not receive the texts, so had to be excluded (one had pre-intervention A1C less than 7). Two participants could not read, so were excluded from the study (their family members read the texts to them). One participant was new to the clinic (was in the hospital the previous week with a glucose over 600) and had blood drawn the day of consent, but the blood was clotted, so there was no valid A1C result. The final study sample that was analyzed was 25 (n=25).

Figure 8. Diabetes Text Message Intervention Participant Flow Diagram



Monitoring of Implementation

Text messages were sent for eight weeks in November and December, 2017 to study participants. A group was created in the CareMessage (CareMessage, 2017) text message platform and all texts were entered in English and Spanish in the "outreach" function of the text message program. After an introduction week text where the participants were given explanation of the program and how to opt out of the texts, then the following seven AADE 7 Self-Care Behaviors (AADE, 2017) were the topics for week's two to eight (See Table 3). Texts were sent twice a week (Tuesdays and Fridays at 7 p.m.). Since the texts could only be a maximum of 160 characters, some weeks two texts were sent the same night to include the necessary information for that topic (see column "number of texts sent" in Table 3). Through the eight-week intervention, the project leader checked responses and response rates weekly for the texts by accessing the summary data information for each text in CareMessage. In the last text the participants were given the opportunity to be part of the CareMessage 25 week diabetes self-management program and eight study participants responded yes to be part of this program. Updates on the progress of the project implementation were given by written and/or oral communication on Tuesdays from September to January to the clinic education coordinator and bi-weekly at the clinic health education staff meeting. For a complete list of all texts sent to project participants, refer to Appendix A.

Table 3

Text Message Intervention Topics, Number of Texts & Texts Requesting a Response

Week Number	Topic	Number of Texts Sent	Response Requested from Participant?	How many of 36 responded (%)?
Week 1	Introduction	3	Yes to see if received first text	20 (56%)
Week 2	AADE 7: Healthy Eating	2	Yes for following plate method and how many days of last 7 did they eat 5 servings of fruits & vegetable/day	7 (19%)
Week 3	AADE 7: Being Active	5	Yes, for type of exercise completed that week	21 (58%)
Week 4	AADE 7: Monitoring	3	No	
Week 5	AADE 7: Taking Medication	2	No	
Week 6	AADE 7: Problem Solving	2	No	
Week 7	AADE 7: Healthy Coping	2	No	
Week 8	AADE 7: Reducing Risks	4	Yes to see if they want to participate in 25 week diabetes text program	8 responded Yes to participate in 25 week program (22%)
Total				
8 weeks	8 Topics	23 texts	4 Weeks a Response to a Text was Requested.	39% average response rate on the 4 texts that requested a response.

Project Closure

Post-tests were administered in person or by phone to project participants in January, 2018 and the first week of February, 2018. The same four pre and post-tests (surveys/tools) were administered to project participants by the project leader. Since 69 of the 94 patients that were scheduled for pre-tests did not come to the appointments, to ensure attendance at post-survey appointments, phone calls were made by project leader to set up the post-test appointment. An appointment was created by the project leader in the electronic health record schedule so that the clinic receptionist would make sure and send the patients to the project leader for their post-test. A text message reminder of the appointment was sent via the CareMessage Text Message system to project participants to remind them of their post-test appointment date and time. Three of the 36 participants were unable to complete the post-tests in person or by phone and were excluded from the final data analysis.

The final text message was an invitation to participate in a 25 week diabetes self-management text message program via CareMessage text messaging. Eight participants indicated interest in the 25 week diabetes CareMessage self-management program and were enrolled in the program in March, 2018. Post study participant A1C results were retrieved from the electronic health record of the clinic. Data analysis and statistical results of pre and post-tests/surveys and pre and post intervention trending A1C results were reported to the clinic at health education staff meetings and to the clinic education coordinator at the end of the study.

SECTION VIII

Interpretation of Data

All statistical data analyses were performed using IBM Statistical Package for the Social Sciences (SPSS) Version 24.0. Statistical analysis of pre and post-test survey data was performed utilizing descriptive statistics and paired sample *t* tests.

Demographic and Descriptive Data

Demographic and descriptive data for study participants is shown in Table 4. In the final sample (n=25) more females participated in the study (55%) versus males (45%). The majority spoke Spanish as their primary language (96%). Participants were from six different countries of origin, and the majority was of Mexican descent (68%), and the second largest group from Honduran descent (12%). Excluded participants (n=11) were of Mexican (seven participants or 63.6%) and El Salvadoran (four participants or 36.4%). Descent. Eight of the study participants had previously received diabetes education at the clinic from the project leader who has been the Spanish-speaking volunteer Certified Diabetes Educator (CDE) at the clinic since 2013. Seven of the participants were on insulin (n= 7 or 28%), and the rest of the included sample (n=18 or 72%) took oral diabetes medications (n=17) or no diabetes medications (diet controlled n=1). The majority of the sample (n=25) came to take the posttest in person at the clinic (n=19 or 76%) versus those that completed the post tests on the phone (n=6 or 24%).

Table 4

Sample Characteristics, Demographics and Health Data for All Subjects (N=36) Versus Included Subjects (n=25) and Excluded Subjects (n=11).

Variable	Frequency (%) N=36	Frequency (%) n=25 included	Frequency (%) n=11 excluded
Age			
Age Range	33-68*	34-64*	33-68*
Average Age	47*	48*	45*
Gender			
Male	16 (44.4)	11 (44)	5 (45)
Female	20 (55.6)	14 (56)	6 (55)
Language			
Spanish	35 (97.2)	24 (96)	11 (100)
English	1 (2.8)	1 (4)	0
Country of Origin			
Mexico	24 (66.7)	17 (68)	7 (63.6)
El Salvador	5 (13.9)	1 (4)	4 (36.4)
Honduras	3 (8.3)	3 (12)	0
Guatemala	2 (5.6)	2 (8)	0
Venezuela	1 (2.8)	1 (4)	0
USA	1 (2.8)	1 (4)	0
Diabetes Education			
No education	24 (66.7)	17 (68)	7 (63.6)
Some prior to study	12 (33.3)	8 (32)	4 (36.4)
Insulin			
No insulin	26 (72.2) oral meds n=24, no meds n=2	18 (72) oral meds n=17, no meds n=1	8 (72) oral meds n=7, no meds n=1
Insulin	10 (27.8)	7 (28)	3 (27)
Post Survey			
In person	24 (72.7)**	19 (76)**	5 (62.5)**
Via phone	9 (27.3)**	6 (24)**	3 (37.5)**

Note. * Age is not listed by frequency or percent, but instead by range and average.
** Post-Survey values for n=33.

Quantitative Data

Methods

Paired *t*-tests were run/conducted to compare the scores/values from the pre-test/survey to the post test/survey scores for teach tool/survey for every diabetes text message intervention participant (N=36) and then for those that were included in the final sample (n=25). The results for n=33 (36 total with three that did not take the post-test) are explained in this paragraph. There was a higher average post test score and significant difference ($p < .05$) in all four tools/surveys. There was a significant difference in the SKILLD (tests diabetes knowledge) pre-test score (M = 6.21, SD =3.07) and the post-test score (M= 7.42, SD = 2.28), with the paired differences (M = -1.2, SD= 1.34), t (32) = -5.19, p = .000. There was a significant difference in the DSES (tests diabetes self-efficacy) pre-test score (M = 61.42, SD = 13.89) and the post-test score (M=69.64, SD = 10.94), with the paired differences (M = -8.21, SD = 9.11), t (32) = -5.18, p =.000. There was a significant difference in the DES-SF (tests diabetes self-efficacy) pre-test score (M =32.33, SD =3.93) and the post-test score (M=34.00, SD = 4.35), with the paired differences (M = -1.67, SD = 4.27), t (32) = -2.24, p = .032. There was a significant difference in the SDSCA (tests diabetes self-care) pre-test score (M = 46.17, SD = 12.70) and the post-test score (M=51.95, SD = 11.59), with the paired differences (M = -5.7, SD = 13.4), t (29) = -2.36, p = .025.

In the paired samples *t*-test, the results for the final sample (n=25) showed significant p values ($p < .05$), except for the DES-SF, (Table 5) for paired t test results and Cronbach α for all surveys/tools ore and post intervention (n=25). There was a significant difference in the SKILLD pre-test score (M = 6.68, SD = 3.02) and the post-

test score (M = 7.72, SD = 2.35) with the paired difference (M = -1.04, SD =1.34), *t* (24) = -3.89, p = .001. There was a significant difference in the DSES pre-test score (M =60.92, SD = 14.36) and the post-test score (M = 68.44, SD = 11.82), with the paired difference (M = -7.52, SD = 7.68), *t* (24) = -4.90, p =.000. There was a significant difference in the SDSCA pre-test score (M = 45.57, SD = 12.58) and the post-test score (M = 51.20, SD = 12.15), with the paired difference (M = -5.63, SD = 12.52), *t* (22) = -2.16, *p* = .042. There was a not a significant difference between the DES-SF pre-test score (M = 32.80, SD = 4.06) and the post-test score (M = 34.44, SD = 3.99), with the paired difference (M = -1.64, SD = 4.54), *t* (24) = -1.80, *p* = .084.

Table 5

Quantitative Data Results: Changes in DM Knowledge (SKILLD), DM Self-Efficacy (DES-SF, DES) & DM Self-Care (SDSCA), n=25.

	Pre			Post			*t* test	*Sig.*
Tool/Survey	M	SD	α	M	SD	α	*t*(24)	*p*
SKILLD	6.68	3.02	.809	7.72	2.35	.705	-3.89	.001
DES-SF	32.8	4.06	.746	34.44	3.99	.879	-1.80	.084
DSES	60.92	14.36	.833	68.44	11.82	.844	-4.90	.000
SDSCA	45.57	12.58	.646	51.20	12.15	.668	-2.16*	.042*

Note. * SDSCA *t* and *p* values for n=23

Two of the tools/surveys have subscales. The DES-SF measures self-efficacy and the three subscales of the DES-SF are: (1) psychosocial aspects, (2) dissatisfaction and change, and (3) goals. The only scale with significant values was the goals subscale [*t* (24) = -2.13, *p* = .044]. The psychosocial aspects [*t* (24) = -.849, *p* = .40] and

dissatisfaction and change scales [t (24) = -1.27, p = .216] were not significant at the p < .05 level.

The other tool with subscales is the SDSCA. This tool has self-care categories or scales for diet, physical activity and exercise, blood sugar testing, foot care and taking medications. The diet scale is broken down into overall diet, and it is further divided into subscales of general diet and specific diet. The only scale with significance at the p < .05 level is the overall diet scale [t (24) = -2.23, p = .036]. The diet scales/subscales show more improvement (overall diet, p = .036; general diet, p = .077, and specific diet, p = .086) than the exercise scale p = .359.

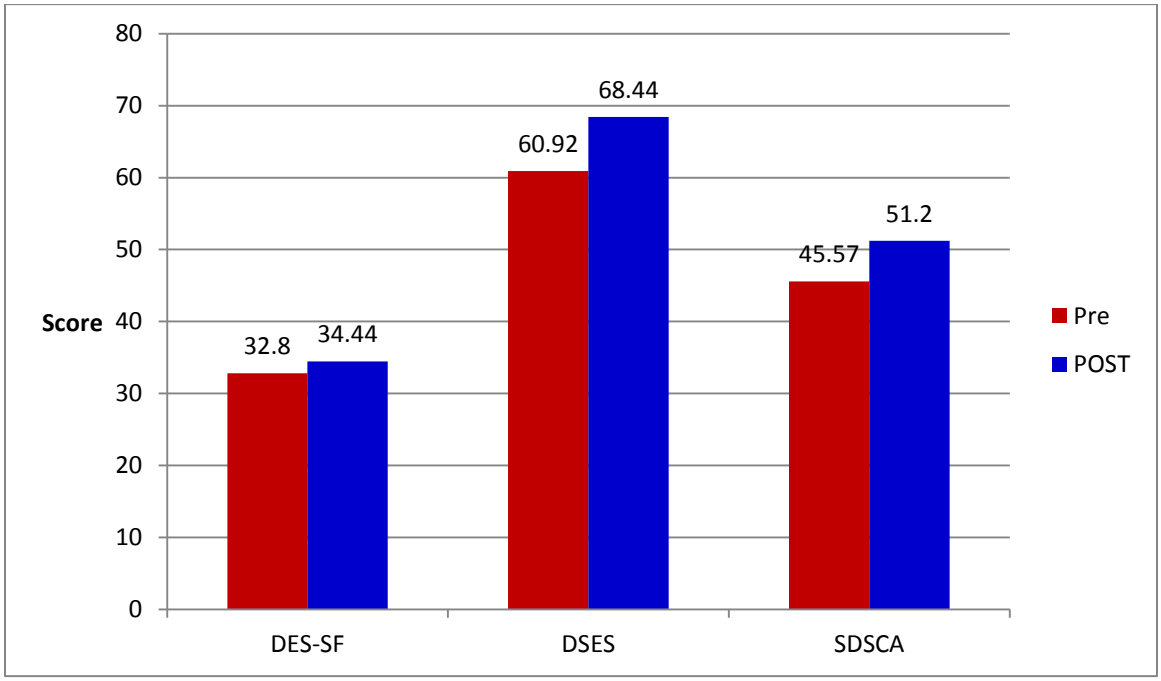
For the initial sample (N=36), A1C pre-intervention values (M = 9.33, SD = 2.02) and the trends for the same participants from January and February, 2018 post-intervention lab values (n=16) show improvements (M=8.09, SD =1.64), with the A1C paired differences (M = 1.24, SD = 1.82), t (15) = 2.73, p = .016.

For the final sample (n=25) with January, February, and March A1C lab results (n=22), A1C improvements were still significant from the pre-intervention (M = 9.10, SD = 1.51), and the trends of the post-intervention January, February, and March lab values (M = 8.26, SD =1.29), with the A1C paired differences (M = .845, SD = 1.42), t (21) = 2.79, p = .011.

Testing for internal consistency with the Cronbach α test showed good reliability for both SKILLD pre (.809) and post (.705) samples. The DES-SF showed good validity for both pre (.746) and post (.879) samples. The DSES was valid across all sample sizes for both pre (.833) and post (.844) samples. The SDSCA was reasonably valid for both pre (.646) and post (.668) samples.

Discussion

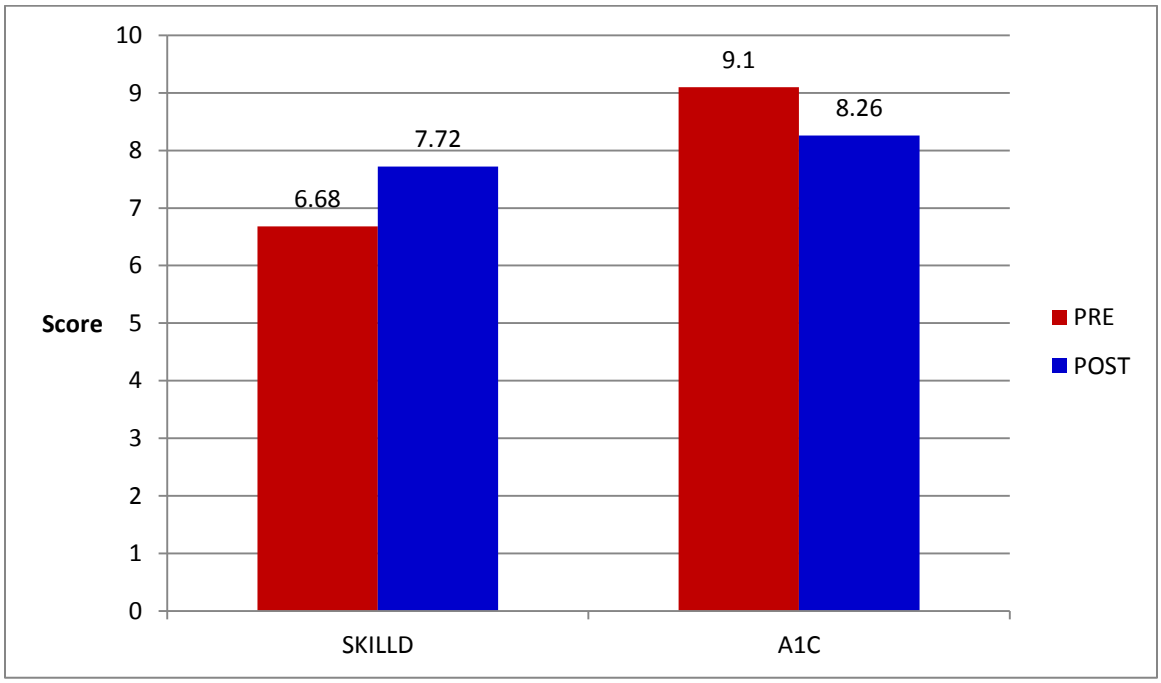
In the final sample (n=25) three of the four tools showed significant *p* values < .05 (SKILLD, *p* =.001; DSES, *p* = .000; SDSCA, *p* = .042). The fourth tool (DES-SF) had a non-significant *p* value (.084). See Figures 9 and 10 for graphs showing the improvements in the pre and post-test average scores for all four tools and for A1C. All of the surveys/tools showed desirable post intervention higher scores and a desirable decrease in the post intervention A1C lab value.



Note. Final Study Sample (n=25) pre and post intervention average scores for the DES-SF diabetes self-efficacy tool, the DSES diabetes self-efficacy tool, and SDSCA diabetes self-care tool.

Figure 9. DES-SF, DSES and SDSCA Pre and Post Intervention Average Score Comparisons

A paired *t*-test of the pre-intervention participant A1C lab results and the post-intervention A1C lab results from April to May will be evaluated later in the summer of 2018 to determine actual pre and post statistics for A1C lab values prior to and after the text message intervention. All A1C *p* values for January, February and March trends for A1C and pre and post lab values were significant at $p = .011$. Clinical significance of improvement in the A1C from 9.10 to 8.26 (n=22) is an improvement of 0.84 in the A1C from the pre to the post intervention. This trend is encouraging. If the intervention was longer the A1C could possibly improve even more.



Note. Final study sample pre and post intervention average scores for the SKILLED (n=25) diabetes knowledge test and the trending A1C pre and post intervention lab values (n=22) from January, February and March 2018.

Figure 10. SKILLD and A1C Pre and Post Intervention Average Score Comparisons

There was less than a 40% average response rate for the four weeks of texts that requested a response (see Table 3). The text requesting a response to following the plate method and asking how many day of the last seven they had eaten five servings of fruits and vegetables per day was the week before Thanksgiving, and seven (19%) responded. The week of Thanksgiving was the week the text was sent requesting a multiple choice response to what type of exercise the participant had completed that week (walk, salsa/Zumba dance, gym, or other exercise) and 21 of 36 participants (58%) responded back with the type of exercise completed. Of those responding, walking was the most common exercise -ten participants (43 %); then dance- three participants (13%); then other exercise- three participants (13%); then two did both walking and dance (9%); and five responded (22%) with yes or gracias. There could possibly have been an effect on the response based on the Thanksgiving holiday (for the text about foods eaten) and the cold weather (for participation in exercise).

The SKILLD is a low literacy tool for diabetes knowledge and is to be administered verbally. The tool/survey has 11 questions and is scored by total number of correct responses. Nine of the 11 questions in this tool are open ended, and five of these questions had great variability in the participant responses. The project leader sought help from the bilingual Nurse Practitioner at the clinic for consistency and accuracy in scoring responses to the open-ended questions. In every case, the Nurse Practitioner agreed with the project leader's initial scoring for the correct response to these questions.

In the SKILLED pre-test for the final sample (n=25) the questions with the most correct responses were questions seven and 10. Twenty of the 25 knew they needed to have an annual eye exam and 20 knew that they should exercise a minimum of 150

minutes per week. The question with the next highest score was question 11, and 19 of the participants could verbalize at least two complications of diabetes. The questions with the lowest score was question eight, where only two people were able to verbalize the correct normal fasting blood sugar range of 70 or 80 to 130. The other two lowest scores were for verbalizing two symptoms of hypoglycemia (13 of 25 correct answers) and two symptoms of hyperglycemia (15 of 25 correct answers).

In the SKILLD post-test survey scores three of the final sample (n=25) participants decreased their final score by one point. Four of the participants had the same overall score and 18 (75% of participants) increased in their overall score with a one to four point improvement in score. There was one question that no participant got right on the posttest: "What is a healthy range for fasting blood glucose or blood sugar? Probe: When you get up first thing in the morning and check your blood sugar before you eat or take medicine, what is the lowest and highest it should be?" (Garcia et al., 2015; Rothman et al., 2005). The correct response had to have both numbers (range) correct. No one gave the correct answer: "between 70-130" (Garcia et al., 2015; Rothman et al., 2005) or "between 80-130" (ADA, 2017). Those that answered incorrectly would state a narrower range like "90-110" or would say, "My sugars are" and then state their normal morning ranges in their blood sugars. The text that explained normal blood sugar ranges was sent in text week four (see Appendix A) and it included both the fasting range and the normal two hour post prandial blood sugar, "Check your blood sugar at least once a day or as directed by clinic staff. Normal blood sugar is 80-130 before eating and 100-180 two hours after eating." The words "healthy range" or "rango saludable" in Spanish were not in the text that was sent. Either the question may not have been clearly

understood in Spanish in the survey, or the answer in the text may not have been clearly presented or understood by the participants.

The DES-SF self-efficacy tool has eight questions and the first question was written as a negative ("dissatisfied") and confused almost all participants in both the pre and posttest. Question 1 was "In general, I believe that I know what part(s) of taking care of my diabetes that I am dissatisfied with" (Michigan Diabetes Research Center, 2017; Anderson et al., 2000; Anderson et al., 2003). Then they had to answer with a Likert scale of strongly disagree, somewhat disagree, neutral, somewhat agree, or strongly agree. The project leader had to repeat the question for almost everyone and then they asked her to explain what it meant. It is possible that this is why this is the only tool that did not have significant results and this is because of the paired samples correlations *p* value for this question was .892 (n=33). The *p* value for the rest of the survey questions was $p < .186$. In the post test, the lowest average score was question one with an average score of 3.64 of 5 points.

Only two of the DES-SF questions showed pre- and post-test significance: Question three "In general, I believe that I can try out different ways of overcoming barriers to my diabetes goals," (Michigan Diabetes Research Center, 2017; Anderson et al., 2000; Anderson et al., 2003) had a *p* value of .049. Question six, "In general, I believe that I can ask for support for having and caring for my diabetes when I need it," (Michigan Diabetes Research Center, 2017; Anderson et al., 2000; Anderson et al., 2003) had a *p* value of .015. In the DES-SF survey for self-efficacy pre-test for the final sample (n=25) the question that had the highest average score (4.48 of 5 possible points) was question six which indicates they know where they can find support to live and care for

their diabetes. The patients indicated in relation to question six that they could come to the clinic for support. They repeatedly expressed great confidence in the clinic, clinic staff and the Nurse Practitioner at the clinic during both the pre and post-tests. The question with the second highest average score (4.26 of 5 points) is "I know enough about myself as a person to make diabetes care choices that are right for me" (Michigan Diabetes Research Center, 2017; Anderson et al., 2000; Anderson et al., 2003).

In the DES-SF survey post-test survey scores final sample (n=25) participants, there were six participants that decreased in their overall average score (24% of participants), six participants stayed the same (24%), and 13 of the 25 (52%) increased in their overall average score. All of the eight questions showed an increase in the average score except for question five that asks if they know positive ways to cope with diabetes-related stress. The two questions that showed the largest increase in average score were questions one and two. Question one was the question that confused them about areas of diabetes dissatisfaction. Question two, related to goals, was the question with the largest increase from pre-test 4.08 to post-test 4.48, or an increase of 0.4. The goals subscales had a significant *p* value of .04. The two questions that showed the smallest improvement were question eight, "I know enough about myself as a person to make diabetes care choices that are right for me" (Michigan Diabetes Research Center, 2017; Anderson et al., 2000; Anderson et al., 2003) (from 4.40 pre to 4.48 post, or a 0.04 improvement in average post test score) and question seven, "I know what helps me stay motivated to care for my diabetes" (Michigan Diabetes Research Center, 2017; Anderson et al., 2000; Anderson et al., 2003) (from 4.28 pre to 4.48 post, or a 0.2 point improvement).

In the DSES survey for self-efficacy pre-test for the final sample (n=25), the question with the highest score (9.08 of 10 possible points) was question seven: "How confident do you feel that you can judge when the changes in your illness mean you should visit the doctor?" (Ritter et al., 2016).The second highest score (8.16) was question eight, "how confident do you feel that you can control your diabetes so that it does not interfere with the things you want to do?" (Ritter et al., 2016).

In the DSES post-test survey scores, only two of the final sample (n=25) participants (8%) had a decreased average in the post-test score. Three participants (12%) had the same pre- and post-test score, and twenty participants (80%) had an increase in their post-test scores. Question seven, "how confident do you feel that you can judge when the changes in your illness mean you should visit the doctor?" was the highest score (9.45 of 10). The second highest scoring question, "how confident do you feel that you can control your diabetes so that it does not interfere with the things you want to do?" was question eight (9.27 of 10). The question with the lowest average score (6.92 of 10 points) was question two "how confident do you feel that you can follow your diet when you have to prepare or share food with other people who do not have diabetes?" The second lowest average score (7.16) was question one and is also diet related, "How confident do you feel that you can eat your meals every four to five hours every day including breakfast every day?" (Ritter et al., 2016). Question seven, both pre- and post-tests, showed confidence (efficacy) that the clinic (NP and staff) and texts have educated them about when they need follow up for their diabetes care and showed great confidence in the care provided to them by the clinic. It can be concluded that the patients feel that the clinic staff cares for them and encourages them in their diabetes self-management.

In the SDSCA survey for diabetes self-care pre-test for the final sample (n=25), the question with the highest score (6.92 of 7 days or 99% compliance) is question 12, "On how many of the last seven days did you take your recommended diabetes medication?" (Toobert, Glasgow, & Radcliffe, 2000; Vincent et al., 2008). This is 99% compliance with taking diabetes medications. There are two questions on the tool that ask about exercise. The lowest average score (1.64 of 7 days) was question seven, "On how many of the last seven days did you participate in a specific exercise session?" (Toobert et al., 2000; Vincent et al., 2008). Participants responded to question six that they participated in at least 30 minutes of exercise an average of 4.12 of 7 days. Participants were exercising individually (mainly walking or dance was mentioned in text response week three), but not in group exercise sessions.

In the SDSCA survey post-test survey scores for the final sample (n=25), eight participants (32%) had lower post-test scores, and three participants (12%) stayed the same. Fourteen participants (56%) improved in their overall diabetes self-care score. Three questions had a lower post-test score (questions eight, nine, and twelve). One participant ran out of test strips so scored zero of seven in questions eight and nine (about blood sugar). The clinic was closed two weeks at Christmas and New Year and participants were unable to buy strips at the clinic, so this may be why question eight about checking blood sugar decreased (from 3.80 to 3.68); and question nine about checking blood sugar according to provider recommendations decreased (from 3.80 to 3.76). Question 12 for medication compliance decreased from 6.92 of 7 days pre to 6.88 of 7 days (98% compliance) post intervention. One participant ran out of medication and could not get a refill since the clinic was closed and they were one of only two

participants that took their medication less than seven days. Even though the question for daily exercise stayed the same in the pre- and post-test (4.12 of 7 days), January was a very cold month and potentially affected the amount of exercise (walking) completed outdoors.

There was only one time when a participant sent a text through the CareMessage system to the project leader and asked, "Que puedo hacer cuando la asucar la tengo alta y no la puedo controlar" (What can I do when my sugar is high and I can't control it?). The response sent back to the participant by the project leader was, "Lower blood sugar by exercising, taking medications as prescribed and cutting down on the amount of food you eat."

During week three of text messages, two of the participants indicated that the phone numbers that had been entered in CareMessage for them were incorrect. The clinic education coordinator indicated that it was permissible to correct the phone numbers. Then weeks one and two texts were sent the third week to catch these participants up with the rest of the study group.

When setting up post-intervention appointments, one participant said he had changed phones and did not receive any texts, and he requested to still receive all texts and be a part of the study. All texts were sent to him and he was still included as a study participant.

Before administering the post-tests, the project leader asked an open-ended question of the participants: "Do you have any comment(s) you would like to make about the text messages?" There were four themes that emerged in the answers of participants: 1. Very good, 2. Remembering, 3. Knowledge, 4. Thanks. The most frequent response

(nine participants) given was “estan muy bien” or they were very good. The second most common response (eight participants) was that they helped them remember what to do to care for their diabetes. The third most common response was that the texts helped them improve in their diabetes knowledge (diet, exercise, checking blood sugars). The last theme was that they expressed thankfulness for the texts. One participant said, “I liked receiving the texts, they were very motivating. They helped me remember what I should do. I liked the texts very much.”

Implications of Findings

The two goals of this project were met: (1) Provide personalized communication, education, and follow up for patients diagnosed with diabetes that are patients at the free clinic; and (2) Improve diabetes outcomes, knowledge, self-care, and self-efficacy in the intervention versus usual care group.

The two outcome objectives of this project were met: (1) By the end of the DNP project text message intervention, Latino adults with diabetes at the free clinic will have improved diabetes control as evidenced by improved A1C; and (2) By the end of the DNP project text message intervention, Latino adults with diabetes at the free clinic will have improved diabetes self-management as measured/evidenced by improved diabetes knowledge, self-care and self-efficacy tool scores.

Overall, the participants improved in diabetes knowledge, self-efficacy and self-care as evidenced by the significant *p* values for tools and by the improved trending in the A1C pre and post intervention lab results.

Application to Theoretical/Conceptual Framework

The theoretical basis of this project was Social Cognitive Theory and the concept of self-efficacy. The results of this project show improved self-efficacy in diabetes self-management as evidenced by the survey results and significant *p* values in this project. Participants improved in diabetes knowledge, diabetes self-efficacy, and diabetes self-care, which will improve their overall diabetes self-management. The use of text message is welcomed and highly utilized by Latinos and the underserved and was an effective platform to use to improve the diabetes outcomes of project participants. In the fall of 2017 when the texts were being sent, the Latino population was more fearful to leave their homes for fear of deportation, so since the texts were received conveniently at any time and place, this was a convenient, cost effective and available technology used to easily deliver information and diabetes education to underserved Latinos.

Limitations

A valid post-intervention A1C value would be collected three months after the end of the intervention. Three-month A1C lab values will continue to be collected through June, 2018. The A1C lab values from January, February, and March were used for trending in the improvement in the A1C values. Three participants are scheduled for A1C tests for April or May and five have no lab date scheduled for a three-month follow up A1C test. Three of the five that have no lab test scheduled did complete pre and post tools/surveys, so were included in the study. In June when post-intervention A1C tests are checked in the electronic health record, if the participant failed to receive a post-intervention A1C lab test, then that participant that was part of the n=25 sample could be excluded from the final sample and final A1C data analysis.

Implications and Recommendations for Practice and Conclusion

The findings in this DNP project validate findings from literature reviewed for this study. From the literature, SMS/text messages are an effective intervention to improve diabetes outcomes. Research studies from Los Angeles specifically looked at how to design a text message intervention among low-income Latino patients with diabetes (Ramirez et al., 2016). Information noted that Latinos are less likely (than non-Latinos) to receive DSME. The article noted that barriers to DSME for this population were health system factors (poor access to healthcare and health education), provider factors (language, cultural, communication barriers), and patient factors (health literacy level, cultural beliefs) (Ramirez et al., 2016).

A text message or short message service (SMS) intervention was considered the best from the identified need of the free clinic and from evidence-based practice research. The prepared proactive team of clinic volunteers and staff can send text messages to patients at any time. A text message/SMS intervention has long term sustainability at the free clinic. The CareMessage text message platform has a 25 week diabetes self-management program built into the system. Eight of the project participants opted to continue in this longer text message program. Any of the clinic patients with diabetes can be enrolled in the system at any time. This program and regular diabetes care provided by the clinic should continue to improve care and outcomes and decrease A1C of those patients at the clinic that have diabetes. Clinic staff/students/volunteers can continue at any time to send texts, messages and education through the CareMessage text message system.

The DNP project leader will continue to provide Spanish diabetes education at the clinic and work with the nurse practitioner, clinic education coordinator, clinic education team and volunteers to help improve the outcomes of patients with diabetes at the free clinic. The nurse practitioner at the clinic will be doing her DNP project at the clinic in 2018-2019 and plans to build upon this DNP text message project by focusing her project on patients at the clinic that have diabetes to continue to improve outcomes for them.

Does personalized communication, education, and follow up for patients at the free clinic improve diabetes outcomes, knowledge, self-care, and self-efficacy? Latino adults with diabetes at the free clinic had poor diabetes control, and because of increased risk due to ethnicity/race, less access to care, low health literacy, and other barriers. The staff at the free clinic did not have the resources to provide face-to-face educational and social support to their diabetic patients. The use of texts and technology to help improve diabetes knowledge, diabetes self-efficacy, and diabetes self-care showed great promise for the future to improve the outcomes of underserved Latinos that have no insurance. Latinos and other minorities use phones at higher rates than those of higher income earners and they use their phones as their primary connection to the internet. This project validated that text messaging was extremely effective with lower income minorities and was an effective alternate way for the clinic to provide education and social support to their patients with diabetes. The patients verbalized high satisfaction with receiving the texts and had excellent improvement in clinical and behavioral outcomes and thereby this helps them to live healthier and more hopeful and productive lives as they deal daily with this chronic illness. This project shows that text message technology is an effective tool

to use to improve diabetes self-management in the underserved free clinic Latino population.

References

Agboola, S., Jethwani, K., Lopez, L., Searl, M., O'Keefe, S., & Kvedar, J. (2016). Text to Move: A randomized controlled trial of a text-messaging program to improve physical activity behaviors in patients with type 2 diabetes mellitus. *Journal of Medical Internet Research*, *18*(11), 1-13. doi:10.2196/jmir.6439

Alvarez, S. (2014). Type 2 diabetes program geared toward Latinos fosters more than self-management. *Generations, 38*(4), 41.

American Association of Diabetes Educators. (2017). AADE7 Self-Care Behaviors. Retrieved from https://www.diabeteseducator.org/patient-resources/aade7-self-care-behaviors

American Diabetes Association. (2017). Standards of medical care in diabetes. In Cefalu, W. D. (Ed.). *Diabetes Care*. *40(*1), 1-135. DOI: 10.2337/dc17-S018

American Diabetes Association. (2018, March). American Diabetes Association releases "Economic Costs of Diabetes in the U.S." report at annual call to Congress event urging legislators to make diabetes a national priority. Retrieved from http://www.diabetes.org/newsroom/press-releases/2018/economic-cost-study-call-to-congress-2018.html

Anderson, R. M., Fitzgerald, J. T., Funnell, M. M., & Feste, C. (1997). Diabetes Empowerment Scale (DES): A measure of psychosocial self-efficacy. *Diabetes, 46*. 269A.

Anderson, R. M., Fitzgerald, J. T., Gruppen, L. D., Funnell, M. M., & Oh, M. S. (2003). The Diabetes Empowerment Scale-Short Form (DES-SF). *Diabetes Care 26*:1641-1643.

Anderson, R. M., Funnell, M. M., Butler, P. M., Arnold, M. L., Fitzgerald, J. T., & Feste, C. C. (1994). Evaluation of a patient empowerment program. *Diabetes 43*:20A, 1994.

Anderson, R. M., Funnell, M. M., Butler, P. M., Arnold, M. S., Fitzgerald, J. T., & Feste, C. C. (1995). Patient empowerment: Results of a randomized controlled trial. *Diabetes Care 18*(7):943-949.

Anderson, R. M., Funnell, M. M., Fitzgerald, J. T., & Marrero, D. G. (2000). The Diabetes Empowerment Scale: A measure of psychosocial self-efficacy. *Diabetes Care 23*(6):739-743.

Anderson, R. M., Funnell, M. M., Nwankwo, R., Gillard, M. L., Fitzgerald, J. T., & Oh, M. (2001). Evaluation of a problem-based, culturally specific, patient education program for African Americans with diabetes. *Diabetes 50(Suppl. 2)*. 195.

Arambepola, C., Ricci-Cabello, I., Manikavasagam, P., Roberts, N., French, D. P., & Farmer, A. (2016). The impact of automated brief messages promoting lifestyle changes delivered via mobile devices to people with type 2 diabetes: A systematic literature review and meta-analysis of controlled trials. *Journal of Medical Internet Research, 18*(4), 1-12. doi:10.2196/jmir.5425

Arora, S., Peters, A. L., Burner, E., Lam, C. N., & Menchine, M. (2014). Trial to examine text message-based mHealth in emergency department patients with diabetes (TExT-MED): A randomized controlled trial. *Annals of Emergency Medicine, 63*(6), 745-754. doi:10.1016/j.annemergmed.2013.10.012

Atarodi, A., RahmaniBeilondi, M., RahmaniBeilondi, R., Bondar, T., & Bagheri, M. (2013). The survey of SMS effect on general health and quality of life in people with diabetes type 2 referring to clinic of 22-Bahman Hospital of Gonabad City in 2011. *Zahedan Journal of Research in Medical Sciences, 15*(4), 56-59.

Attridge, M., Creamer, J., Ramsden, M., Cannings-John, R., & Hawthorne, K. (2014). Culturally appropriate health education for people in ethnic minority groups with type 2 diabetes mellitus. Cochrane Database of Systematic Reviews. Issue 9. Art. No.: CD006424. DOI: 10.1002/14651858.CD006424.pub3.

Bandura, A. (1977a). Self-efficacy: toward a unifying theory of behavioral change. *Psychological Review, 84*, 191-215. doi:10.1037/0033-295X.84.2.191

Bandura, A. (1977b). *Social learning theory.* Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Englewood Cliffs, NJ: Prentice-Hall. ISBN 0-13-815614-X

Barley, E., Clifton, A., Enright, A., Lee, G., Norman, I., Richards, D., & Sturt, J. (2014). Development of an online platform to support the self-management of symptoms and promote the wellbeing of people with cardiovascular disease (CVD). *International Journal of Integrated Care,* 1419. doi: 10.2196/resprot.4280.

Bernal, H., Woolley, S., Schensul, J., & Dickinson, J. (2000). Correlates of self-efficacy in diabetes self-care among Hispanic adults with diabetes. *Diabetes Educator, 26*(4), 673-680.

Berra, K., Rippe, J., & Manson, J. E. (2015). Making physical activity counseling a priority in clinical practice: The time for action is now. *Journal of the American Medical Association, 314*(24), 2617-2618. doi:10.1001/jama.2015.16244

Bobrow, K., Brennan, T., Springer, D., Levitt, N. S., Rayner, B., Namane, M., & ... Farmer, A. (2014). Efficacy of a text messaging (SMS) based intervention for adults with hypertension: protocol for the StAR (SMS Text-message Adherence suppoRt trial) randomized controlled trial. *BMC Public Health, 14*(1), 1-17. doi:10.1186/1471-2458-14-28

Buchholz, S. W., Sandi, G., Ingram, D., Welch, M. J., & V Ocampo, E. (2015). Bilingual text messaging translation: Translating text messages from English into Spanish for the Text4Walking Program. *Journal of Medical Internet Research, 4*(2), 1-6. doi:10.2196/resprot.3984

Buis, L. R., Hirzel, L., Turske, S. A., Jardins, T. D., Yarandi, H., Bondurant, P., & Eysenbach, G. (2013). Use of a text message program to raise type 2 Diabetes risk awareness and promote health behavior change (Part II): Assessment of participants' perceptions on efficacy. *Journal of Medical Internet Research, 15*(12), 1-14. doi:10.2196/jmir.2929

Burner, E. R., Menchine, M. D., Kubicek, K., Robles, M., & Arora, S. (2014). Perceptions of successful cues to action and opportunities to augment behavioral triggers in diabetes self-management: qualitative analysis of a mobile intervention for low-income Latinos with diabetes. *Journal of Medical Internet Research, 16*(1), 1-8. doi:10.2196/jmir.2881

Butts, J. B., & Rich, K. L. (2015). *Philosophies and theories for advanced nursing practice.* Burlington, MA: Jones and Bartlett Learning.

Cadburnay, C. A., Graff, K., Harris, J. K., McQueen, A., Smith, M., Fairchild, M., & Kreuter, M. W. (2015). Evaluating diabetes mobile applications for health literate designs and functionality, 2014. *Preventing Chronic Disease, 12(* 61). 1-13. doi:10.5888/pcd12.140433

Capozza, K., Woolsey, S., Georgsson, M., Black, J., Bello, N., Lence, C., & ... North, C. (2015). Going mobile with diabetes support: A randomized study of a text message-based personalized behavioral intervention for type 2 diabetes self-care. *Diabetes Spectrum, 28*(2), 83-91. doi:10.2337/diaspect.28.2.83

CareMessage (2017). Make underserved populations healthier. Retrieved from https://caremessage.org/

Caro-Bautista, J., Martín-Santos, F. J., & Morales-Asencio, J. M. (2013). Systematic review of the psychometric properties and theoretical grounding of instruments evaluating self-care in people with type 2 diabetes mellitus. *Journal of Advanced Nursing*, *70*(6), 1209-1227.

Caro-Bautista, J., Morilla-Herrera, J. C., Villa-Estrada, F., Cuevas-Fernández-Gallego, M., Lupiáñez-Pérez, I., & Morales-Asencio, J. M. (2016). Adaptación cultural al español y validación psicométrica del Summary of Diabetes Self-Care Activities measure (SDSCA) en personas con diabetes mellitus tipo 2. *Atencion Primaria*, 48458-48467. doi:10.1016/j.aprim.2015.08.005

Cassimatis, M., Kavanagh, D. J., Hills, A. P., Smith, A. C., Scuffham, P. A., Edge, S., & … Gericke, C. (2015). Development of the OnTrack Diabetes Program. *Journal of Medical Internet Research, 17*(5), 1-12. doi:10.2196/resprot.2823

Celik, S., Cosansu, G., Erdogan, S., Kahraman, A., Isik, S., Bayrak, G., & ... Olgun, N. (2015). Using mobile phone text messages to improve insulin injection technique and glycaemic control in patients with diabetes mellitus: a multi-centre study in Turkey. *Journal of Clinical Nursing, 24*(11/12), 1525-1533. doi:10.1111/jocn.12731

Centers for Disease Control and Prevention. (2013). Diagnosed diabetes percentage: North Carolina, Mecklenburg County. Retrieved from https://www.cdc.gov/diabetes/atlas/countydata/atlas.html

Centers for Disease Control and Prevention. (2016). Diabetes at a glance 2016. Retrieved from https://www.cdc.gov/chronicdisease/resources/publications/aag/pdf/2016/diabetes-aag.pdf

Centers for Disease Control and Prevention. (2017). Diabetes 2017 report card. Retrieved from https://www.cdc.gov/diabetes/pdfs/library/diabetesreportcard2017-508.pdf

Chaet, A. V., Morshedi, B., Wells, K. J., Barnes, L. E., & Valdez, R. (2016). Spanish-language consumer health information technology interventions: A systematic review. *Journal of Medical Internet Research, 18*(8), e214. doi:10.2196/jmir.5794

Chen, R., Cheadle, A., Johnson, D., & Duran, B. (2014). US trends in receipt of appropriate diabetes clinical and self-care from 2001 to 2010 and racial/ethnic disparities in care. *Diabetes Educator, 40*(6), 756-766. doi:10.1177/0145721714546721

Cherrington, A., Wallson, K. A., & Rothman, R. L. (2010). Exploring the relationship between diabetes self-efficacy, depressive symptoms, and glycemic control among men and women with type 2 diabetes. *Journal of Behavioral Medicine 33,* 81-89. doi: 10.1007/s10865-009-9233-4

Coffman, M. J. (2008). Effects of tangible social support and depression on diabetes self-efficacy. *Journal of Gerontological Nursing, 34*(4), 32-39.

Cole-Lewis, H. & Kershaw, T. (2010). Text Messaging as a tool for behavior change in disease prevention and management. Epidemiology Review, 32 (1): 56-69. doi: 10.1093/epirev/mxq004

Connelly, J., Kirk, A., Masthoff, J., & MacRury, S. (2013). The use of technology to promote physical activity in type 2 diabetes management: a systematic review. *Diabetic Medicine: A Journal of the British Diabetic Association, 30*(12), 1420-1432. doi:10.1111/dme.12289

Cund, A., Birch-Jones, J., Kay, M., & Connolly, P. (2015). Self-management: keeping it simple with "Flo". *Nursing: Research and Reviews (49),* 49-55.

Dobson, R., Carter, K., Cutfield, R., Hulme, A., Hulme, R., McNamara, C., & ... Whittaker, R. (2015). Diabetes text-message self-management support program (SMS4BG): A pilot study. *Journal of Medical Internet Research, 17*(3), 1-9. doi:10.2196/mhealth.3988

Dobson, R., Whittaker, R., Yannan, J., Shepherd, M., Maddison, R., Carter, K., & ... Jiang, Y. (2016). Text message-based diabetes self-management support (SMS4BG): study protocol for a randomized controlled trial. *Trials.17*(179). 1-10. doi:10.1186/s13063-016-1305-5

Faridi, Z., Liberti, L., Shuval, K., Northrup, V., Ali, A., & Katz, D. L. (2008). Evaluating the impact of mobile telephone technology on type 2 diabetic patients' self-management: the NICHE pilot study. *Journal of Evaluation in Clinical Practice, 14*(3), 465-469. doi:10.1111/j.1365-2753.2007.00881.x

Farmer, A. J., McSharry, J., Rowbotham, S., McGowan, L., Ricci-Cabello, I., & French, D. P. (2016). Effects of interventions promoting monitoring of medication use and brief messaging on medication adherence for people with type 2 diabetes: a systematic review of randomized trials. *Diabetic Medicine: A Journal of the British Diabetic Association, 33*(5), 565-579. doi:10.1111/dme.12987

Faruque, L. I., Wiebe, N., Ehteshami-Afshar, A., Yuanchen, L., Dianati-Maleki, N., Hemmelgarn, B. R., & ... Tonelli, M. (2017). Effect of telemedicine on glycated hemoglobin in diabetes: a systematic review and meta-analysis of randomized trials. *Canadian Medical Association Journal, 189*(9), 341-364. doi: 10.1503/cmaj.150885

Fatehi, F., Malekzadeh, G., Akhavimirab, A., Rashidi, M., & Afkhami-Ardekani, M. (2010). The effect of short message service on knowledge of patients with diabetes in Yazd, Iran. *Iranian Journal of Diabetes & Obesity, 2*(1), 27-31.

Fioravanti, A., Fico, G., Salvi, D., García-Betances, R. I., & Arredondo, M. T. (2015). Automatic messaging for improving patient's engagement in diabetes management: an exploratory study. *Medical & Biological Engineering & Computing, 53*(12), 1285-1294. doi:10.1007/s11517-014-1237-8

Fitzner, K. K., Heckinger, E., Tulas, K. M., Specker, J., & McKoy, J. (2014). Telehealth technologies: Changing the way we deliver efficacious and cost-effective diabetes self-management education. *Journal of Health Care for the Poor & Underserved, 25*(4), 1853-1897. doi:10.1353/hpu.2014.0157

Fjeldsoe, B. S., Marshall, A. L., & Miller, Y. D. (2009). Review and special article: Behavior change interventions delivered by mobile telephone short-message service. *American Journal of Preventive Medicine, 36*(2):165–173. doi:10.1016/j.amepre.2008.09.040

Fottrell, E., Jennings, H., Kuddus, A., Ahmed, N., Morrison, J., Akter, K., & ... Azad, K. (2016). The effect of community groups and mobile phone messages on the prevention and control of diabetes in rural Bangladesh: study protocol for a three-arm cluster randomised controlled trial. *Trials, 17*, 1-15. doi:10.1186/s13063-016-1738-x

Franklin, V. L., Greene, A., Waller, A., Greene, S. A., & Pagliari, C. (2008). Patients' engagement with 'Sweet Talk'— A text messaging support system for young people with diabetes. *Journal of Medical Internet Research, 10*(2), 126-135. doi:10.2196/jmir.962

Franklin, V. L., Waller, A., Pagliari, C., & Greene, S. A. (2006). A randomized controlled trial of Sweet Talk, a text-messaging system to support young people with diabetes. *Diabetic Medicine, 23*(12), 1332-1338. doi:10.1111/j.1464-5491.2006.01989.x

Friedman, M. A., Niznik, C. M., Bolden, J. R., & Yee, L. M. (2016). Reciprocal peer support for post-partum patients with diabetes: A needs assessment for the diabetes buddy program. *Journal of Community Health: The Publication For Health Promotion And Disease Prevention, 41*(2), 354-358. doi:10.1007/s10900-015-0103-4

Funnell, M.M., & Anderson, R.M. (2000). The problem with compliance in diabetes. *JAMA. 284*(13), 1709. doi:10.1001/jama.284.13.1709-JMS1004-6-1

Garcia, A. A., Zuniga, J., Reynolds, R., Cairampoma, L., & Sumlin, L. (2015). Evaluation of the Spoken Knowledge in Low Literacy in Diabetes Scale for use with Mexican Americans. *Journal of Transcultural Nursing, 26*(3), 279-286. doi:10.1177/1043659614524246

Gatwood, J., Balkrishnan, R., Erickson, S. R., An, L. C., Piette, J. D., & Farris, K. B. (2016). Original research: The impact of tailored text messages on health beliefs and medication adherence in adults with diabetes: A randomized pilot study. *Research in Social And Administrative Pharmacy, 12,* 130-140. doi:10.1016/j.sapharm.2015.04.007

Gleeson-Kreig, J., Bernal, H., & Woolley, S. (2002). The role of social support in the self-management of diabetes mellitus among a Hispanic population. *Public Health Nursing, 19*(3), 215-222.

Gonzalez-Barrera, A., & Lopez, M. (2015, June 15). Pew Research Center: Is being Hispanic a matter of race, ethnicity or both? Retrieved from http://www.pewresearch.org/fact-tank/2015/06/15/is-being-hispanic-a-matter-of-race-ethnicity-or-both/

Goodarzi, M., Ebrahimzadeh, I., Rabi, A., Saedipoor, B., & Jafarabadi, M. (2012). Impact of distance education via mobile phone text messaging on knowledge, attitude, practice and self-efficacy of patients with type 2 diabetes mellitus in Iran. *Journal of Diabetes & Metabolic Disorders, 11*(10), 1-8. doi:10.1186/2251-6581-11-10

Gurol-Urganci, I., De Jongh, T., Vodopivec-Jamsek, V., Atun, R., & Car, J. (2013). Mobile phone messaging reminders for attendance at healthcare appointments (review). Cochrane Database of Systematic Reviews, Issue 12, Art. No. CD007458. DOI: 10.1002/14651858.CD007458.pub3

Haddad, N. S., Istepanian, R., Philip, N., Khazaal, F. K., Hamdan, T. A., Pickles, T., & ... Gregory, J. W. (2014). A feasibility study of mobile phone text messaging to support education and management of type 2 diabetes in Iraq. *Diabetes Technology & Therapeutics, 16*(7), 454-459. doi:10.1089/dia.2013.0272

Hamine, S., Gerth-Guyette, E., Faulx, D., Green, B. B., & Ginsburg, A. S. (2015). Impact of mHealth chronic disease management on treatment adherence and patient outcomes: A systematic review. *Journal of Medical Internet Research, 17*(2), e52. 1-15. doi:10.2196/jmir.3951

Han, Y., Faulkner, M. S., Fritz, H., Fadoju, D., Muir, A., Abowd, G. D., & ... Arriaga, R. I. (2015). A pilot randomized trial of text-messaging for symptom awareness and diabetes knowledge in adolescents with type 1 diabetes. *Journal of Pediatric Nursing, 30*(6), 850-861. doi:10.1016/j.pedn.2015.02.002

Harrison, S., Stadler, M., Ismail, K., Amiel, S., & Herrmann-Werner, A. (2014). Are patients with diabetes mellitus satisfied with technologies used to assist with diabetes management and coping?: A structured review. *Diabetes Technology & Therapeutics, 16*(11), 771-783. doi:10.1089/dia.2014.0062

Health IT Buzz (2011, June 24). Beacon communities: New mobile app will use texting for diabetes management. Retrieved from https://www.healthit.gov/buzz-blog/beacon-community-program/mobile-app-texting-diabetes-management/

Healthcare Information and Management Systems Society. (2017). Definitions of mHealth. Retrieved from http://www.himss.org/definitions-mhealth

Herbert, L. J., Collier, S., Stern, A., Monaghan, M., & Streisand, R. (2016). A pilot test of the Self-Management and Research Technology project: A text message-based diabetes self-management program for adolescents. *Journal of Child Health Care, 20*(4), 456-463. doi:10.1177/1367493515603829

Herbert, L., Owen, V., Pascarella, L., & Streisand, R. (2013). Text message interventions for children and adolescents with type 1 diabetes: a systematic review. *Diabetes Technology & Therapeutics, 15*(5), 362-370. doi:10.1089/dia.2012.0291

Holtz, B., & Lauckner, C. (2012). Diabetes management via mobile phones: a systematic review. *Telemedicine Journal and E-Health: The Official Journal Of The American Telemedicine Association, 18*(3), 175-184. doi:10.1089/tmj.2011.0119

Hussein, W. I., Hasan, K., & Jaradat, A. A. (2011). Effectiveness of mobile phone short message service on diabetes mellitus management; the SMS-DM study. *Diabetes Research and Clinical Practice, 94(*1), e24-e26. doi:10.1016/j.diabres.2011.07.025

Islam, S. M., Niessen, L. W., Ferrari, U., Ali, L., Seissler, J., & Lechner, A. (2015). Effects of mobile phone SMS to improve glycemic control among patients with type 2 diabetes in Bangladesh: A prospective, parallel-group, randomized controlled trial. *Diabetes Care, 38*(8), 112-113. doi:10.2337/dc15-0505

Kamal, A. K., Shaikh, Q. N., Pasha, O., Azam, I., Islam, M., Memon, A. A., & ... Khoja, S. (2015). Improving medication adherence in stroke patients through Short Text Messages (SMS4Stroke)-study protocol for a randomized, controlled trial. *BMC Neurology*, *15*(157), 1-9. doi:10.1186/s12883-015-0413-2

Kamimura, A., Christensen, N., Myers, K., Nourian, M., Ashby, J., Greenwood, J., & Reel, J. (2014). Health and Diabetes Self-efficacy: A Study of Diabetic and Non-diabetic Free Clinic Patients and Family Members. *Journal of Community Health, 39*(4), 783. doi:10.1007/s10900-014-9831-0

Kannisto, K. A., Koivunen, M. H., & Välimäki, M. A. (2014). Use of mobile phone text message reminders in health care services: a narrative literature review. *Journal of Medical Internet Research, 16*(10), e222. doi:10.2196/jmir.3442

Kim, H. (2007). A randomized controlled trial of a nurse short-message service by cellular phone for people with diabetes. *International Journal of Nursing Studies, 44*(5), 687-692. DOI: 10.1016/j.ijnurstu.2006.01.011

Kim, H., & Jeong, H. (2007). A nurse short message service by cellular phone in type-2 diabetic patients for six months. *Journal of Clinical Nursing, 16*(6), 1082-1087. doi:10.1111/j.1365-2702.2007.01698.x

Kim, H., Kim, N., & Ahn, S.H. (2006). Impact of a nurse short message service intervention for patients with diabetes. *Journal of Nursing Care Quality, 21*(3), 266-271.

Kim, C., Kim., H, Nam, J, N., Cho, M., Park, J., Kang, E., & ... Lee, H. (2007). Internet diabetic patient management using a short messaging service automatically produced by a knowledge matrix system. Diabetes Care, 30(11), 2857-2858. doi:10.2337/dc06-2464

Kirwan, M., Vandelanotte, C., Fenning, A., & Duncan, M. J. (2013). Diabetes self-management smartphone application for adults with type 1 diabetes: randomized controlled trial. *Journal of Medical Internet Research, 15*(11), e235. 1-14. doi:10.2196/jmir.2588

Kozak, A., Buscemi, J., Hawkins, M., Wang, M., Breland, J., Ross, K., & Kommu, A. (2017). Technology-based interventions for weight management: current randomized controlled trial evidence and future directions. *Journal of Behavioral Medicine, 40*(1), 99-111. doi:10.1007/s10865-016-9805-z

Krishna, S., Boren, S. A., & Balas, E. A. (2009). Healthcare via cell phones: a systematic review. *Telemedicine Journal And E-Health: The Official Journal of The American Telemedicine Association, 15*(3), 231-240. doi:10.1089/tmj.2008.0099

Lancaster-Sandlin, M. (2013). 2013 Mecklenburg County community health assessment: A profile of health indicators and prevention priorities for our community. Retrieved from http://charmeck.org/mecklenburg/county/HealthDepartment/HealthStatistics/Documents/2013%20Mecklenburg%20CHA%20Feb%207.pdf

Levy, N., Moynihan, V., Nilo, A., Singer, K., Bernik, L. S., Etiebet, M., & ... Natarajan, S. (2015). The Mobile Insulin Titration Intervention (MITI) for insulin adjustment in an urban, low-income population: Randomized controlled trial. *Journal of Medical Internet Research*, *17*(7), e180. 1-11. doi:10.2196/jmir.4716

Liang, X., Wang, Q., Yang, X., Cao, J., Chen, J., Mo, X., & ... Gu, D. (2011). Effect of mobile phone intervention for diabetes on glycaemic control: a meta-analysis. *Diabetic Medicine*, *28*(4), 455- 463. doi:10.1111/j.1464-5491.2010.03180.x

López, L., & Grant, R. W. (2012). Closing the gap: eliminating health care disparities among Latinos with diabetes using health information technology tools and patient navigators. *Journal Of Diabetes Science And Technology, 6*(1), 169-176. doi: 10.1177/193229681200600121

Markowitz, J. T., Harrington, K. R., & Laffel, L. B. (2013). Technology to optimize pediatric diabetes management and outcomes. *Current Diabetes Reports, 13*(6), 877-885. doi:10.1007/s11892-013-0419-3

McCloskey, J., & Flenniken, D. (2010). Overcoming cultural barriers to diabetes control: A qualitative study of southwestern New Mexico Hispanics. *Journal of Cultural Diversity*, *17*(3), 110-115.

Mecklenburg County Government. (2017a). 2016 State of the county health report. Retrieved from http://charmeck.org/mecklenburg/county/HealthDepartment/HealthStatistics/Documents/2016%20Mecklenburg%20SOTCH%20Report.pdf

Mecklenburg County Government. (2017b). Community services grants. Retrieved from http://charmeck.org/mecklenburg/county/CountyManagersOffice/OMB/Pages/Grants.aspx

Michigan Diabetes Research Center. (2017). Tools for health professionals: Diabetes Empowerment Scale Short Form. Retrieved from http://diabetesresearch.med.umich.edu/Tools_SurveyInstruments.php

Misra, S. (2015, Sept. 17). iMedical Apps Medpage Today: New report finds more than 165,000 mobile health apps now available, takes close look at characteristics and use. Retrieved from http://www.imedicalapps.com/2015/09/ims-health-apps-report/

Morton, K., Sutton, S., Hardeman, W., Troughton, J., Yates, T., Griffin, S., & ... Eborall, H. (2015). A text-messaging and pedometer program to promote physical activity in people at high risk of type 2 diabetes: The development of the PROPELS follow-on support program. *Journal of Medical Internet Research, 17*(12), 1-16. doi:10.2196/mhealth.5026

Mundi, M. S., Lorentz, P. A., Grothe, K., Kellogg, T. A., & Collazo-Clavell, M. L. (2015). Feasibility of smartphone-based education modules and ecological momentary assessment/intervention in pre-bariatric surgery patients. *Obesity Surgery, 25*(10), 1875-1881. doi:10.1007/s11695-015-1617-7

Nelson, L. A., Mulvaney, S. A., Gebretsadik, T., Johnson, K. B., & Osborn, C. Y. (2016b). The MEssaging for Diabetes (MED) intervention improves short-term medication adherence among low-income adults with type 2 diabetes. *Journal of Behavioral Medicine, 39*(6), 995-1000. doi:10.1007/s10865-016-9774-2

Nelson, L. A., Mulvaney, S. A., Johnson, K. B., & Osborn, C. Y. (2017). mHealth intervention elements and user characteristics determine utility: A mixed-methods analysis. *Diabetes Technology & Therapeutics, 19*(1), 9-17. doi:10.1089/dia.2016.0294

Newton, K., Wiltshire, E., & Elley, C. (2009). Pedometers and text messaging to increase physical activity: randomized controlled trial of adolescents with type 1 diabetes. *Diabetes Care, 32*(5), 813-815. doi:10.2337/dc08-1974

Nundy, S., Dick, J. J., Goddu, A. P., Hogan, P., Lu, C. E., Solomon, M. C., & ... Peek, M. E. (2012). Using mobile health to support the chronic care model: Developing an institutional initiative. *International Journal of Telemedicine & Applications, 2012*, 1-8. doi:10.1155/2012/871925

Nundy, S., Dick, J. J., Solomon, M. C., & Peek, M. E. (2013). Developing a behavioral model for mobile phone-based diabetes interventions. *Patient Education and Counseling, 90*(1), 125-132. doi:10.1016/j.pec.2012.09.008

Nundy, S., Dick, J., Chou, C., Nocon, R., Chin, H., & Peek, M. (2014a). Mobile phone diabetes project led to improved glycemic control and net savings for Chicago plan participants. *Health Affairs 33*(2). 265-271. Doi:10.1377/hlthaff.2013.0589

Nundy, S., Mishra, A., Hogan, P., Lee, S. M., Solomon, M. C., & Peek, M. E. (2014b). How do mobile phone diabetes programs drive behavior change?: Evidence from a mixed methods observational cohort study. *Diabetes Educator, 40*(6), 806-819. doi:10.1177/0145721714551992

Nuti, L., Turkcan, A., Lawley, M. A., Zhang, L., Sands, L., & McComb, S. (2015). The impact of interventions on appointment and clinical outcomes for individuals with diabetes: a systematic review. *BMC Health Services Research*, 15(355). 1-54. doi:10.1186/s12913-015-0938-5

Oh, H., Ahn, S., & Song, R. (2012). A structural model of quality of life in adults with type 2 diabetes. *Western Journal of Nursing Research, 34*(8), 1065. doi:10.1177/0193945912453682

Orr, J. A., & King, R. J. (2015). Mobile phone SMS messages can enhance healthy behaviour: A meta-analysis of randomised controlled trials. *Health Psychology Review, 9*(4), 397-416. doi:10.1080/17437199.2015.1022847

Osborn, C. Y. & Mulvaney, S. A. (2013). Development and feasibility of a text messaging and interactive voice response intervention for low-income, diverse adults with type 2 diabetes mellitus. *Journal of Diabetes Science and Technology*, 7(3), 612 – 622. doi: 10.1177/193229681300700305

Pal, K., Eastwood, S. V., Michie, S., Farmer, A. J., Barnard, M. L., Peacock, R., Wood, B., Inniss, J. D., &Murray, E. (2013). Computer-based diabetes self-management interventions for adults with type 2 diabetes mellitus. *Cochrane Database of Systematic Reviews, Issue 3.* Art. No.: CD008776. DOI: 10.1002/14651858.CD008776.pub2.

Peimani, M., Rambod, C., Omidvar, M., Larijani, B., Ghodssi-Ghassemabadi, R., Tootee, A., & Esfahani, E. N. (2016). Effectiveness of short message service-based intervention (SMS) on self-care in type 2 diabetes: A feasibility study. *Primary Care Diabetes, 10*(4), 251-258. doi:10.1016/j.pcd.2015.11.001

Peña-Purcell, N. C., Boggess, M. M., & Jimenez, N. (2011). An empowerment-based diabetes self-management education program for Hispanic/Latinos: A quasi-experimental pilot study. *The Diabetes Educator, 37*(6), 770-779. doi:10.1177/0145721711423319

Pew Research Center. (2017a). Hispanic Trends, Mecklenburg County, North Carolina. Retrieved from http://www.pewhispanic.org/states/county/37119/

Pew Research Center. (2017b). Hispanic trends, North Carolina. Retrieved from http://www.pewhispanic.org/states/state/nc/

Pfammatter, A., Spring, B., Saligram, N., Davé, R., Gowda, A., Blais, L., & ... Ramalingam, S. (2016). mHealth intervention to improve diabetes risk behaviors in India: A prospective, parallel group cohort study. *Journal of Medical Internet Research, 18*(8), 169-177. doi:10.2196/jmir.5712

Piette, J., Valverde, H., Marinec, N., Jantz, R., Kamis, K., Lazo de la Vega, C., Woolley, T., & Pinto, B. (2014). Establishing an independent mobile health programme for chronic disease self-management support in Bolivia. *Frontiers in Public Health, 2*(95), 1-10. doi:10.3389/fpubh.2014.00095/full

Powers, M. A., Bardsley, J., Cypress, M., Duker, P., Funnell, M. M., Fischl, A. H., & ... Vivian, E. (2015). Diabetes self-management education and support in type 2 diabetes: A joint position statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *The Diabetes Educator, 41*(4), 417-430. doi:10.1177/0145721715588904

Pulizzi, J., Bollyky, J., Toles, A., Boulos, M., Schneider, J., & Hale, T. (2016). Targeted diabetes education text messaging program increases requests for Certified Diabetes Educator coaching and improves blood glucose trends. *Journal of Medical Internet Research, 18*(12), 1-2. doi:10.2196/iproc.6163

Ramirez, M., Wu, S., & Beale, E. (2016). Designing a text messaging intervention to improve physical activity behavior among low-income Latino patients with diabetes: A discrete-choice experiment, Los Angeles, 2014-2015. *Preventing Chronic Disease, 131*(9). 1-9. doi:10.5888/pcd13.160035

Ranney, M. L., & Suffoletto, B. (2014). Extending our reach: use of mHealth to support patients after emergency care. *Annals of Emergency Medicine, 63*(6), 755-756. doi:10.1016/j.annemergmed.2014.01.01

Renders, C. M., Valk, G.D., Griffin, S. J. , Wagner, E., Van Eijk, J. T., & Assendelft, W. J. J. (2000). Interventions to improve the management of diabetes mellitus in primary care, outpatient and community settings. *Cochrane Database of Systematic Reviews, Issue 4*. Art. No.: CD001481. DOI: 10.1002/14651858.CD001481.

Ritter, P. L., Lorig, K., & Laurent, D. D. (2016). Characteristics of the Spanish- and English-Language Self-Efficacy to Manage Diabetes Scales. *Diabetes Educator, 42*(2), 167-177. doi:10.1177/0145721716628648

Rosal, M. C., Heyden, R., Mejilla, R., DePaoli, M. R., Veerappa, C., & Wiecha, J. M. (2012). Design and methods for a comparative effectiveness pilot study: Virtual world vs. face-to-face diabetes self-management. *Journal of Medical Internet Research, 1*(2), 1-9. doi:10.2196/resprot.2415

Rotheram-Borus, M. J., Tomlinson, M., Gwegwe, M., Comulada, W. S., Kaufman, N., & Keim, M. (2012). Diabetes buddies: Peer support through a mobile phone buddy system. *The Diabetes Educator, 38*(3), 357-365. doi:10.1177/0145721712444617

Rothman, R. L., Malone, R., Bryant, B., Wolfe, C., Padgett, P., DeWalt, D. A., & ... Pignone, M. (2005). The Spoken Knowledge in Low Literacy in Diabetes Scale. *Diabetes Educator, 31*(2), 215. doi:10.1177/0145721705275002

Russell, L., Suh, D. & Safford, M. (2005). Time requirements for diabetes self-management: Too much for many? *Journal of Family Practice. 54*(1), 52-56. Retrieved from http://www.mdedge.com/jfponline/article/65560/time-requirements-diabetes-self-management-too-much-many/pdf

Saffari, M., Ghanizadeh, G., & Koenig, H. G. (2014). Health education via mobile text messaging for glycemic control in adults with type 2 diabetes: A systematic review and meta-analysis. *Primary Care Diabetes, 8,* 275-285. doi:10.1016/j.pcd.2014.03.004

Sarabi, R. E., Sadoughi, F., Orak, R. J., & Bahaadinbeigy, K. (2016). The effectiveness of mobile phone text messaging in improving medication adherence for patients with chronic diseases: A systematic review. *Iranian Red Crescent Medical Journal, 18*(5), 1-8. doi:10.5812/ircmj.25183

Sarkar, U., Fisher, L., & Schillinger, D. (2006). Is self-efficacy associated with diabetes self-management across race/ethnicity and health literacy?. *Diabetes Care, 29*(4), 823-829. doi.org/10.2337/diacare.29.04.06.dc05-1615

Senécal, C., Nouwen, A., & White, D. (2000). Motivation and dietary self-care in adults with diabetes: are self-efficacy and autonomous self-regulation complementary or competing constructs?. *Health Psychology, 19*(5), 452-457.

Sezgin, H., & Çınar, S. (2013). Tip 2 Diyabetli Hastaların Cep Telefonu ileTakibi: Randomize Kontrollü Çalışma. *Journal of Marmara University Institute of Health Sciences, 3*(4), 173-183. doi:10.5455/musbed.20131203074020

Shetty, A. S., Chamukuttan, S., Nanditha, A., Raj, R. C., & Ramachandran, A. (2011). Reinforcement of adherence to prescription recommendations in Asian Indian diabetes patients using short message service (SMS)--a pilot study. *The Journal of the Association of Physicians of India, 59,* 711-714.

Shi, C. (2013). Mobile phone messaging for facilitating self- management of long- term illnesses. *International Journal of Evidence-Based Healthcare, 11*(4), 344-345. doi:10.1111/1744-1609.12041 COCHRANE

Siddiqui, M., Islam, M. u., Mufti, B. I., Khan, N., Farooq, M. S., Muhammad, M. G., & ... Kazi, A. M. (2015). Assessing acceptability of hypertensive/diabetic patients towards mobile health based behavioral interventions in Pakistan: A pilot study. *International Journal of Medical Informatics, 84*(11), 950-955. doi:10.1016/j.ijmedinf.2015.08.009

Tapp, H., Smith, H, Dixon, J.T., Ludden, T., & Dulin, M. (2013). Evaluating primary care delivery systems for an uninsured Hispanic immigrant population. Family Community Health 36 (1), 19-33. doi: 10.1097/FCH.0b013e31826d7562

Tapp, H., White, L., Steuerwald, M., & Dulin, M. (2013). Use of community-based participatory research in primary care to improve healthcare outcomes and disparities in care. *Journal of Comparative Effectiveness Research, 2*(4), 405-419. doi:10.2217/cer.13.45

Terry, M. (2008). Text messaging in healthcare: the elephant knocking at the door. *Telemedicine Journal and E-Health: The Official Journal of the American Telemedicine Association, 14*(6), 520-524. doi:10.1089/tmj.2008.8495

Toobert, D. J., Glasgow, R. E., & Radcliffe, J. L. (2000). Summary of Self-Care Activities Questionnaire. *Annals of Behavioral Medicine, 22*(1), 1-9.

Toobert, D. J., Hampson, S. E., & Glasgow, R. E. (2000). The Summary of Diabetes Self-Care Activities Measure. *Diabetes Care*, 23(7), 943-950. doi:10.2337/diacare.23.7.943

U.S. Census Bureau. (2010). Population of the United States by race and Hispanic/Latino origin, Census 2000 and 2010. Retrieved from http://www.infoplease.com/ipa/A0762156.html

U.S. Census Bureau. (2015). Projections of the size and composition of the U.S. Population: 2014 to 2060. Retrieved from https://www.census.gov/content/dam/Census/library/publications/2015/demo/p25-

U.S. Department of Health and Human Services. (2014). Health Resources Services Administration: Using health text messages to improve consumer health knowledge, behaviors, and outcomes: an environmental scan. Retrieved from: http://www.hrsa.gov/healthit/txt4tots/environmentalscan.pdf.

Vaala, S. E., Hood, K. K., Laffel, L., Kumah-Crystal, Y. A., Lybarger, C. K., & Mulvaney, S. A. (2015). Use of commonly available technologies for diabetes information and self-management among adolescents with type 1 diabetes and their parents: A web-based survey study. *Journal of Medical Internet Research, 17*(12), 1-13. doi:10.2196/ijmr.4504

Van der Bijl, Poelgeest-Eeltink, A., & Shortridge-Baggett, L (1999). The psychometric properties of the diabetes management self-efficacy scale for patients with type 2 diabetes mellitus. *Journal of Advanced Nursing, 30*(2). 352-359. Doi:10.1046/j.1365-2648.1999.01077.x

Van Olmen, J., Ku, G. M., van Pelt, M., Kalobu, J. C., Hen, H., Darras, C., & ... Kegels, G. (2013). The effectiveness of text messages support for diabetes self-management: protocol of the TEXT4DSM study in the democratic Republic of Congo, Cambodia and the Philippines. *BMC Public Health, 13*(423). 33-41. doi:10.1186/1471-2458-13-423

Van Olmen, J., Kegels, G., Korachais, C.., de Man, J., Van Acker, K, Kalobu, J.C., & ... Schellevis, F. (2017). The effect of text message support on diabetes self-management in developing countries – A randomised trial. Journal of Clinical & Translational Endocrinology, 7(C), 33-41. doi:10.1016/j.jcte.2016.12.005

Vervloet, M., Van Dijk, L., De Bakker, D. H., Souverein, P. C., Santen-Reestman, J., Van Vlijmen, B., & ... Bouvy, M. L. (2014). Short- and long-term effects of real-time medication monitoring with short message service (SMS) reminders for missed doses on the refill adherence of people with type 2 diabetes: evidence from a randomized controlled trial. *Diabetic Medicine: A Journal of the British Diabetic Association, 31*(7), 821-828. doi:10.1111/dme.12439

Vincent, D., McEwen, M., & Pasvogel, A. (2008). The validity and reliability of a Spanish version of the Summary of Diabetes Self-Care Activities Questionnaire. *Nursing Research 57*(2). 101-106.

Vincent, D., McEwen, M. M., Hepworth, J. T., & Stump, C. S. (2014). The effects of a community-based, culturally tailored diabetes prevention intervention for high-risk adults of Mexican descent. *The Diabetes Educator, 40*(2), 202-213. doi:10.1177/0145721714521020

Wong, C. H., Fung, C. C., Siu, S. C., Lo, Y. C., Wong, K. W., Fong, D. T., & Lam, C. K. (2013). A short message service (SMS) intervention to prevent diabetes in Chinese professional drivers with pre-diabetes: a pilot single-blinded randomized controlled trial. *Diabetes Research & Clinical Practice, 102*(3), 158-166. doi:10.1016/j.diabres.2013.10.002

Wong, C. H., Jiao, F., Siu, S., Fung, C. C., Fong, D. T., Wong, K., & ... Lam, C. K. (2016). Cost-effectiveness of a short message service intervention to prevent type 2 diabetes from impaired glucose tolerance. *Journal of Diabetes Research, 2016*(2016), 1-8. doi:10.1155/2016/1219581

World Health Organization. (2011). mHealth: New horizons for health through mobile technologies. Retrieved from http://www.who.int/goe/publications/goe_mhealth_web.pdf

World Health Organization. (2016, November). Media center: Diabetes fact sheet. Retrieved from http://www.who.int/mediacentre/factsheets/fs312/en/

Wu, C. J., Chang, A. M., Courtney, M., & Ramis, M. (2012). Using user- friendly telecommunications to improve cardiac and diabetes self- management programme: A pilot study. *Journal of Evaluation in Clinical Practice, 18*(3), 695-697. doi:10.1111/j.1365-2753.2010.01621.x

Yates, T., Griffin, S., Bodicoat, D. H., Brierly, G., Dallosso, H., Davies, M. J., & ... Khunti, K. (2015). PRomotion Of Physical activity through structured Education with differing Levels of ongoing Support for people at high risk of type 2 diabetes (PROPELS): study protocol for a randomized controlled trial. *Trials, 16*(1), 1-16. doi:10.1186/s13063-015-0813-z

Yu, C. H., Parsons, J. A., Hall, S., Newton, D., Jovicic, A., Lottridge, D., & ... Straus, S. E. (2014). User-centered design of a web-based self-management site for individuals with type 2 diabetes – providing a sense of control and community. *BMC Medical Informatics & Decision Making, 14*(1), 60-74. doi:10.1186/1472-6947-14-60

Zaccagnini, M., & White, K. (2017). *The Doctor of Nursing Practice Essentials: A new model for advanced practice nursing.* (3rd ed.). Sudbury, MA: Jones & Bartlett.

Zolfaghari, M., Mousavifar, S. A., & Pedram, S. (2009). Mobile phone text messaging and telephone follow-up in Iranian type 2 diabetic patients for 3 Months: A comparative study. *Iranian Journal of Diabetes & Obesity, 1*(1), 45-51.

Zolfaghari, M., Mousavifar, S. A., Pedram, S., & Haghani, H. (2012). The impact of nurse short message services and telephone follow-ups on diabetic adherence: Which one is more effective? *Journal of Clinical Nursing, 21*(13-14), 1922-1931. doi:10.1111/j.1365-2702.2011.03951.x

Appendix A

Text Messages for the Diabetes Text Message Intervention

English Spanish

Week 1- Introduction	**Semana 1 - Introducción**
Welcome to the Health Center Diabetes Text message program! We will send 2-3 messages per week. Text STOP at any time to stop receiving messages (153*)	¡Bienvenido al programa de mensajes de texto! Enviaremos 2-3 mensajes por semana. Envie ALTO en cualquier momento para dejar de recibir mensajes (155)
2nd Text same day: Respond Yes if you received this text (37)	Segundo Texto el mismo día: Responda Si si recibió este mensaje (35)
Diabetes control depends on you! What you do daily determines your blood sugar level. It can be managed with meal planning, exercise & medications (146)	Lo que Ud hace diariamente determina su nivel de azúcar en la sangre. Se puede manejar con la planificación de comidas, el ejercicio y los medicamentos (151)
Week 2- AADE 7: Healthy Eating- Plate method	**Semana 2 - AADE 7: Comida sana, Método de plato**
Eat 3 meals/day & bedtime snack. Fill only ¼ of plate w/starchy food. Eat 5 or more servings/day of fruits/vegetables. How many days in last 7 did this occur? (158)	Coma 3 comidas/día & 1 bocadillo en la noche.Llene ¼ del plato con almidónes.Coma 5 + porciones/día de frutas/verduras.Cuantos días de los últimos 7 lo hizo? (157)
Fill half of your plate with non-starchy vegetables like green beans or broccoli. Measure food portions. Increase fiber and avoid sugary drinks & sweets (152)	Llene la mitad de su plato con verduras como judías verdes o brócoli. Medir las porciones de alimentos. Aumente la fibra y evite bebidas azucaradas y dulces (156)
Week 3- AADE 7: Being Active	**Semana 3 - AADE 7: Ser activo**
Keep moving & be active every day! Exercise 30 minutes/day at least 5 days a week. Walking helps to improve blood sugar, reduce stress and improve your mood (156) Exercise is good for diabetes to lower blood sugar & help you lose weight & help you feel better. Find an exercise buddy. Take charge of your diabetes! (151)	Manténgase activo todos los días! Hacen ejercicio 30 min/día-5 días/semana reduce el azúcar en la sangre y el estrés y mejora su estado de ánimo (144) El ejercicio ayuda para bajar el azúcar en la sangre y a perder peso y a sentirse mejor. Busca un compañero de ejercicio. ¡Tome control de su diabetes! (151)
Text: requiring a response: What exercise did you do this week? Reply w/ one letter A,B,C or D: A walk, B Salsa/Zumba, C Gym, D Other exercise (114)	Texto que require una respuesta: Que ejercicio hizo esta semana? Responda con una letra A,B,C o D: A Caminar, B Salsa/Zumba, C Gimnasio, D Otro ejercicio (120)

Even if you are glued to your phone, you don't have to be glued to your seat. Try talking & walking this week (109) Regular exercise helps weight loss & improves health, mood & confidence & gives a sense of control & accomplishment (115)	Aunque Ud está pegado a su teléfono, Ud no tiene que estar pegado a su asiento. Trate de hablar y caminar esta semana (115) El ejercicio regular ayuda a pérder peso y mejora la salud, el estado de ánimo y la confianza y da una sensación de control y logro (131)
Week 4- AADE 7: Monitoring	**Semana 4- AADE 7: Monitoreo**
Check your blood sugar at least once a day or as directed by clinic staff. Normal blood sugar is 80-130 before eating & 100-180 two hours after eating (152)	Revise azúcar en la sangre 1 vez/día o según instrucciones del Médico. El nivel normal debe ser 80-130 antes de comer y 100-180 dos horas después de comer (154)
Low blood sugar happens from too little food, skipping meals, too much diabetes medicine or from exercise (105) Blood sugars too high & too low are bad. Low blood sugar happens suddenly. If you feel bad, check blood sugar & if less than 70 drink ½ cup of juice (148)	El nivel bajo de azúcar en la sangre sucede debido a la escasez de alimentos, saltos de comidas, demasiada medicina diabética o mucho ejercicio (143) Los azúcares en la sangre demasiado altos y bajos son malos. De repente si se siente mal, revise el azúcar en la sangre y si menos de 70 beba ½ taza de jugo (156)
Week 5- AADE 7: Taking Medication	**Semana 5- AADE 7: Tomar medicamentos**
Take your diabetes medicine every day as prescribed and not just when you think you need it. Call clinic staff if blood sugar regularly over 240 (146)	Tome su medicina para la diabetes todos los días según lo recetado y no sólo cuando piensa que lo necesita. Llame a la clinica si el azúcar es +240 por muchos días (160)
To help you remember, try taking medicines with your daily activities. You can use an alarm on your phone to help you not forget to take your medicines (151).	Para ayudarle a recordar, trate de tomar medicamentos con sus actividades diarias.Puede poner una alarma en su teléfono para no olvidar a tomar sus medicamentos (160)
Week 6- AADE 7: Problem Solving	**Semana 6- AADE 7: Solución de problemas**
Bring a family member with you to your appointments so they can help you care for your diabetes (95)	Traiga a un familiar con usted a sus citas para que puedan ayudarle a cuidar su diabetes (88)
Know your A1C, keep Blood pressure below 130/80, Total Cholesterol less than 200 & bad Cholesterol (LDL) less than 100 & good Cholesterol (HDL) greater than 50 (159)	Conozca su A1C, Presión arterial por debajo de 130/80, Colesterol total menor de 200 y Colesterol malo (LDL) menos de 100 y Colesterol bueno (HDL) mayor de 50 (158)
Week -7 AADE 7: Healthy Coping	**Semana -7 AADE 7: Enfrentamiento saludable**
Stress increases blood sugar. Find healthy ways to de-stress: exercise, pray,	El estrés aumenta azúcar en la sangre. Busca maneras saludables de destresarse:

sleep enough. Share your feelings w/those who love & support you (143)	ejercicio, ore, duerma bien. Comparte sentimientos con los que te aman/apoyan (157)
Losing 10-20 pounds helps you better manage diabetes & lower risk for heart disease. You are not alone-the clinic is committed to help you manage your diabetes! (160)	Perder 10-20 libras le ayuda a controlar la diabetes y bajar el riezgo de enfermedades de corazón¡ La clinica está comprometida a ayudarle a controlar su diabetes! (157)
Week 8- AADE 7: Reducing Risks	**Semana 8- AADE 7: Reducción de riesgos**
Keeping your blood sugar within normal limits decreases risk of diabetes hurting your body (eyes, kidneys, heart and nerves) (124) A1C (average blood sugar for 3 months) of less than 7 is ideal. Wash and check your feet every day (98)	Mantener el azúcar dentro de límites normales disminuye el riesgo que la diabetes haga daño al cuerpo (ojos, riñones, corazón y nervios) (136) A1C (promedio de azúcar en la sangre por 3 meses) menos de 7 es ideal. Lave/revise sus pies cada día (99)
Thank you for participating in this text message study. We hope it has helped you better control your diabetes. Contact will be made for follow up surveys (154)	Gracias por participar en este estudio. Esperamos que los textos le ayuden a controlar mejor su diabetes. Se realizará contacto para encuestas de seguimiento (157)
If you would like to be part of a 25 week Diabetes text message program please text the word YES (96)	Si usted quisiera ser parte de un programa de 25 semanas de mensajes de texto sobre la diabetes por favor responda con la palabra SÍ (132)

*Note: Max of 160 characters can be used per text sent in CareMessage. Numbers in parentheses indicate number of characters per text message in English and Spanish. The name of the clinic has been removed and replaced with the words “clinic” or “la clinica” in both the English and Spanish versions, so the text character count may vary from the character number listed in this appendix.

Goals of texts: Increased DM Knowledge, Improved DM Self-Care and DM Self-Efficacy.

Texts based on Social Cognitive Theory, the Concept of Self-Efficacy, ADA Standards of Medical Care in Diabetes and AADE7 Self-Care Behaviors.