The Efficacy of Tailored Text Messages to Improve Medication Adherence and Lifestyle Changes for Patients with Type 2 Diabetes Mellitus

Vanessa B. Silverio

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THE EFFICACY OF TAILORED TEXT MESSAGES TO IMPROVE MEDICATION
ADHERENCE AND LIFESTYLE CHANGES FOR PATIENTS WITH
TYPE 2 DIABETES MELLITUS

by

VANESSA B. SILVERIO

EVIDENCE-BASED PRACTICE PROJECT REPORT

Submitted to the College of Nursing and Health Professions
of Valparaiso University,
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For the degree of

DOCTOR OF NURSING PRACTICE

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Advisor  Date
DEDICATION

This project is dedicated to my dad and grandma Dolly in heaven. Thank you both for your unconditional love and support, and still protecting me from up above.
ACKNOWLEDGMENTS

I would like to acknowledge the most encouraging person in my life, my husband, Patrick. Thank you for encouraging me to go back to school to earn my doctorate, and for supporting me through these challenging times of multi-tasking between working full time, being a mom, wife, and student. I could not have done this program without your care and support. To my daughter, Vivienne, you are an amazing soul. Thank you for being patient and understanding with me when I was not able to give you the attention you desired. Thank you for being my personal health coach when I was not always in the mood to exercise after work. To my dad and grandmother, without your genes, I would not be the healthcare provider that I am today. Both of you have always been my role model. Your spirit and ambition lives inside of me and drives me to be my very best. Thank you for being my guardian angels. To my mom, thank you for advising me to answer my calling and vocation in life, which was to become a nurse. Thank you to Kelley Eshenaur for motivating me to do the DNP program while I was working at the student health center, and for being my professional mentor through all of it. Thank you to Dr. Patel and to my staff at the health and wellness center for helping me implement my EBP project. I also would like to acknowledge Kacy Davis for being my peer support through this program. To all the college of nursing professors, including my advisor, Professor Spain, thank you for your guidance and allowing me to reach my goals.
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ABSTRACT

Type 2 diabetes mellitus (T2DM) is a chronic disease characterized by increased amounts of glucose in the blood, and is the seventh leading cause of death in the United States (United Health Foundation [UHF]), 2021). T2DM can be effectively treated with medication and behavioral lifestyle modifications. Even small improvements in glycemic control can reduce the risk for debilitating complications such as heart disease, stroke, kidney disease, sepsis, and retinopathy (Wang et al., 2021, Haider et al., 2019). The purpose of this evidence-based practice (EBP) project was to identify the most effective intervention for improving medication adherence, lifestyle changes, and hemoglobin A1C (HbA1c). Participants were recruited from a primary care practice in Northwest Indiana. Eligible participants included adults aged 18 to 65 years old, with a diagnosis of T2DM, HbA1c greater than 7%, and prescribed one or more OAD medications. Participants completed a questionnaire containing the eight-item Morisky Medication Adherence Scale (MMAS-8) to assess medication nonadherence, and two Likert scale questions on diet and exercise to assess lifestyle changes before and after the 12-week practice change. HbA1c was collected prior to and after the practice change of receiving one daily one-way text message reminder to take their OAD medications, brief diabetic education, and/or motivational text messages focused on healthy eating habits and exercise. Data was analyzed using a Wilcoxon Signed Ranks matched pairs t-test to compare the pre-and post-intervention MMAS-8 scores and HbA1c data. Statistically significant differences were noted between the pre and post HbA1c levels (p-value = .002) and the pre and post MMAS-8 scores (p-value = .004). The Spearman correlation test was performed to show correlations between the pre-and post-MMAS-8 scores and HbA1c, and lastly a Kruskal-Wallis test was used to show if diet and exercise played a role in improving HbA1c. Findings from this project support the use of this simple and cost-effective mobile intervention in the management of diabetic patients in a primary care setting.
CHAPTER 1

INTRODUCTION

Background

Type 2 diabetes mellitus (T2DM), formerly known as “adult-onset” or “non-insulin diabetes mellitus” accounts for 90-95% of those with DM (Centers for Disease Control and Prevention [CDC], 2021). T2DM is a chronic disease characterized by increased amounts of glucose in the blood also known as hyperglycemia. Naturally, when the blood glucose rises in the body, it signals the pancreas to release insulin, and then the insulin carries the blood glucose into the body’s cells for use as energy (CDC, 2021). In T2DM, the pancreatic beta cells fail to secrete insulin to lower glucose in the blood and the body’s tissues do not respond appropriately to insulin, resulting in a worsening metabolic state that can cause serious health problems such as heart disease, vision loss, and kidney disease (Galicia-Garcia et al., 2020, CDC, 2021).

According to the American Diabetes Association (ADA), the criteria for the diagnosis of T2DM consists of either hemoglobin (HbA1c) ≥ 6.5%, or fasting plasma glucose (FPG) ≥ 126 mg/dL (7mmol/L), or 2-hour plasma glucose ≥ 200 mg/dL (11.1 mmol/L) during an oral glucose tolerance test (OGTT), or in a patient with classic symptoms of hyperglycemia (polyuria, polydipsia, and nocturia), or a random plasma glucose (RPG) ≥ 200 mg/dL (11.1 mmol/L) (ADA, 2021).

In addition to genetics and aging playing a role in the development of T2DM, environmental factors such as overeating and sedentary lifestyle play even a larger role. Being overweight or obese, which is defined as a body mass index (BMI) of 30 or higher, is a major risk factor for T2DM (CDC, 2021). Other risk factors for developing T2DM are prediabetes, 45 years or older, diabetes during pregnancy, or are African American, Hispanic/Latino American, American Indian, Alaska Native, Pacific Islander, or Asian (CDC, 2021). T2DM is often
accompanied by other conditions including high blood pressure and mixed hyperlipidemia, which in combination increases the risk for cardiovascular disease, stroke, leg and foot amputations, and even early death (CDC, 2021).

T2DM can be effectively treated with medication and behavioral lifestyle modifications. Even small improvements in glycemic control can reduce the risk for debilitating complications such as heart disease, stroke, kidney disease, sepsis, and retinopathy (Wang et al., 2021, Haider et al., 2019). Studies have shown that reductions in HbA1c were associated with a 21% reduction in the risk of diabetes-related deaths (Trevisan et al., 2020). Despite compelling evidence about the effectiveness of oral anti-diabetic (OAD) medications in combination with lifestyle changes to improve glucose control, many adults with T2DM are non-adherent to their treatment regimen (Nelson et al., 2021). Medication nonadherence of OAD medications in T2DM adult patients ranges from 30-89.9% (Trevisan et al., 2020). Lack of adherence and high rates of discontinuation of OAD medications have been shown to be contributing factors of uncontrolled T2DM, classified as HbA1c > 7%.

Medication nonadherence has been a healthcare challenge across the United States, costing $300 billion annually in the healthcare system (Nelson et al., 2021). Medication nonadherence is characterized as not consuming a prescribed medication at the correct dose or at the correct time. Nonadherence can be intentional or unintentional. Intentional non-adherence is illustrated as patients deciding to take less of their prescribed medication or miss a dose or a day of their medications; whereas unintentional nonadherence is referred to when patients do not take their medications as prescribed because they forget or misunderstood the directions of when and how to take their medications (Kassavou, 2020). Low levels of medication adherence, or suboptimal adherence is defined as taking medications less than 80% of the days covered (Zomahoun et al., 2016). Evidence has shown that suboptimal adherence to OAD medications is associated with higher risks of hospitalizations, financial burden to patients and family members,
and life-threatening health consequences (Zomahoun et al., 2016, Haider et al., 2019, & Nelson et al., 2021).

**Data Supporting Need for the Project**

**Global, National, Regional, and State Data**

Globally, the prevalence of T2DM in adults in 2040 is projected to be 10.4% because of the rising aging population, sedentary lifestyle, and obesity contributing to an increased morbidity and mortality worldwide (Haider et al., 2019 & Sarayani et al., 2019). According to the World Health Organization (WHO) and the International Diabetes Federation, the global prevalence of adults aged 20-79 years old with T2DM was “8.5% in 2014”, with 75% of the people residing in developing countries (CDC, 2021). The CDC National Diabetes Statistics Report from 2017 estimated that 30.3 million Americans have T2DM; of those, 7.2 million people have been undiagnosed (CDC, 2021). Diabetes is the seventh leading cause of death in the nation, and has a high correlation to cardiovascular disease and stroke deaths, accounting for more than 79,000 deaths annually (United Health Foundation [UHF], 2021). Populations in the US that are more affected by diabetes include a) men; b) American Indian/Alaska Native adults; c) adults with less than a high school education; d) adults with income less than $25,000; and e) older adults (UHF, 2021). The rate of new cases of diagnosed diabetes are estimated to be higher among adults aged 45-64 years old compared to adults aged 18-44 years old (CDC, 2021).

Indiana ranks 36th in the US for prevalence of DM as shown in the UHF’s America’s Health Rankings (CDC, 2021). The percentage of adults aged 18 years or older with T2DM diagnosis in Indiana was 10.4% in 2016 (CDC, 2021). Indiana’s obesity rate is higher than the national average, with 35% of adults in Indiana being classified as obese compared to 31% nationally (CDC, 2021). There is a positive correlation between rates of obesity and T2DM in Indiana. The annual report from 2020 in Indiana displayed a 9% increase in obesity in adults between 2016 and 2019 from 32.5% to 35.3%. Consequently, adults with diabetes increased 22% between 2011 and 2019 from 10.2% to 12.4% (UHF, 2021).
Having a diagnosis of T2DM is costly. In 2012, adults with diabetes spent an estimated average of $13,700 for the year of total medical expenses (CDC, 2021). Additionally, in 2017, diabetes and its related complications accounted for $327 billion in direct and indirect medical costs and lost work and wages in the US (CDC, 2021). Thus, the burden of increased healthcare costs and co-morbid complications related to T2DM can be minimized by improved medication adherence (Kassavou, 2020).

Clinical Agency Data

The facility where this evidence-based project (EBP) was conducted is a direct primary care (DPC) health and wellness center in Northwest Indiana. This wellness center is part of a larger organization, with 60 wellness centers throughout Indiana, Illinois, South Carolina, Texas, and New Mexico. The DPC model covers most primary care services including clinical, laboratory, prescriptive medications, and consultative services, as well as care coordination and comprehensive care management. The clinic consists of a family nurse practitioner (FNP), a registered nurse (RN), and a certified medical assistant (CMA). The ages treated in the clinic ranges from pediatrics to adults, and serves a diverse group of patients consisting of African Americans, Hispanics, Asians, and Caucasians (personal communication, May 25, 2021). In the summer of 2021, patients resumed seeing the FNP at the wellness center after several months of staying quarantined during the COVID-19 pandemic. The FNP noticed a trend of patients complaining of increased weight gain during the pandemic, and patients with T2DM prescribed two or more OADs had HbA1c’s greater than 7% (personal communication, May 28, 2021). The wellness center carries several OAD medications that are provided to the patient free of cost under the DPC model. Patients can receive 3 months-worth of medications at a time and are able to request refills at the end of their third month. One of the staff members noticed that patients were requesting medications to be refilled, but not picking up their medications until weeks later after being reminded by phone call that they have medications ready for pick up at the clinic (personal communication, July 22, 2021). Metformin, which is often the first-line
medication used as oral treatment for T2DM was among those chronic medications not being picked up demonstrating noncompliance with T2DM medication regimen with patients in this practice. If diabetic patients were not picking up their medications at the clinic and not getting medications at an outside pharmacy, then it could be assumed that patients are not adhering to their prescribed medication regimen if their glucose levels are still not in control (personal communication, July 22, 2021).

Moreover, the organization does not have a set protocol or program in place for educating patients on the importance of adhering to their treatment regimen. Each provider has their own verbiage when educating patients on lifestyle modifications related to the diagnosis and treatment of T2DM (personal communication, June 2, 2021). Education on the diagnosis of T2DM and the importance of keeping stable glucose levels to avoid the risk of complications may need to be reinforced during office visits. Additionally, counseling on signs and symptoms of hypo and hyperglycemia, and how to intervene if experiencing any of the symptoms are some of the important topics of discussion during the office visit. Under the DPC model, patients are scheduled for 30–45-minute blocks with the FNP, or 60 minutes if needed for special circumstances such as a need for more patient education. Although provider visits are longer, patient counseling on diet and exercise may be overwhelming to hear all in one visit (personal communication, June 2, 2021). Based on the patient’s increased BMI and report of not taking medications as prescribed, it was determined that there was a need for an intervention to improve medication adherence and lifestyle changes in T2DM patients in this clinical practice.

**Purpose of the Evidence-Based Practice Project**

**Purpose Statement and PICOT Question**

The purpose of the EBP project was to identify the most effective intervention for improving medication adherence and lifestyle changes in T2DM patients. Specifically, this project will address the following PICOT question: In adult non-insulin dependent T2DM patients (P), does text messaging reminders (I) compared to no text messaging reminders (C) effectively
improve medication adherence, lifestyle changes, and decrease hemoglobin A1C (O) over a 12-week period (T)?

**EBP Project Description**

The literature supports tailoring daily text messages to individuals to improve medication adherence and treatment regimen with T2DM patients (Haider et al., 2019, Kassavou et al., 2020, & Nelson et al., 2021). Patients with a diagnosis of T2DM with a HbA1c greater than 7% and taking one or more OAD medications were recruited to join the EBP project. One daily text message using the SPRUCE application (app) was sent to individual participants by the FNP. The SPRUCE app is currently used within the organization for providers to perform virtual visits with patients and to communicate with other healthcare providers. The app allows for secure healthcare communication to take place, and disguises the provider’s real phone numbers to increase confidentiality. The text messages were one-way text message reminders focusing on taking their OADs daily, diabetic education from the ADA on diet and exercise, and motivational text messages (see Appendix F). The primary outcome for this EBP project was improvement in glycemic control measuring the HbA1c at baseline, then again in 3 months to evaluate improvements from the intervention. The secondary outcome was improvement in medication adherence and lifestyle changes measured by a pre and post questionnaire, which included the 8-item Morisky Medication Adherence (MMAS-8) scale and two Likert scale questions focusing on diet and exercise (Morisky et al., 2008).
CHAPTER 2

EBP MODEL AND REVIEW OF LITERATURE

Evidence-based Practice Model

Overview of EBP Model

The revised Iowa Model of evidence-based practice guided this EBP project. Six steps listed in the revised Iowa Model provided a guide for developing, implementing, and evaluating the EBP project. The revised Iowa Model encourages a collaborative approach and considers the entire healthcare system, which includes healthcare providers, patients, and the clinical setting, while using research within these contexts to guide the implementation of research into clinical practice (Melnyk & Fineout-Overholt, 2019). The revised Iowa Model was chosen because of its straightforward and easy-to-navigate algorithm, which contains decision points to analyze if the topic is a priority, if there is sufficient evidence, and if the change is appropriate to adopt and be sustainable within an organization. The revised Iowa Model requires key stakeholders to identify the importance of the topic to the organization before initiating the implementation of change (Melnyk & Fineout-Overholt, 2019).

The first step in the revised IOWA model is identifying a trigger or clinical problem. Medication nonadherence to OAD medications in T2DM patients was the problem-focused trigger or clinical problem. The second step is forming a team. A team of key stakeholders consisting of the FNP, RN, CMA, physician, patients at the clinical site, and the informational technology (IT) team was formed to help retrieve site data related to medication nonadherence. The third step is assembling relevant research from databases such as Joanna Briggs Institute (JBI), Cochrane Library, Turning Research Into Practice (TRIP), Cumulative Index of Nursing and Allied Health (CINAHL), and Medline. Once the pieces of evidence were collected, appraisal of each piece was performed using the Critical Appraisals Skills Programme (CASP) tool for randomized controlled trials (RCT) and systematic reviews (SR) to critique and synthesize the
evidence, which is the fourth step. An intervention to improve medication adherence in T2DM patients was developed, using tailored text messages. The fifth step in the revised Iowa Model is to pilot the change in practice. The intervention was implemented and evaluated during the Fall 2021 and Spring 2022 semesters. Lastly, evaluating the outcomes and assessing if the daily text messaging intervention can be sustainable in practice to improve patient outcomes is the last step in the revised Iowa Model. The revised Iowa Model was chosen to be used at the EBP practice site because the model can be used to effectively implement a practice change to improve patient outcomes and overall healthcare costs.

Literature Search

Sources Examined for Relevant Evidence

An exhaustive literature search was conducted within the electronic databases of JBI, Cochrane Library, TRIP, CINAHL, and Medline. Initial searches included several variances of keywords to reach a suitable relevant evidence search. The following keywords, phrases, Boolean Operators, and truncation options were used in different combinations to retrieve the best evidence within each respective database: (“Type 2 Diabetes Mellitus” OR “Diabetes Mellitus, Type 2” OR diabetes) AND (MM “Medication Compliance” OR MM “Medication Adherence” OR “medication compliance” OR “medication adherence” OR MeSH descriptor [Medication Adherence]) AND intervent*. Limiters used in databases included the English language, publication dates from 2016-2021 or past 5 years, and searching for articles published in scholarly peer-reviewed journals.

For this review, the inclusion criteria for the pieces of evidence selected were adults aged 18 to 65 years old, diagnosed with T2DM, taking oral medications for treatment of diabetes, and evaluating effectiveness of interventions for medication adherence. Additionally, evidence was included if it was written in English, published within the last 5 years, and was rated as Levels I or II. Exclusion criteria included systematic protocols, articles that focused on older adults greater than 65 years old, children, insulin-dependent T2DM, prediabetes and gestational diabetes.
Using keywords, diabetes AND medication adherence OR medication compliance in JBI, 29 possible sources resulted with a yield of 3 because the other sources did not fit the inclusion criteria. Citation chasing from an evidence summary (Yimei, 2021) led to the identification of one SR with meta-analysis (Zomahoun, 2017) which met the inclusion criteria and was kept to critique. The other 2 pieces of evidence from the yield of 3 were discarded because they did not fit the inclusion criteria. After scanning titles and abstracts in the Cochrane Library using the MeSH descriptor [Medication Adherence] AND diabetes, 22 pieces of evidence resulted with a yield of 3. However, one was excluded because the sample studied older adults 65 and older versus the inclusion criteria of adults 18-65 years old. The other SR was not focused on medication adherence and contained exclusion criteria. The SR (Van Driel et al., 2016) was kept and included in the project even though the study focused on interventions to improve adherence to lipid-lowering medication.

Since T2DM is a chronic disease needing long-term medication treatment, evidence that included medication adherence to chronic diseases such as hypertension or hyperlipidemia were included in the search. In the TRIP database, a limiter of USA guidelines was added to the search, which yielded 0 pieces of evidence from 81 results. Using MM “Medication Compliance” AND “Diabetes Mellitus, Type 2” AND interven* in CINAHL resulted in 70 sources, with a yield of 5, which included 4 RCTs (Kassavou et al., 2020, Nelson et al., 2021, Sarayani et al., 2018, and Trevisan et al., 2020) and 1 SR (Haider et al., 2019). In Medline, MM “Medication Adherence” AND “Diabetes Mellitus, Type 2” AND interven* keyword combinations were used to result in 103 sources. The relevant evidence discovered in Medline did not fit criteria due to being duplicates of articles found from CINAHL, and not high-level evidence. Only 1 RCT (Varming et al., 2019) was chosen to be included in the paper because it met all the inclusion criteria. Use of mobile apps, text messaging, and short message services (SMS) were noted as a theme throughout the literature so articles including these interventions in the title or abstract were included in the
search. See the Literature Search Grid in Appendix B and Figure 1 for a condensed view of the literature search.

**Figure 1**

*PRISMA Flow Diagram*

Note. A figure describing the literature search
Levels of Evidence

The Melnyk and Fineout-Overholt Hierarchy of Evidence was used to level the pieces of evidence for this EBP project. The Melnyk and Fineout-Overholt Hierarchy of Evidence tool includes seven levels of evidence ranging from Level I to Level VII. Level I, the top of the pyramid and the highest level of evidence consists of systematic reviews or meta-analyses. Level II includes evidence from well-designed randomized controlled trials (RCTs). Level III encompasses controlled trials without randomization. Level IV includes evidence from controlled cohort and case-control studies. Level V comprises uncontrolled cohort and case-control studies, whereas single descriptive or qualitative studies are considered Level VI. Finally, the lowest level of evidence is Level VII, which is composed of the opinions and guidelines of experts or authorities (Melynk & Finout-Overholt, 2019).

A total of 8 pieces of evidence were selected to be included in the review of literature of this EBP project. Among the 8 pieces of evidence, 3 were SRs (Van Driel et al., 2016, Haider et al., 2019, & Zomahoun et al., 2017) which are considered level 1 evidence and the top of the hierarchy pyramid providing the highest level of confidence. The other 5 pieces of evidence were RCTs (Nelson et al., 2021, Sarayani et al., 2018, Trevisan et al., 2020, Kassavou et al., 2020, & Varming et al., 2019). RCTs are level 2 evidence in the hierarchy illustrating a lower risk of bias and provides the best information about cause-and-effect relationships (Melnyk & Fineout-Overholt, 2019). Refer to table 2.1 Summary of Evidence Table.

Analysis and Appraisal of Relevant Evidence

The CASP tool for Systematic Reviews and Randomized Control Trials (CASP, 2020) tool were used to conduct quality appraisals for the SRs and RCTs. The CASP tool was chosen because of its bullet-point considerations to prompt thinking when choosing an answer (yes, no, or can’t tell) for each of the criteria listed on the checklist. Section A in the CASP tool for appraising RCTs relates to validity, asking if the trial focused on the population studied, the intervention given, the comparator given, and if outcomes were considered. Other important
points to consider validity are knowing if the assignment of patients to treatments were randomized and if all participants who entered the trial were properly accounted for at its conclusion (CASP, 2020). Likewise, the CASP tool for appraising SRs had questions related to validity to analyze before moving forward with the rest of the appraisal. The first question asks if the review addressed a clearly focused question, and the second question asks if the authors looked for the right type of papers consisting of an appropriate study design and addressing the review’s question (CASP, 2020). If any of the responses to these questions related to validity are unclear, then the study is not worth including in the search. This made the appraising process of each piece of evidence more efficient. In addition to scoring the piece of evidence for quality, the final consideration is to decide if the interventions could be applicable and implemented safely in practice, and if the benefits of the outcomes are worth the harms and costs (CASP, 2020).

The evidence from Van Driel et al. (2016) and Haider et al. (2019) were high quality. There was minimal bias found in the design, conduct, and analysis of both the systematic reviews. There were reasonably consistent, generalizable results of the use of digital interventions for patients with chronic diseases needing long-term medications. The quality of the evidence from Zomahoun et al. (2017), Sarayani et al. (2018), and Varming et al. (2019) were moderate. Due to the nature of the intervention, participants were not blind to allocation which could have led to bias and distortion of the study outcomes. Nelson et al. (2021), Trevisan et al. (2020), and Kassavou et al. (2020) were high quality evidence pieces. There was true randomization of participants blinded to the intervention or control group in the trials resulting in decreased bias. These RCTs also had large sample sizes with low attrition bias. See Appendix A, the Evidence Synthesis Table with details of each of the pieces of evidence reviewed for this EBP project.
Table 1

Summary of Evidence

<table>
<thead>
<tr>
<th>Author/yr</th>
<th>Database(s)</th>
<th>Level of Evidence/Type</th>
<th>Quality/Tool</th>
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<td>JBI</td>
<td>I/SR</td>
<td>Moderate/CASP</td>
</tr>
<tr>
<td>Van Driel et al. (2016)</td>
<td>Cochrane</td>
<td>I/SR</td>
<td>High/CASP</td>
</tr>
<tr>
<td>Haider et al. (2019)</td>
<td>CINAHL</td>
<td>I/SR</td>
<td>High/CASP</td>
</tr>
<tr>
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<td>I/SR</td>
<td>II/RCT</td>
<td>Moderate/CASP</td>
</tr>
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<td>II/RCT</td>
<td>High/CASP</td>
</tr>
<tr>
<td>Trevisan et al. (2020)</td>
<td>I/SR</td>
<td>II/RCT</td>
<td>High/CASP</td>
</tr>
<tr>
<td>Kassavou et al. (2020)</td>
<td>I/SR</td>
<td>II/RCT</td>
<td>High/CASP</td>
</tr>
<tr>
<td>Varming et al. (2019)</td>
<td>MEDLINE</td>
<td>II/RCT</td>
<td>Moderate/CASP</td>
</tr>
</tbody>
</table>

Construction of Evidence-based Practice

Synthesis of Critically Appraised Literature

Throughout the evidence, telecommunication interventions emerged as a low cost and viable option for improving medication adherence in adults diagnosed with T2DM (Sarayani et al., 2018, Haider et al., 2019). Telecommunication interventions include the use of telephone, email, text messaging, and video call. These tools have been used to improve service delivery, reduce costs, and studies have noted the benefits of mobile phone interventions to improve diabetes management (Sarayani et al., 2018, Haider et al., 2019). In the United States, 96% of adults use the text messaging feature on their phones the most because it requires very little knowledge of technology and is not internet-based. Accumulating evidence has shown that text messaging interventions can improve medication adherence in patients with chronic diseases, including T2DM (Nelson et al., 2021, Van Driel et al., 2016, Haider et al., 2019).
**Mobile Phone Text Messages**

Mobile phone text messages have been used for appointment reminders, and more recently, medication reminders to improve medication adherence. However, there were differences found in the literature in the frequency of sending text messaging reminders and the type of message content. Text messaging interventions as illustrated in four of the trials in the SR (Haider et al., 2019) sent three to four messages per week focusing on lifestyle management including diet, exercise, self-monitoring of blood glucose levels and medication reminders during a three-to-six-month duration. Five studies sent one or more lifestyle focused text messages per day, and two studies had a pre-determined and set time for sending medication reminder messages on a daily basis (Haider et al., 2019). Participants in the RCT (Nelson et al., 2021) received three types of automated text messages including a one-way text message promoting self-care, interactive texts about medication adherence, and texts that provided weekly adherence feedback and encouragement (Nelson et al., 2021).

Although studies have demonstrated a positive impact in medication adherence using a variation of strategies, daily text messages at every medication dosing time for at least 3 months were the most common pattern used in the literature and were shown to significantly improve medication adherence in the short term and after 6 months (Haider et al., 2019, Kassavou et al., 2020, van Driel et al., 2016). Additionally, studies have demonstrated that lifestyle focused text messages tailored to the individual were more effective at improving medication adherence and feasible to obtain clinically meaningful outcomes when compared to the standardized text (Haider et al., 2019, Kassavou et al., 2020). Examples of tailored text messages include words of encouragement, brief education on the benefits of proper diet and exercise, or content specifically from the provider-patient consultation such as habit-forming or self-monitoring advice (van Driel et al., 2016).
Motivational Interviewing

Motivational Interviewing (MI) is defined as a collaborative approach between the patient and provider that aims to strengthen the patient’s motivation and commitment to change (Zomahoun et al., 2017). Once a trusting relationship is formed between the provider and patient, they can focus on the goals of the patient and assess the motivation for change. The last step in MI is developing a plan of action. There are different modes of communication for MI including face-to-face, phone, internet, written documentation, or group. There were trends found in the literature that demonstrated MI interventions as an effective method to guide collaboration between practitioner and patient with setting goals and addressing barriers to self-care, in addition to improving medication adherence in T2DM patients (Zomahoun et al., 2017, Trevisan et al., 2020, Van Driel et al., 2016, Varming et al., 2019). Evidence was shown that face-to-face MI was more effective than a phone call alone (Zomahoun et al., 2017). The intervention group from the RCT (Trevisan et al., 2020) displayed statistically significant improvements in medication adherence ($p<0.0001$) and glycemic control ($p<0.0001$) when MI is used to enhance understanding of the goals and strategies to cope with barriers in taking long-term medication (Trevisan et al., 2020 & Zomahoun et al, 2017). Face-to-face delivery of MI showed a positive effect in medication adherence with $B = 0.192$, 95% CI (0.039, 0.344) (Zomahoun et al., 2017).

In the RCT (Varming et al., 2019), participants in the intervention group had four one-on-one (in-person) patient-centered diabetic consultations and one telephone follow up call. A face-to-face consultation was done in months one and two, then participants received a phone call to follow up on goals between the second and third month. In month three, participants had another face-to-face consultation. The intervention ended after three months, but participants were followed up in six months with a face-to-face consultation to assess sustainability in the intervention (Varming et al., 2019). The results of the RCT (Varming et al., 2019) showed no significant improvements in HbA1C with four additional face-to-face patient-centered diabetic
consultations in addition to usual care compared to the control group who received usual care consisting of consultations with nurses, physicians, dieticians, chiropodists, and eye specialists.

Patients need to collaborate with their providers and come up with an action plan detailing how they intend to adhere to their medications, as well as develop a coping plan with strategies to address barriers for not adhering to their treatment plan. This collection of data to tailor text messages may be gained from face-to-face MI during the patients’ regular office visit rather than having multiple face-to-face diabetes consultations. Furthermore, there was a small sample size and limited data on MI characteristics such as delivery mode, duration of each session, number of sessions, and MI training for practitioners resulting in increased bias (Zomahoun et al., 2017). Sustainability of MI over time was also not studied. Although MI is an important step to gather vital information on patients’ goals and barriers to medication adherence, having additional face-to-face consultations was not clinically significant compared to providing tailored text message reminders after the visit to improve medication adherence.

**Outcomes**

The primary outcome for all the studies was improvement in glycemic control measuring the HbA1c at baseline, then again in three months to evaluate improvements from the intervention. In the SR (Haider et al., 2019), nine out of the eleven studies showed a statistically significant improvement in HbA1c with educational and motivational text messaging [0.38% (−0.53; −0.23, p-value < 0.001)] (Haider et al., 2019). Statistically significant evidence was found in the RCT (Nelson et al., 2021) of the use of REACH (Rapid Education/Encouragement and Communications for Health) intervention through mobile phone delivery. Treatment effects on HbA1c were found at three months (−0.26%; 95% CI −0.48%, −0.05%; p = 0.018) (Nelson et al., 2021). The evidence from the literature illustrated mobile phone text messaging to be a low cost but effective digital intervention for improving medication adherence and lowering HbA1c (Nelson et al., 2021, Kassavou et al., 2020, Van Driel et al., 2016, Haider et al., 2019, & Sarayani et al., 2018).
A secondary outcome found in the literature was improvement in medication adherence. There were differences in how medication adherence that was measured in several of the RCTs, but patterns in the literature displayed using both the Medication Event Monitoring Systems (MEMS) and the Medication Adherence Report Scale (MARS-5) or using the MMAS-8 tool by itself (Zomahoun et al., 2017, Van Driel et al., 2016, Kassavou et al., 2020, and Sarayani et al., 2018). MEMS is an electronic system that uses microprocessors built into the pill-bottle cap that registers the date and time of the bottle opening. MEMS, although expensive, provides detailed and reliable outcome measures with low risk of bias (Van Driel et al., 2016, Zomahoun et al., 2017, & Kassavou et al., 2020). MARS-5 is an inexpensive tool providing more detail and differentiation between individuals by assessing adherence, identifying patients reporting low adherence and the specific types of non-adherence behaviors (intentional versus unintentional). The MARS-5 tool scores each item on a 5-point scale (5 = never, 4 = rarely, 3 = sometimes, 2 = often, 1 = very often), rating the frequency of which the five different medication-taking behaviors occur. The higher the score, the higher the reported adherence (Chan et al., 2019). The MMAS-8 is a low cost, simple, and self-reported tool for assessment of medication adherence to chronic conditions. There are 8 items on the questionnaire, with questions 1 through 7 requiring “yes” or “no” responses and item 8 described as a 5-point Likert response. Each “yes” response is rated as “1” and each “no” is rated as “0”. For item 8, “a never/rarely or 0” response is scored as a “1” and “all the time or 4” response is scored as a “0”. Responses “1, 2, 3” are respectively rated as “0.25, 0.75, 0.75.” A score of 8 would mean a high adherence, a score between 6 and 8 indicates medium adherence, and a score of less than 6 would mean low adherence (Okello et al., 2017).

**Recommendation for Best Practice**

After a comprehensive literature search and appraising high-level pieces of evidence, using tailored text messages containing reminders to take their OAD medications, motivational text messages to focus on diet and exercise, and educational text messages on diabetic
management were identified as the best practice to improve medication adherence and improve HbA1c in T2DM patients. Evidence from the literature exhibited lifestyle focused text messaging tailored to the individual was more effective than the standardized text (Haider et al., 2019). There were reports on the acceptability of the text messaging intervention with participants responding that they would recommend this to family members, and that the messages were reminders to encourage healthy lifestyle (Haider et al., 2019 & Van Driel et al., 2016). There were no negative outcomes with the use of text messaging reminders found from the studies. Utilization of text messages is a cost-effective, time-efficient, patient-centered intervention that can benefit many patients to improve medication adherence and lifestyle changes, and ultimately decrease the risk of co-morbid complications resulting in uncontrolled T2DM.
CHAPTER 3

IMPLEMENTATION OF PRACTICE CHANGE

The purpose of the EBP project was to find the best evidence to improve medication adherence and lifestyle changes in T2DM patients. The synthesis of the literature supported the cost-effective and patient-centered intervention of sending daily one-way tailored text messages from medication reminders, diabetic education, motivational texts to improve medication adherence, lifestyle changes (diet and exercise), and lower HbA1c. This DNP student is also the NP at the clinical practice site and implemented the practice change in collaboration with the RN and CMA.

Participants and Setting

Participants that took part of the practice change were patients with a diagnosis of T2DM with a HbA1c greater than 7%. Other eligible criteria include adults aged 18 to 65 years old, prescribed one or more OAD medications or injections excluding insulin. Participants of any gender, race, or socioeconomic background were included in the project. Participants that were ineligible to participate in the practice change included pregnant women, patients under the age of 18, insulin-dependent patients, those who do not own a mobile phone, or non-English speaking patients. There were two nurse practitioners working at the clinical practice site, one who works full-time during the week and the other NP working part-time on the weekends. The full-time nurse practitioner at the site who implemented the practice change has been practicing as an advanced practice nurse for seven years in primary care and thirteen years total in the nursing field. There were two RNs and one CMA who assisted in calling participants to set up visits with the NP, collected blood work in the office to assess HbA1c, and triaged participants during office visits.

The setting for this EBP project was in a DPC wellness center in Northwest Indiana. The office is open Monday through Saturday with variable hours. The center is open Monday and
Friday from 7:00 am to 4:00 pm, Tuesday from 6:00 am to 5:00 pm, Wednesday and Thursday from 7:00 am to 6:00 pm, and Saturday from 7:00 am to 12:00 pm. In addition to the medical staff and eligible participants at the clinical site, pertinent key stakeholders were the collaborative physician/clinical advisor, nurse manager, and the IT team.

**Pre-Intervention Group Characteristics**

Participants were recruited based on a T2DM diagnosis, HbA1c of 7% or greater, adults aged 18-65 years old, and non-insulin dependent. Participants were recruited in two ways. The first method was when patients requested medication refills of OAD medications such as Metformin, the NP flagged the request and performed a chart review in the electronic medical record (EMR) to search for recent labs done within six months. If there were no labs drawn within six months, the MA or RN called the patient to schedule fasting labs which included the HbA1c, a lipid profile, thyroid level, vitamin D, B12, folate, a comprehensive metabolic panel, a complete blood count, and insulin. The MA or RN also scheduled the patient a week later for a wellness visit to review labs with the NP. Once lab results returned, the NP reviewed and documented the interpretation of the labs in the patient's chart. During the wellness visit and after reviewing the HbA1c greater than 7%, illustrating uncontrolled T2DM, the NP then explained the purpose of the EBP project and recruited the patient to be a part of the practice change.

The second method of recruiting participants to join the EBP project was during a patient’s regular or acute visit to the health center. While the MA or RN triaging the patient were reviewing the patient’s past medical history, and if there was a diagnosis of T2DM, the staff notified the NP by adding a comment “**T2DM**” in the chief complaint section. The NP then reviewed the EMR to assess trends of the HbA1c. If there was no recent HbA1c within the last six months, the RN or MA collected blood work at that visit. If the patient fit the inclusion criteria of 1) diagnosis of T2DM, 2) on OAD medications or injections, other than insulin, and 3) HbA1c > 7%, then the patient was asked if they would like to participate in the EBP project. At that time, the patient was given the consent form (see Appendix D) describing the project's goals and
expectations, risks, and benefits. Additionally, patients were given a pre-questionnaire containing the MMAS-8 to assess the type of medication nonadherence, and two Likert scale questions assessing their current diet and exercise regimen (see Appendix E). Demographics such as age, gender, and race were found through chart reviews and confirmed on the questionnaire.

**Intervention**

Once participants signed the consent form, the NP added the participant’s name and phone number into the SPRUCE application and sent a text message inviting the participant to download the free SPRUCE app on their mobile phone. The SPRUCE app is a secure platform already used among providers within the organization to text, call, or video chat between patients and providers, or providers to providers. The SPRUCE app disguises the providers’ phone number to be able to connect with patients without compromising their personal information. Before participants left the wellness center, the NP asked the participant to send an ‘OK’ message after they received the first welcome greeting text message through the SPRUCE app to assure that the participant was able to sign in and receive text messages.

Participants included in the EBP project received one daily one-way text message for twelve weeks consisting of either diabetic education from the ADA, lifestyle focused text messages encouraging healthy eating habits and exercise, and/or text message reminders to take their OAD medications (see Appendix F). Through SPRUCE, there was no capability of sending mass text messages to all the participants at one time, so the NP created daily text messages, and copied and pasted the message to each of the participants’ SPRUCE account. In addition to receiving the daily text message intervention, participants also received usual care for a diabetic patient at the wellness center, which included six month fasting labs, a wellness visit to review labs with the NP, a complete physical examination, and patient counseling on healthy diet and exercise recommended by the ADA to improve glycemic control. Specifically, T2DM patients who were uncontrolled with a HbA1c greater than 7% were recommended to
increase their current medications or add another OAD medication to their existing medication
treatment plan, and have closer monitoring of the HbA1c every three months until their levels are
less than 7%.

**Comparison**

Pre-implementation data and post-implementation data were compared. The pre-
implementation data consisted of a baseline HbA1c and the pre-questionnaire containing MMAS-
8 questions on medication nonadherence and two Likert-type questions on diet and exercise.
Post-implementation data, which consisted of HbA1c and the post questionnaire containing the
same MMAS-8 and two Likert-type questions on diet and exercise as the pre-questionnaire were
collected after twelve weeks of receiving the daily text message reminders. The questionnaires
were analyzed for improvements in medication adherence and lifestyle changes. A paired t-test
was used to compare pre- and post-intervention MMAS-8 scores to determine if providing daily
and tailored lifestyle text messages will influence medication adherence rates, lifestyle changes,
and decreased HbA1c levels.

**Outcomes**

The primary outcome for this EBP project was improved glycemic control measured by
the HbA1c. A venipuncture was done, and labs were sent to LabCorp for analysis. Blood work
typically resulted in 1-2 days. A HbA1c was collected at baseline, then again in 3 months after
receiving the text messages. A decreased HbA1c less than 7% shows an improvement in
glycemic control. The secondary outcome for this EBP project was improved medication
adherence by measuring the scores found on the questionnaire at baseline and again in 3
months. The pre and post MMAS-8 scale measures the severity of non-adherence and illustrates
why the patient is not taking their medication. For example, question three on the MMAS-8 scale
asks if participants have ever cut back or stopped taking their OAD medication without telling
their provider, because they felt worse when taking their OAD medication. This type of question
is assessing intentional non-adherence. The MMAS-8 scale has been an established screening
tool with evidence of validity and reliability in several research for use in chronic conditions (Morisky et al., 2008). There are 8 items on the questionnaire, with questions 1 through 7 requiring “yes” or “no” responses and item 8 as a 5-point Likert response. Each “yes” response is rated as “1” and each “no” is rated as “0”. For item 8, “a never/rarely or 0” response is scored as a “1” and “all the time or 4” response is scored as a “0”. Responses “1, 2, 3” are respectively rated as “0.25, 0.75, 0.75.” A score of 8 would mean a high adherence, and a score of less than 6 would mean low adherence (Okello et al., 2017). There was one Likert scale question assessing how often one exercises with responses as a) never/rarely, b) once in a while, c) sometimes, d) usually, and e) all the time. The last question on the pre and post questionnaires assessed how participants rated their current diet. The question was formatted in a Likert scale question with responses as a) not good, b) decent, c) moderate, d) great, and e) excellent (see Appendix E). The expected outcome in 3 months’ time would be a higher score to show improved medication adherence. The other secondary outcome would be improved diet and exercise before and after the text message intervention.

**Time**

The implementation of the EBP project was a duration of twelve weeks, providing participants enough time to make therapeutic lifestyle changes (TLC) until their next HbA1c drawn in three months. The EBP project implementation was divided into three phases: pre-implementation, pilot, and evaluation. The pre-implementation phase consisted of talking to providers within the organization to explore trends of problems found within their practice that needed change. Improving medication adherence and lifestyle changes (diet and exercise) in T2DM patients to decrease HbA1c was the priority based on conversations with other providers and speaking with T2DM patients. The next step was introducing the project and expected outcomes to key stakeholders. During the summer 2021 semester, the NP reached out to the IT team within the organization to assist with chart reviews in the new EMR. The organization switched from one EMR system to another in March 2021 and the transfer of data was still in
process in the summer months. Some important information such as labs and medications patients were on did not transfer over to the new EMR. The NP and director of the IT team provided chart reviews collecting data from the old and new EMR based on eligibility criteria. Participants that fit the inclusion criteria were documented in a secure spreadsheet with name, date of birth, last HbA1c date and result, how many OAD medications were listed in their record, last office visit, and phone number.

Prior to the pilot phase and implementing the EBP practice change, the DNP student completed the “Social Behavioral Educational Researchers” web-based training and certification through the Collaborative Institutional Training Initiative (CITI) program. In addition, IRB approval from both the organization and university were requested and obtained. In the pilot phase, participants were recruited at the start of the Fall 2021 semester from September to November. All participants were asked to sign a consent form understanding the EBP project, expected outcomes, risks and benefits of being in the practice change. Participants were also asked to download the free SPRUCE application on their mobile phones. At the start of October 2021, participants started receiving one daily text message reminder to take their medications and/or a tailored text message focused on healthy eating and encouraging regular exercise. In the evaluation phase, after 12 weeks, a HbA1c was collected, and participants were scheduled a follow up visit with the NP to review lab results to assess effectiveness of their 3-month TLC. Participants were asked to complete the MMAS-8 and Likert-style questions to evaluate improvement in medication adherence and lifestyle changes. Permission was requested and granted to use the MMAS-8 tool by the original author, Dr. Morisky during the Spring 2022 semester (see Appendix E). Please see the GANTT chart in appendix C.

Protection of Human Subjects

At the end of the summer 2021 semester, the DNP student received approval from the Chief Medical Officer of the organization to implement the practice change. IRB approval from Valparaiso University was also achieved prior to the start of the Fall 2021 semester. In the Spring
of 2021, the DNP student completed the web-based “Social Behavioral Educational Researchers” course through CITI to ensure protection of human rights. Participants’ information was stored in a Microsoft Excel spreadsheet on a private password protected laptop. Anonymity was maintained by assigning a four-digit numeric code to each participant rather than using patient identifying information. Data collected was protected to maintain standards of the Health Insurance Portability and Accountability Act (HIPAA). Questionnaire forms were filed in a locked cabinet in the provider’s office.
CHAPTER 4

FINDINGS

The purpose of this EBP project was to implement the best practice to improve medication adherence, lifestyle changes, and HbA1c in uncontrolled T2DM patients with a HbA1c greater than 7%. The primary objective was to determine if sending daily one-way text message reminders to take OAD medications and tailored lifestyle text messages motivating participants to eat healthy and exercise regularly will decrease their HbA1c over a 12-week period. Secondary objectives included evaluation of the pre-and post-MMAS-8 scores to assess medication adherence, and overall participant’s improvement in therapeutic lifestyle changes. The desired outcome was to have an improved MMAS-8 score, between six to eight showing medium to high medication adherence, and a lower HbA1c showing improved diabetic management. Statistical Package for Social Sciences (SPSS-25) was used to perform a Wilcoxon Signed Ranks matched pairs t-test to show statistical differences between pre-and post-MMAS-8 scores and pre-and post-HbA1c levels. The Spearman correlation test was performed to show correlations between the pre-and post-MMAS-8 scores and HbA1c, and lastly a Kruskal-Wallis test was used to show if diet and exercise played a role in improving HbA1c.

This chapter will present participants’ demographic information and statistical analyses on the data collected over the 12-week period.

Participants

Sample Size

A total of 24 individuals agreed to participate in the EBP project. They all signed a consent form to receive daily one-way text messages through the SPRUCE app for 12-weeks. Participants (n=24) completed the pre-MMAS-8 questionnaire and had their baseline pre-HbA1c drawn, and agreed to follow up in 12-weeks to complete a post-MMAS-8 questionnaire and have their blood drawn to collect a post-HbA1c level. At completion of the project, 21 participants had
completed the 12-week practice change that included a follow up to have their HbA1c level drawn and completion of the post intervention MMAS-8 questionnaire. Three participants finished the 12-week practice change, but did not have a follow up appointment soon enough to be included in the data analysis.

**Characteristics.** Participants demographic characteristics were analyzed. Participants of any race, gender, or socioeconomic status were included in the EBP project. Inclusion criteria included: patients (1) aged 18-65 years old with a diagnosis of T2DM; (2) a HbA1c greater than 7%; and (3) prescribed one or more OAD medications. Exclusion criteria included: patients (1) under 18 years old; (2) insulin-dependent; (3) unable to speak or understand English; and (4) does not own a mobile phone or have access to email. There were equal males (50%) to females (50%) who participated in the EBP practice change (Table 4.1). The ages of the participants ranged between 28 to 65 years old. The average age of the participants was 52.33 ($SD = 9.319$). More than half of the participants were Caucasian (52%) and Hispanic individuals made up 24% of the population. African American individuals made up 16% of the population, and only 4% of the population was Asian. The minimum number of OAD medications participants were prescribed was one OAD medication and the maximum number of OAD medications prescribed was four. The mean number of OAD medications was 1.75 ($SD = .737$). Participants’ pre-HbA1c ranged from 7% to 11%, with a mean of 8.38 ($SD = 1.391$). The scoring for the pre-MMAS-8 scores ranged from 1.5 to 8, with mean of 5.77 ($SD = 2.32$). Descriptive statistics of the demographic data are presented in Table 2.
<table>
<thead>
<tr>
<th>Demographic</th>
<th>Frequency (%)</th>
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<tr>
<td>Number of participants at commencement</td>
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<tr>
<td>Number of participants at completion</td>
<td>21 (87.5%)</td>
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<tr>
<td>Attrition</td>
<td>3 (12.5%)</td>
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<tr>
<td>Age</td>
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</tr>
<tr>
<td>Mean/SD</td>
<td>52.33/9.319</td>
</tr>
<tr>
<td>Range</td>
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</tr>
<tr>
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</tr>
<tr>
<td>Male</td>
<td>12 (50%)</td>
</tr>
<tr>
<td>Female</td>
<td>12 (50%)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>13 (52%)</td>
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<tr>
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<td>4 (16%)</td>
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<td>1 (4%)</td>
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<tr>
<td>Hispanic</td>
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<tr>
<td>Number of OAD Medications</td>
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<tr>
<td>Mean/SD</td>
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</tr>
<tr>
<td>Range</td>
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<tr>
<td>Pre-HbA1c</td>
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</tr>
<tr>
<td>Mean/SD</td>
<td>8.38/1.391</td>
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Pre-MMAS-8 score

<p>| | |</p>
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<tr>
<td>Mean/SD</td>
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<tr>
<td>Range</td>
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</table>

Changes in Outcomes

This EBP project addressed the following PICOT question: in adult non-insulin dependent T2DM patients (P), does text messaging reminders (I) compared to no text messaging reminders (C) effectively improve medication adherence, lifestyle changes, and decrease hemoglobin A1C (O) over a 12-week period (T)? The primary outcome for this EBP project was improved glycemic control measured by the HbA1c. A HbA1c was collected at baseline, then again in 3 months after receiving daily text message reminders. A decreased HbA1c shows an improvement in glycemic control. The secondary outcome for this EBP project was improved medication adherence by measuring the scores found on the MMAS-8 questionnaire at baseline and again in 3 months.

Statistical Testing and Significance

The SPSS 25 system was used for data analysis. Cronk (2019) was used as a guide for data analysis and interpretation. To determine if the EBP practice change was statistically significant, a non-parametric version of a matched pairs t-test called the Wilcoxon Signed Ranks test was performed to show significant differences between the pre-and post HbA1c levels and the pre-and post MMAS-8 scores. To measure the correlation between those participants who improved in MMAS-8 scores and those who improved in HbA1c levels, a Spearman’s correlation test was performed. Additionally, a non-parametric version of a one-way ANOVA test called a Kruskal-Wallis test was performed to measure independent variables such as diet and exercise and its effect on HbA1c.
Findings

Primary Outcomes

**Improvement in HbA1c.** The primary outcome for this EBP project was improved glycemic control measured by the HbA1c. A HbA1c was collected by venipuncture and sent to LabCorp for analysis at baseline, then again after completion of the EBP practice change. A decreased HbA1c less than 7% showed an improvement in glycemic control. Participants’ (n=21) post-HbA1c ranged from 5.9% to 11.2% with an average of 7.74% (SD = 1.293). Prior to the practice change, participants’ pre-HbA1c ranged from 7% to 11%, with an average of 8.38% (SD = 1.391). After performing a Wilcoxon Signed Ranks test, the two-tailed p-value was smaller than .05 (p-value = .002) suggesting significant evidence to conclude that there was a statistical difference between pre and post HbA1c levels (Table 3).

Secondary Outcomes

**Medication Adherence.** The secondary outcome for this EBP project was improved medication adherence by measuring the MMAS-8 scores found on the questionnaire at baseline and again after 12 weeks. The pre and post MMAS-8 scale measures the severity of medication non-adherence and illustrates why the patient is not taking their medication. The MMAS-8 scale consists of 8 items. Questions 1 through 7 requires a response of either a “yes” or “no.” Each “yes” response is scored as “1” and each “no” is rated as “0”. For item 8, “a never/rarely or 0” response is scored as a “1” and “all the time or 4” response is scored as a “0”. Responses “1, 2, 3” are respectively rated as “0.25, 0.75, 0.75.” A score of 8 would translate to a high medication adherence, a score between 6 to 8 would mean medium adherence, and a score of less than 6 would mean low adherence (Okello et al., 2017). The post-MMAS-8 scores ranged from 2.75 to 8, with an average score of 6.79 (SD = 1.42). At baseline, the pre-MMAS-8 scores ranged from 1.5 to 8, with an average score of 5.77 (SD = 2.32). After performing a Wilcoxon Signed Ranks test, the two-tailed p-value was smaller than .05 (p-value = .004), this suggests that there was significant evidence to conclude that there was a statistical difference between pre and post
MMAS-8 scores (Table 4). To measure the correlation between MMAS-8 scores and HbA1c, Spearman’s correlation test was performed, which showed a weak positive correlation between those who improved in MMAS-8 scores and those who improved in HbA1c levels. The weak positive correlation means that as improvement in MMAS-8 scores increased, the improvement in HbA1c levels increased, however, the result was not statistically significant ($p$-value = .575) (Figure 2). At the completion of the EBP practice change, participants made anecdotal comments that can provide evidence of clinical significance. One participant said, “I miss receiving your daily text message reminders to take my medication, all your messages were so motivating, I have not missed a dose since I stopped receiving your texts.” Another participant commented, “I thought they (text messages) were good reminders to not forget to take my medications, I looked forward to receiving the daily text messages. It kept me on track when life gets busy.”

**Therapeutic Lifestyle Changes.** Therapeutic lifestyle changes include diet and exercise. A secondary outcome would be improved diet and exercise after the EBP practice change. Participants filled out a similar Likert-scale question for diet and exercise. Question 9 in the pre and post questionnaire assessed how often one exercises with responses as a) never/rarely, b) once in a while, c) sometimes, d) usually, and e) all the time. Question 10 on the pre and post questionnaire assessed how participants rated their current diet as a) not good, b) decent, c) moderate, d) great, and e) excellent. A Kruskal-Wallis test was performed for each independent variable (diet group vs HbA1c) and (exercise group vs HbA1c). After performing a Kruskal-Wallis test, the $p$-value was not significant for the diet lifestyle change in either the pre ($p$-value = .433) or the post ($p$-value = .884). This means that the different levels of diet did not have a significant difference in HbA1c levels (Table 5). Likewise, using the Kruskal-Wallis test for showing significance of exercise on HbA1c, the $p$-value was not significant for the exercise lifestyle change in either the pre ($p$-value = .575) or the post ($p$-value = .367) (Table 6). This means that the different levels of exercise did not have a significant difference in HbA1c levels.
Although these findings were not statistically significant, there was a 71.4% increase in diet and exercise (Figure 3) after the 12-week practice change. Additionally, many anecdotal comments from participants demonstrated clinical significance. One participant stated during a follow-up visit, “Thank you and I cannot express my gratitude enough for everything you have done for me. Your guidance has brought me back to a healthy lifestyle.” Another participant texted in Spruce, “I must say that I find these reminders and messages extremely helpful. The encouragement I receive is valuable to me. Thank you for all the time you dedicate to fostering better health for me. My family also appreciates the effort as it does help me share the information on healthy eating habits and exercise. Thank you and keep it coming!”

**Table 3**

*Pre and Post HbA1c Levels*

<table>
<thead>
<tr>
<th>Wilcoxon Signed Ranks Test</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ranks</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Post_a1c - Pre_a1c</td>
</tr>
<tr>
<td>Negative Ranks</td>
</tr>
<tr>
<td>Positive Ranks</td>
</tr>
<tr>
<td>Ties</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

a. Post_a1c < Pre_a1c
b. Post_a1c > Pre_a1c
c. Post_a1c = Pre_a1c

**Test Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Post_a1c - Pre_a1c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>-3.139b</td>
</tr>
<tr>
<td>Asymp. Sig. (2-tailed)</td>
<td>.002</td>
</tr>
</tbody>
</table>

a. Wilcoxon Signed Ranks Test
b. Based on positive ranks.
Note. The p-value = .002 suggesting significant evidence to conclude that there was a statistical difference between pre and post HbA1c levels.

Table 4

*Pre and Post MMAS-8 Scores*

**Wilcoxon Signed Ranks Test**

<table>
<thead>
<tr>
<th>Ranks</th>
<th>N</th>
<th>Mean Rank</th>
<th>Sum of Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post_MMAS_8_Score -</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre_MMAS_8_Score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative Ranks</td>
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<td>4.17</td>
<td>12.50</td>
</tr>
<tr>
<td>Positive Ranks</td>
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<td>9.50</td>
<td>123.50</td>
</tr>
<tr>
<td>Ties</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- a. Post_MMAS_8_Score < Pre_MMAS_8_Score
- b. Post_MMAS_8_Score > Pre_MMAS_8_Score
- c. Post_MMAS_8_Score = Pre_MMAS_8_Score

**Test Statistics**

\[ Z = -2.892^b \]

Asymp. Sig. (2-tailed) .004

- a. Wilcoxon Signed Ranks Test
- b. Based on negative ranks.

Note. The p-value = .004, this suggests that there was significant evidence to conclude that there was a statistical difference between pre and post MMAS-8 scores.
Figure 2

Correlation Between MMAS-8 Scores and HbA1c

*Note.* The R squared value is .0229. The R-value is .0539 showing a very weak positive correlation between MMAS-8 scores and HbA1c levels. As MMAS-8 scores improve, HbA1c levels slightly improve.
Figure 3

*Therapeutic Lifestyle Changes (Diet and Exercise) After Practice Change*

Note. There was a 71.4% increase in diet and exercise after the 12-week practice change. 4.8% decrease in diet and exercise after the 12-week practice change. 23.8% no change in diet and exercise after the 12-week practice change.
Table 5

*Correlation Between Post-MMAS-8 Scores and Post-HbA1c Levels*

**Nonparametric Correlations**

<table>
<thead>
<tr>
<th></th>
<th>a1c_difference</th>
<th>MMAS_Increase</th>
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</thead>
<tbody>
<tr>
<td>Correlation Coefficient</td>
<td>1.000</td>
<td>.130</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.</td>
<td>.575</td>
</tr>
<tr>
<td>N</td>
<td>21</td>
<td>21</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>a1c_difference</th>
<th>MMAS_Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation Coefficient</td>
<td>.130</td>
<td>1.000</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.575</td>
<td>.</td>
</tr>
<tr>
<td>N</td>
<td>21</td>
<td>24</td>
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</tbody>
</table>

Table 6

*Diet (Pre and Post) vs HbA1c*

**Kruskal-Wallis Test**

<table>
<thead>
<tr>
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<th>Pre_Q10</th>
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<th>Mean Rank</th>
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</thead>
<tbody>
<tr>
<td>a1c_difference</td>
<td>Not good</td>
<td>14</td>
<td>10.57</td>
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<tr>
<td></td>
<td>Decent</td>
<td>4</td>
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</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>2</td>
<td>10.50</td>
</tr>
<tr>
<td></td>
<td>Great</td>
<td>1</td>
<td>21.00</td>
</tr>
<tr>
<td>Total</td>
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**Test Statistics**

<table>
<thead>
<tr>
<th>a1c_difference</th>
<th>Kruskal-Wallis H</th>
<th>df</th>
<th>Asymp. Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.745</td>
<td>3</td>
<td>.433</td>
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</table>

a. Kruskal Wallis Test
b. Grouping Variable: Pre_Q10

d. df

c. Asymp. Sig.
### Table 7

**Exercise (Pre and Post) vs HbA1c**

#### Kruskal-Wallis Test

<table>
<thead>
<tr>
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<th>Pre_Q9</th>
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</thead>
<tbody>
<tr>
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<td>10.14</td>
</tr>
<tr>
<td></td>
<td>Once in a while</td>
<td>8</td>
<td>10.94</td>
</tr>
<tr>
<td></td>
<td>Usually</td>
<td>1</td>
<td>19.00</td>
</tr>
<tr>
<td></td>
<td>All the time</td>
<td>1</td>
<td>13.00</td>
</tr>
<tr>
<td></td>
<td>Total</td>
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</table>

#### Kruskal-Wallis Test

<table>
<thead>
<tr>
<th>Ranks</th>
<th>Post_Q9</th>
<th>N</th>
<th>Mean Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>a1c_difference</td>
<td>Never/Rarely</td>
<td>2</td>
<td>19.00</td>
</tr>
<tr>
<td></td>
<td>Once in a while</td>
<td>7</td>
<td>9.21</td>
</tr>
<tr>
<td></td>
<td>Sometimes</td>
<td>7</td>
<td>11.14</td>
</tr>
<tr>
<td></td>
<td>Usually</td>
<td>4</td>
<td>9.38</td>
</tr>
<tr>
<td></td>
<td>All the time</td>
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<td>13.00</td>
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#### Test Statistics\(^{a,b}\)

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<tr>
<td>Kruskal-Wallis H</td>
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<td>df</td>
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<tr>
<td>Asymp. Sig.</td>
<td>.575</td>
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</tr>
</tbody>
</table>

\(^{a}\) Kruskal Wallis Test  
\(^{b}\) Grouping Variable: Pre_Q9
CHAPTER 5

DISCUSSION

The aim of this EBP project was to evaluate the effect of sending daily tailored one-way text message reminders to T2DM patients to remember to take their OAD medications, focus on eating a healthy diabetic diet, and exercising regularly. The practice change was implemented with desired outcomes being improved medication adherence, therapeutic lifestyle changes, and decreased HbA1c. This chapter will provide an explanation and interpretation of project findings, strengths, limitations, and sustainability of the project, and future research recommendations.

Explanation of Findings

The statistically significant findings provide supporting evidence for implementation of sending daily tailored text messaging reminders to take OAD medications and focus on eating healthy and exercising regularly to improve medication adherence, therapeutic lifestyle changes, and ultimately lowering HbA1c in T2DM patients. Results from this EBP project were consistent with current literature regarding best evidence to improve medication adherence and glucose control in T2DM patients.

Improvement in HbA1c

There was a statistically significant difference in HbA1c from baseline to after the 12-week practice change. Mean HbA1c among the 21 participants who completed the 12 week follow up showed a decrease in HbA1c levels indicating that the daily text message reminders helped improve medication adherence and lifestyle changes. The minimum HbA1c after the practice change was 5.9% in comparison to the baseline HbA1c inclusion criteria of 7% or greater to be included in the practice change. This illustrated better management of diabetes after the 12 weeks. Findings from the literature showed an improvement in HbA1c after three months of receiving an intervention to improve HbA1c in T2DM patients which helped to initiate this evidence-based practice project. In both RCTs reviewed (Sarayani et al., 2017 & Kassavou
et al., 2020), HbA1c was significantly improved in the intervention group (received a digital intervention) compared to the control group (received usual care) after three months. In the RCT (Kassavou et al., 2020), those participants receiving highly tailored text messages for 12 weeks lowered their HbA1c from an average of 13% to 4.7% (Kassavou et al., 2020). In the RCT (Nelson et al., 2021), significant treatment effects were found at three months (-0.26%, 95% CI -0.48%, -0.05%, p=0.018) rather than at 12 and 15 months. In the SR (Haider et al., 2019), text messaging interventions as illustrated in four of the trials sent three to four messages per week focusing on diet, exercise, self-monitoring of blood sugar levels and cardiovascular risk factor reduction during a three-to-six-month duration. Nine out of the eleven studies found an overall reduction in HbA1c of 0.38% (p-value less than 0.001) (Haider et al., 2019).

There were trends found in the literature that demonstrated motivational interviewing interventions as an effective method to guide collaboration between practitioner and patient with setting goals and addressing barriers to self-care, in addition to improving medication adherence in T2DM patients (Zomahoun et al., 2017, Trevisan et al., 2020, Van Driel et al., 2016, Varming et al., 2019). The SR (Zomahoun et al., 2017), showed positive effects with face-to-face MI in improving medication adherence in adults with chronic diseases (B =0.192, 95% CI (0.039, 0.344)) (Zomahoun et al., 2017). The positive findings from this project could be attributed to the motivational interviewing that took place at the initial visit with the NP. At the initial visit, the NP assessed barriers to medication adherence and lifestyle changes and aimed to strengthen the patient’s motivation by providing them a three-month therapeutic lifestyle challenge. The information gathered from the visit were then used to tailor daily text messages to participants.

**Medication Adherence**

Medication adherence measured by the MMAS-8 scale provided before and after the practice change showed statistically significant improvements in MMAS-8 scores illustrating higher medication adherence. The mean post-MMAS-8 score was 6.79 in comparison to the mean pre-MMAS-8 score of 5.77. This shows that participants had medium to high medication
adherence after the practice change. Findings in the literature were congruent with the results of the EBP project in regard to medication adherence. In the RCT (Kassavou et al., 2020), among nonadherent patients with either or both hypertension and T2DM, a highly tailored digital intervention was effective at improving treatment adherence and feasible to obtain clinically meaningful outcomes (Kassavou et al., 2020). As stated earlier in chapter 4, many participants made positive anecdotal comments regarding the use of daily text message reminders to improve medication adherence. Providing daily tailored text messages to participants improved intentional and nonintentional nonadherence. A participant commented on how he remembered to bring his medications with him on vacation because of the daily text message reminders to take his OAD medications. The same participant also commented on bringing his workout clothes with him on vacation to continue exercising regularly.

**Therapeutic Lifestyle Changes (Diet and Exercise)**

Improvement in TLC (diet and exercise) played a pivotal role in addition to medication adherence to improve HbA1c. There was a 71.4% increase in diet and exercise after the practice change showing a positive improvement in lifestyle changes. Before the practice change, 66% of participants marked their diet as “not good” in the Likert-scale question. After the practice change, only 9.5% marked their diet as “not good” and almost half of the participants rated their diet as “moderate.” Likewise, 52% of participants marked “never/rarely” for exercising before the practice change. After the practice change, 33% of participants marked “once in a while” or “sometimes” to exercising, which showed an improvement in the number of times participants exercised per week during and after the practice change. Evidence from the literature exhibited lifestyle focused text messaging tailored to the individual was more effective than the standardized text (Haider et al., 2019). Rather than sending automated text messages to participants with generic information on diet and exercise, the NP tailored the text messages to focus on participants’ barriers to making lifestyle changes as mentioned during their initial visit. Examples of text message content included encouraging reminders to exercise, educational
information on diabetic diet, and reminders to make meals colorful like the rainbow by including more vegetables and fruits, and less carbohydrates. Text message reminders to meal prep for the week were regularly sent on Sundays to remind participants to bring a healthy lunch and snacks to work instead of buying fast food or junk food. All 21 participants who followed up after 12 weeks provided positive feedback, even requesting to continue receiving text messages after the project.

Strengths and Limitations of the DNP Project

Strengths

There were many strengths of the DNP project. Being the NP at the practice site was an advantage in recruiting established patients to be a part of the EBP project. Once a good rapport and mutually trusting relationship was built between the NP and patient, patients were more motivated to join the EBP project to improve their diabetes. Recruitment took place in the Fall of 2021, during the months of September and October when participants were due for their six-month labs and annual physical with the NP. With the help of the IT team, the NP and IT director were able to scan through the EMR to find patients with a T2DM diagnosis and assess when and what level their last HbA1c was. The NP was able to reach out to participants who fit the eligibility criteria by chart reviews to join the EBP project. The clinical practice site’s DPC model permitting 30–60-minute patient appointments allowed for more motivational interviewing to take place at the initial visit. The NP was able to collect vital information on participant’s barriers to medication adherence, lifestyle changes, and assess their motivation to improve their diabetes. Based on the initial visit, the NP was able to provide tailored text messages to individual participants based on their own barriers in managing their diabetes effectively. Being able to tailor text messages to participants made participants feel as if they had their own personal health coach cheering them on daily to choose the right food options, to prioritize exercise, and to remember to take their medications. Choosing to use the widely-used valid and reliable MMAS-8 scale to measure medication nonadherence versus creating a new questionnaire and
test for validity and reliability saved time in collecting data. Also, having supportive staff (the CMA and RN) call and follow up on participants to schedule appointments to get their blood drawn after the 12-week practice change, and performing phlebotomy to collect the HbA1c at the practice site assured for timely data collection. Furthermore, the SPRUCE app was readily available to use by the NP to implement the EBP project since the organization already had a contract with SPRUCE. Advantages to using SPRUCE versus other apps were the ability to disguise the NP’s personal phone number when sending texts to participants, being able to schedule text messages to be sent at a specific day and time, and being able to copy and paste text messages to individual SPRUCE accounts rather than having to type out a text message individually to each participant. Lastly, another strength of the project was the low attrition allowing for more statistically significant differences between groups.

Limitations

There were limitations to this project. Since recruitment was done in the Fall of 2021, the practice change went through Thanksgiving, Christmas, New Years, and for some participants, Valentine’s Day. Some participants who did not have an improved HbA1c reported that eating healthy and exercising was challenging during the holidays because of traveling and having family over for meals. The COVID pandemic also seemed to impact participants’ outcomes. There were participants who reported having COVID during the practice change and were too ill to exercise and/or focus on eating healthy and were not taking their OAD medications appropriately because they were not eating enough. An important theme that was observed in several participants was depression, playing a role in diabetes. One participant commented after the practice change that her mood affected how she ate. When her mood was happy, she would focus more on eating healthy, but when she felt stressed or sad, she would eat more carbohydrates and sweets to make her feel better. Having untreated or undertreated depression negatively impacted how participants managed their diabetes. Participants expressed feeling
overwhelmed by having diabetes and feared the complications of worsening diabetes, yet still had low motivation to make therapeutic lifestyle changes.

Although the SPRUCE app was readily available to use for the EBP project, the SPRUCE app also had limitations. A major limitation was not being able to send mass tailored text messages to participants all at once. This could have been time saving for the NP in regards to sending daily text messages to participants. Another limitation was not being able to see if the participant received or read the text message. The text messages were one-way text messages that were previously established before the start of the project. Being that participants did not need to reply back, engagement throughout the 12-week period was not monitored. Another barrier was the collection of data that was set to be completed between January to February, and into early March. Some participants had to cancel their blood draw and follow up appointments because the office was closed due to winter storms and unsafe driving conditions. This consequently led to some challenges in rescheduling those participants in time for the data analysis. Lastly, participants rated their diet and exercise before and after the practice change by answering two Likert-type questions. For the exercise question, measurements would have been more meaningful if each level was categorized as how many times a participant exercised per week. For example, “once in a while” would be exercising once a week, “sometimes” would be two or three times a week, “usually” being three to five times a week, and “all the time” being seven days a week. Additionally, when analyzing data on diet and exercise, variables were not statistically significant because participants were not equally distributed in each level making the sample sizes smaller to test for any significant differences between each variable.

**Sustainability**

The NP met with the IT director towards the end of the practice change to discuss sustainability of the EBP project. The IT director suggested a new platform called Carium that allows for real time collaboration between patients and providers. This Carium app has many features including remote patient monitoring, chronic care management, and health coaching.
The Carium app can be linked to other apps such as the MyFitness Pal app to record daily food intake and weight, or the IPhone watch to measure the progress of exercise per week. The Carium app also can be linked to any cellular or Bluetooth device to track glucose or blood pressure readings. Rather than waiting three months to assess the HbA1c to evaluate effectiveness of treatment and make changes to a patient’s treatment plan, use of the Carium app would be beneficial because providers will be able to see daily glucose logs and determine sooner if medication changes need to be made. A benefit of using the Carium app instead of SPRUCE is that the app allows for mass text messages to be sent to patients rather than individually copying and pasting text messages to each participants’ SPRUCE account. One of the disadvantages of using the SPRUCE app was not being able to see if the participant read the message. In the Carium app, providers will not only be able to see if messages were opened and read, but how the patient is managing their diabetes. Utilization of the Carium app would be a valuable tool to increase patient engagement and deliver care in a meaningful and proactive way.

Beneficial changes for implementation of this EBP project in the future would be one-month check-ins with participants by phone or through Zoom to assess how participants’ therapeutic lifestyle challenge is going, and how they are perceiving the daily text message reminders. At the one-month check-in, the NP can assess what other barriers participants are experiencing, for example, participants can be provided with the Patient Health Questionnaire (PHQ-9) to assess how their depression has been. Another change would be referring participants to the organization’s health coach for a 60-minute session to assess barriers and recommendations to improve diet and exercise, and plan development that would allow the NP to use information from the plan to tailor daily text messages to participants. For a few participants who did not improve the HbA1c after the practice change, they would be referred to the health coach for further management of lifestyle changes. The NP will present this practice change to the organization at one of their weekly clinical management meetings with all the other
providers working at other wellness centers to assess acceptability of the Carium app part of their treatment plan for patients with chronic conditions needing long term management.

Relevance for EBP Model

The revised IOWA model for the EBP project was very useful because the steps of the algorithm were straightforward and easy-to-navigate and allowed for changes to be made throughout the process if key stakeholders identified an issue to be a priority. For example, initially the EBP project was focused on just improving medication adherence to OAD medications, but from gathering data from participants’ pre-MMAS-8 scores, most participants were taking their medications as prescribed, but had poor diet and exercise. The EBP project included lifestyle changes to be a secondary outcome in addition to medication adherence because both medication adherence and lifestyle changes play a large role in managing diabetes effectively. Text messages were not only daily medication reminders, but focused lifestyle text messages on healthy eating and prioritizing exercise. The revised IOWA model encourages a collaborative approach and considers the entire healthcare system, which includes healthcare providers, patients, and the clinical setting, using research within these contexts to guide the implementation of research into clinical practice (Melnyk & Fineout-Overholt, 2019). All steps in the model were necessary to complete the EBP project, particularly, the last step of instituting the change in practice and considering the environment, staff, cost, patient and family. This practice change of sending daily text messages to patients who have uncontrolled T2DM, or even newly diagnosed with T2DM, or any chronic condition where patients are needing to take long-term medications is a simple, cost-effective, and valuable tool in managing care and increasing patient engagement with their health.

Recommendations for the Future

This EBP project provided valuable insight in managing T2DM patients in a primary care setting, with use of a simple and cost-effective method to improve overall patient health and
wellness. This section will outline future research and education that may effectively guide evidence-based practice into clinical practice.

Research

Areas of further research were identified during the course of this EBP project. After hearing some participants openly talk about depression and how their mood negatively impacted their diabetic management, sparked the spirit of inquiry for this DNP student. Participants dealing with depression were unable to focus on their health and felt overwhelmed with how to manage their diabetes. One participant reported difficulty finding the right foods to eat that would not increase glucose levels. Another participant mentioned stress eating to feel better and requested resources to find diabetic support groups. More research needs to be done on the correlation between depression and diabetes, and how to effectively manage both in a primary care setting. Future projects could be focusing on the effects of support groups for diabetics in improving HbA1c and lifestyle changes. Further research on the use of the Carium app or any digital app for patients and providers to continue real life collaboration after the office visit to show how monitoring glucose logs, food intake, and amount of exercise per week will effectively increase patient engagement and improve HbA1c. More research is needed to refine whether there is a best combination of OAD medications to effectively improve different levels of HbA1c, or whether there are certain OAD medications that should be prescribed for certain individuals. In regards to TLC, more research is needed to explore best methods of sustaining a healthy diabetic diet and exercise. For future projects on TLC, it is recommended to use an existing reliable and valid tool for measuring improvements in diet and exercise. Lastly, it is recommended that future projects related to improving HbA1c in T2DM patients try to enhance sample size of the project, at least over 30 participants for more statistical power.

Education

This EBP project has highlighted areas where education is needed for practicing providers, staff, nursing and medical students. Primary care providers need to understand the
most common barriers patients are having that are negatively affecting diabetes management. Staff should be knowledgeable on how to educate patients on how to use their glucometer, as well as counseling patients on the common signs and symptoms of hypo-and-hyperglycemia, and what to do when they are having hypoglycemic episodes. Furthermore, patients need to have more education on the risk for severe complications of T2DM when their glucose is consistently elevated. Some participants reported prior to the practice change that they did not fully understand the risk of complications with T2DM, such as having nephropathy, neuropathy, retinopathy, increased risk for infection, heart disease, and stroke. Some participants reported because they were not feeling sick or having symptoms of hyperglycemia, they were not taking their prescribed OAD medications regularly because of the gastrointestinal side effects of Metformin.

Moreover, providers need to be familiar with the DSM-V criteria for depression and should regularly assess diabetic patients for depression by providing patients with the PHQ-9. A score between 15 and 19 on the PHQ-9 would show moderately severe depression indicating initiation of pharmacotherapy and psychotherapy (MDCalc, 2022). Providers need to be educated on what the next steps are in treating depression in T2DM patients.

**Conclusion**

In conclusion, the results of this EBP project showed that sending daily tailored one way text message reminders to take OAD medications, and motivational text messages focusing on eating a healthy diabetic diet and exercising regularly significantly improved medication adherence, lifestyle changes, and HbA1c levels in T2DM patients. Globally, the prevalence of T2DM in adults in 2040 is projected to be 10.4% because of the aging population, sedentary lifestyle, and obesity which all will contribute to an increased morbidity and mortality worldwide (Haider et al., 2019 & Sarayani et al., 2019).

T2DM can be effectively treated with medication and behavioral lifestyle modifications. Even small improvements in glycemic control can reduce the risk for debilitating complications
such as heart disease, stroke, kidney disease, sepsis, and retinopathy (Wang et al., 2021, Haider et al., 2019). Primary care providers are at the forefront of preventing and slowing down the progression of chronic disease. Therefore, utilization of text messages is a highly acceptable, cost-effective, time-efficient, patient-centered intervention that can benefit many patients to improve medication adherence and lifestyle changes, and ultimately decrease the risk of co-morbid complications resulting in uncontrolled T2DM. Furthermore, sending tailored text messages to patients will enhance collaboration between the provider and patient, and most importantly, improve patient’s overall well-being.
REFERENCES


Centers for Disease Control and Prevention [CDC]. (2021, June 21). *Type 2 Diabetes*. 
https://www.cdc.gov/diabetes/basics/type2.html


BIOGRAPHICAL MATERIAL

Vanessa Silverio earned her Bachelors in Business Administration (BBA) degree in 2005 with a major in International Business and Marketing and a minor in Professional Writing from Saint Mary’s College in Notre Dame, Indiana. She then went on to study nursing and graduated from Rush University in Chicago, Illinois with a Bachelor of Science in Nursing (BSN) degree in 2009. While working in an intensive care unit (ICU) as a registered nurse in Chicago, Vanessa realized some reasons for admission to the ICU are preventable. She decided to pursue her Masters in Nursing at the University of Cincinnati, Ohio in 2013, and become a Family Nurse Practitioner (FNP) to focus on preventative care. Vanessa’s experience as an FNP has been focused on primary care with diverse pediatric, adult, geriatric, and college health patients. She has a passion for women’s health, mental health, and preventative medicine. Vanessa is an active member of the American Association of Nurse Practitioners (AANP) and the Zeta Epsilon Chapter of Sigma Theta Tau. She is currently in a Post-Master’s Doctorate in Nursing Practice program at Valparaiso University in Valparaiso, Indiana to earn her terminal degree in the nursing field, expected May 2022. Vanessa believes her values in nursing, and vision for the future of healthcare are aligned with her current company’s mission and vision of “Care without Compromise.” Vanessa is happily employed in a direct primary care wellness center focusing on educating patients on becoming the healthiest version of themselves, and preventing or slowing down the progression of chronic diseases.
ACRONYM LIST

ADA: American Diabetes Association
App: Application
BMI: Body mass index
CDC: Centers for Disease Control
CITI: Collaborative Institutional Training Initiative
CMA: Certified medical assistant
DM: Diabetes Mellitus
EBP: Evidence-based practice
EMR: Electronic Medical Record
DPC: Direct primary care
FNP: Family nurse practitioner
FPG: Fasting plasma glucose
HbA1c: Glycated hemoglobin
HIPAA: Health Insurance Portability and Accountability Act
IRB: Institutional Review Board
MMAS-8: Morisky Medication Adherence Scale
MI: Motivational interviewing
OAD: Oral anti-diabetic
OGG: Oral glucose tolerance test
PHQ-9: Patient Health Questionnaire-9
RCT: Randomized controlled trial
RN: Registered nurse
RPG: Random plasma glucose
SR: Systematic review
TLC: Therapeutic Lifestyle Changes/Challenge
T2DM: Type 2 Diabetes Mellitus

UHF: United Health Foundation

WHO: World Health Organization
### APPENDIX A

**Evidence Synthesis Table**

<table>
<thead>
<tr>
<th>Lead Author/Year/Quality</th>
<th>Purpose/Design/Sample</th>
<th>Interventions</th>
<th>Measurement/Outcomes</th>
<th>Results/Findings</th>
<th>Strengths/Limitations</th>
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</thead>
<tbody>
<tr>
<td>Van Driel, M.L./2016/High Quality</td>
<td><em>Purpose</em>: To evaluate the effectiveness of interventions to improve medication adherence to lipid-lowering drugs. <em>Design</em>: Systematic Review <em>Sample</em>: 35 RCTs of adults over 18 years of age who were prescribed lipid-lowering medication for primary or secondary prevention of cardiovascular disease.</td>
<td>Intensified patient care intervention involving electronic reminders, pharmacist-led interventions, education from healthcare professionals versus usual care or no intervention. Interventions include: -“simple drug regimen -patient education and information -increased follow-up, sending out reminders -group sessions, rewards -computer-based information systems</td>
<td>“Methods used to measure adherence include self-report, Medication Adherence Report Scale (MARS), medication possession ratio (MPR), proportion of days covered (PDC), medication event monitoring systems (MEMS), prescription refill rate, pill count” (p. 11). Primary outcomes: Measuring adherence “Indirect – pill count, prescription refill rate, electronic monitoring; “Subjective – person’s self-report in diaries, interviews;</td>
<td>Medication adherence at less than 6 months between participants receiving usual care vs intensified patient care had 95% CI, OR 1.93 (1.29 to 2.88). Greater than 6 months: 95% CI, OR 2.87 (1.91 to 4.29). Polypill vs separate dosing regimens resulted in improved adherence. Rather than dosing 4 times a day, switching it to twice daily is preferred. Intensified patient care interventions including telephone reminders, calendar reminders, integrated multidisciplinary educational activities and</td>
<td>Strengths: assessed a wide range of interventions for medication adherence for lipid-lowering treatments that could also be generalized to other chronic conditions needing long-term medication therapy. Low risk of selection, reporting, and attrition bias.</td>
</tr>
</tbody>
</table>
| **Haider, R./2019/High Quality** | **Purpose:** To assess the effectiveness of mobile phone text messaging in improving glycemic control for patients with Type 2 Diabetes Mellitus.  
**Design:** Systematic Review and meta-analysis  
**Sample:** 11 RCTs with adult patients over 18 | **Text messaging interventions as illustrated in 4 of the trials sent 3-4 messages per week focusing on diet, exercise, self-monitoring of blood sugar levels and cardiovascular risk factor reduction during 3-6 month duration.**  
5 studies sent one or more messages per day. | **Primary outcomes:** improving glycemic control, measuring HbA1c in 3 follow up periods (<3 months, 4-12 months, and >12 months).  
Secondary outcomes: assessing the acceptability of mobile phone interventions and reduction in cardiovascular risk factors. | **5 studies showed a significant improvement in HbA1c with educational and motivational text messaging, and the other studies showed trends of improvement.**  
9 out of the 11 studies found an overall reduction in HbA1c of 0.38% (-0.53; -0.23, p-value less than 0.001).  
Lifestyle focused text messaging tailored to the | **Strengths:** “All 11 studies described random sequence generation, which resulted in low risk of bias” (p. 34).  
**Limitations:** Due to the nature of the intervention, blinding was not done for the |
| Zomahoun, 2017/Moderate Quality | **Purpose:** To assess if motivational interviewing (MI) is an effective way to improve medication adherence in adults with chronic diseases.  
**Design:** Systematic | Motivational interviewing between practitioners and patients that aim to strengthen the motivation and commitment to change.  
Different modes of communication for MI: face-to-face, phone, internet, written documentation, group. | Primary outcome: increased medication adherence for chronic diseases.  
Used Hedge’s g (a standardized mean individual is more effective than the standardized text.  
Only 3 out of the 11 studies reported on the acceptability of the text messaging intervention with participants responding that they would recommend it to family members and that the messages were reminders to encourage healthy lifestyle.  
There were no negative outcomes with these interventions.  
Lifestyle focused text messaging is low cost and may act as an adjunct to standard care.  
Although sample size was small, there were positive effects with MI face-to-face and being coached through the session than just a phone call alone.  
“Face-to-face delivery of MI showed a positive effect with $B = 0.192$, 95% CI (0.039, 0.344)” (p. 595). | Participants in the intervention group in any of the trials.  
RCTs chosen with unidirectional messaging intervention which may have limited the number of studies chosen.  
Strengths: Assessed risk of bias for each of the studies before including in the final meta-analysis.  
Limitations: Sample size small leading to bias. |
| Review and meta-analysis. Sample: 19 RCTs with 16 included in the meta-analysis with focus on adults with chronic diseases who self-manage their own medication treatment. | Lacking MI characteristics such as delivery mode, duration of each session, number of sessions, and MI training for practitioners. | difference (SMD) to measure for small sample size. | MI was illustrated to be an effective way for patients to adhere to their medications. “The pooled effect size of MI interventions that was measured using all 17 studies was 0.23 [95% CI = (0.08, 0.37), p value = 0.003] (p. 593). | Other delivery modes such as face-to-face combined with phone calls, group delivery, or computer-based delivery were only found in 1 study and therefore, not analyzed. Sustainability of MI over time was not studied. More exploration is needed to understand the behavioral changes that result as an effect of MI on medication adherence. |

| **Level II Evidence** (use this format to add additional levels as your evidence warrants) |

<p>| Nelson, L.A./2021/ | <em>Purpose:</em> “Evaluate two mobile phone-REACH participants received three types of automated text Primary outcome: Hemoglobin A1C measured at baseline At 6 months, “the treatment effect on HbA1c was greater (-0.31%; 95% CI - | <strong>Strengths:</strong> Matched randomization |</p>
<table>
<thead>
<tr>
<th>High Quality</th>
<th>delivered interventions (REACH [Rapid Education/Encouragement and Communications for Health] and Family-Focused Add-on for Motivating Self-Care [FAMS] on diabetes outcomes” (p. 27).</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design:</strong> RCT Sample: Half racial/ethnic minorities and half underinsured, had annual household incomes less than $35,000, high school education or less. Average baseline HbA1c greater than 8.5%. Adult patients from primary care locations in Vanderbilt diagnosed with Type 2 DM.</td>
<td>messages: “self-care promotion one-way texts, interactive texts that asked about medication adherence, and adherence feedback texts that provided weekly feedback and encouragement based on responses to the interactive texts” (p. 29).</td>
</tr>
<tr>
<td>FAMS was delivered for the first 6 months to complement REACH. It consisted of monthly phone coaching to set diabetes self-care goals and improve family/friend involvement.</td>
<td>and then compared at 3, 6, 12, and 15 months. Secondary outcome: “Diabetes medication adherence measured by ARMS-D (Adherence to Refills and Medications Scale for Diabetes) and SDSCA-MS (Summary of Diabetes Self-Care Activities medications subscale” (p. 29).</td>
</tr>
<tr>
<td>“MEMOTEXT, a digital health platform, used relevant participant information transferred from REDCap (Research Electronic Data Capture) via an application programming interface to tailor, schedule, and then compared at 3, 6, 12, and 15 months.</td>
<td>0.61%, -0.02%) than those with baseline HbA1c greater than 8.5% (-0.74%; 95% CI -1.26%, -0.23%)” (p.26).</td>
</tr>
<tr>
<td>Significant treatment effects were found at 3 months (-0.26%; 95% CI -0.48%, -0.05%; p = 0.018).</td>
<td>Treatment effects were not significant at 12 and 15 months.</td>
</tr>
<tr>
<td>“REACH improved medication adherence and diet through 12 months and self-efficacy through 6 months” (p. 26).</td>
<td>Participants found the 2-way adherence text messages and associated feedback messages to be helpful.</td>
</tr>
<tr>
<td>“Oversampling racial/ethnic minorities and patients with lower socioeconomic status enhances generalizability to adults with diabetes at higher risk for poor outcomes” (p. 32). Limitations: Self-report measures for behavioral outcomes were subject to recall and social desirability bias.</td>
<td>resulted in strong balance across conditions at baseline, with all P values greater than 0.05.</td>
</tr>
</tbody>
</table>
| **Trevisan, D.D./2019/High Quality** | **Purpose:** To evaluate the effects of an implementation intention intervention for medication adherence to Type 2 DM patients taking oral hypoglycemics. **Design:** Single-blinded RCT with an IG and CG. **Sample:** Adults diagnosed with Type 2 DM on oral hypoglycemics for more than 6 months and have a positive intention for taking their medications. **Intervention group:** received an implementation intention intervention consisting of action and coping plans: “participants filled out an action plan of when, where, and how they intend to take their medications over the next 2 months” and coping strategies for obstacles and barriers to taking their medication (p. 583). **Control group:** standard care of traditional office visits with provider. | **Primary outcome:** Increased medication adherence to oral hypoglycemics, decreased hemoglobin A1C. Medication adherence measured by use of the Instrument for the Global Evaluation of Medication Adherence (IAGAM). Patients reporting taking medication more than 80% of the time and exercising appropriate care were deemed “adherent.” HbA1C measured at baseline then again in 15 weeks. **Secondary outcome:** diabetes related distress (DRD) and intention to adhere to medications. DRD measured using the 17-item Diabetes Distress Scale | **IG showed improvements in medication adherence (p<0.0001), glycemic control (p<0.0001), and diabetes related distress (p<0.0001).** Collaboration between patient and practitioner is increased when both parties understand the goals and strategies to cope with barriers in taking long term medication. This is a low cost intervention to improve DRD and HbA1C. | **Strengths:** True randomization and blinding of participants to IG and CG decreasing risk of bias. Sample size sufficient to assess primary outcomes. **Limitations:** Inclusion criteria did not include a minimum HbA1C level at baseline. Useful to have followed patients for a longer time to assess long term impact on HbA1C. Self-reports for adherence
| Kassavou, 2020/High Quality | Purpose: Aims to assess behavioral change to medication adherence using a highly tailored digital intervention to improve outcomes in patients with HTN or Type 2 DM. Design: RCT of 2 paralleled groups. Sample: 135 nonadherent patients greater than 50 years old with either or both HTN and Type 2 DM. | Intention was measured using Likert scale (1, absolutely not to 5, very likely). | which is subjective data versus objective. Further research is needed to assess objective data on medication adherence. |
| IG received highly tailored text messages and interactive voice response intervention for 12 weeks as an adjunct to usual care. Patients were able to tailor how many messages they wanted to receive each week. CG received usual care of traditional office visits with their provider. | Primary outcomes were the efficacy of the intervention to support medication adherence, measured using 2 self-reported items of adherence. Secondary outcomes include the mechanisms used as interventions for medication adherence, satisfaction and engagement of the intervention. | Medication adherence was significantly improved in the intervention group compared with the control group (P = .02, 2-tailed). Systolic blood pressure was 0.6 mmHg (95% CI −7.423 to 6.301), and hemoglobin was 4.5 mmol/mol (95% CI −13.099 to 4.710) lower in the intervention group compared with the control group. Among nonadherent patients with either or both hypertension and type 2 diabetes, a highly tailored digital intervention was effective at improving treatment adherence and |
| Strengths: Attrition rate was low. Engagement and satisfaction were high. Recruitment was high. Patients were recruited from a range of primary care practices, most in deprived areas, scalable. |
| Limitations: Could not reliably
| Sarayani, 2017/ Moderate Quality | Purpose: To evaluate the effectiveness of a telephone-based intervention provided by a pharmacist in improving care and clinical outcomes in the short- and long-term care for Type 2 DM patients. Design: 2-armed parallel group RCT with 1:1 allocation ratio. | IG: Received 16 telephone calls in 3 months by a trained pharmacist. 2 calls/week x 1 month, 1 call/week x 2-3 months. Pharmacists had a checklist to review and reinforce diabetes education from live seminar prior to recruitment of participants into the study. CG: received usual care. | Primary outcome: Improvement in HbA1C Measured at baseline, 3 months (after intervention), then in 9 months (follow-up). Secondary outcomes: Changes to lipid profile, medication adherence measured using the 8-item Morisky Medication Adherence questionnaire by phone interview and self-care measured by Self-care Activities Measure questionnaire by phone interview. | Medication adherence and self-care significantly improved with the IG after 3 months. Telephone follow ups after a live educational session in 3 or 9 months may improve medication adherence. HbA1C was significantly improved in both IG and CG at month 3 (6.97+ or -1.41 vs 7.09+or-1.78). | Strengths: Use of a balanced block randomization method to generate random allocation sequence. Limitations: Due to the nature of the study intervention, blinding of participants was not performed. |
Sample: 100 patients with Type 2 DM with HbA1C greater than 7%, on oral diabetic medications.

**Purpose:** To examine whether patient-centered diabetes consultations using the EMMA (empowerment, motivation, medication adherence) framework improves glycemic control and self-management skills in uncontrolled Type 2 DM patients.

**Design:** RCT

**Sample:** 97 adults diagnosed with Type 2 DM for more than 1 year with levels of Hemoglobin A1C greater than 8%.

**Intervention group:** patient-centered diabetes consultations using the EMMA framework.

4 one-on-one (in-person) consultations and 1 telephone follow up call. “Dialogue tools consist of images, quotes, questions, illustrations and worksheets to facilitate learning and goal setting” (p. 2239).

Face-to-face consultations with providers on months 1 and 2, then phone call, and another face-to-face on month 3, then follow up in 6 months.

**Primary outcome:** HbA1C, BMI, BP

**Secondary outcome:** Autonomy support, motivation, self-management skills, and well-being.

Outcomes assessed at baseline, after intervention, and 6 months after for follow up.

Secondary outcomes measured by 6 questionnaires: “Health Care Climate Questionnaire (HCCQ), Treatment Self-Regulation Questionnaire (TSRQ), Perceived Competence in Diabetes (PCD), Summary of Diabetes Self Care Activities (SDSCA), WHO-5, and EMMA was not superior to usual care as far as decreasing HbA1C.

EMMA is an effective framework to guide collaboration between practitioner and patient with setting goals and addressing barriers to self-care.

Medication adherence was high in comparison to lifestyle challenges of losing weight, eating a healthier diet, and increasing physical activity.

**Strengths:** Randomized design, inclusion of unique study group for a long duration of time.

**Limitations:** Differences in baseline characteristic data for the groups may have affected the results.

Intervention and follow up time may have been too short to see significant changes in HbA1C.
| Control group: usual care consisting of consultations with nurses, physicians, dieticians, chiropodists, and eye specialists. Time frame varies per individual. | Problem Areas in Diabetes (PAID-5)” (p.2240). |
## APPENDIX B

### Literature Search Grid

<table>
<thead>
<tr>
<th>Database/Resource Searched</th>
<th>Keywords/Phrases Used</th>
<th>Limiters Used</th>
<th>Number of Results from Search</th>
<th>Number of Pieces of Evidence Selected for Use In Paper</th>
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<tr>
<td>CINAHL</td>
<td>(MM “Medication Compliance”) AND “Diabetes Mellitus, Type 2” AND interven’</td>
<td>English language, published dates 2016-2021, scholarly (peer reviewed) journals</td>
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<td>5</td>
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<tr>
<td>Cochrane</td>
<td>MeSH descriptor: [Medication Adherence] AND diabetes</td>
<td>publication dates 2016-2021</td>
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<tr>
<td>JBI</td>
<td>Diabetes AND medication adherence OR medication compliance</td>
<td>English language and publication dates from 2016-2021 (past 5 years)</td>
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<td>Database</td>
<td>Search Query</td>
<td>Search Criteria</td>
<td>Number of Pieces Searched</td>
<td>Number of New Pieces of “Chased” Evidence Selected for Use</td>
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<tr>
<td>Medline</td>
<td>(MM “Medication Adherence”) AND “Diabetes Mellitus, Type 2” AND interven*</td>
<td>English language and publication dates from January 2016 to June 2021, scholarly peer reviewed journals</td>
<td>103</td>
<td>1 (many duplicates of studies found from other databases)</td>
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<tr>
<td>TRIP</td>
<td>(“Type 2 Diabetes Mellitus”) AND (“medication compliance” OR “medication adherence”)</td>
<td>USA guidelines, Since 2016</td>
<td>81</td>
<td>0</td>
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</table>

List the Title of the Article/Original Piece of Evidence that contained the “Citations Chased”:

- Medication Adherence in Chronic Illness: Motivational Interviewing (MI)

List the Title of each of the Journal(s) that were “Hand Searched”:

- USA guidelines, Since 2016
Selected for Use

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<tr>
<th>Pieces of Evidence selected that were “Hand Searched” from the table of contents of specific journals</th>
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</table>

Total Number of pieces of Evidence Identified for Use: 8
Appendix C

Gantt Chart

- Reaching out to providers to assess practice problems
- Introduction of EBP to key stakeholders
- Research – literature search of high-level studies
- Chart reviews
- Calling to schedule patients for labs and visits
- In-person or phone consultations
- Phlebotomy, collecting HbA1c and MMAS-8

Pre-implementation Phase
Evaluation Phase

- SPSS analyzing data
- Collecting MMAS 8 tool from each participant
- Collecting HbA1c

Data Collection Dates:
- 10-Dec
- 30-Dec
- 19-Jan
- 8-Feb
- 28-Feb
- 20-Mar
- 9-Apr
Appendix D

Patient Consent Form

Title of Evidence Based Practice Project (EBP)
The Efficacy of Tailored Text Messages to Improve Medication Adherence and Lifestyle Changes in Patients with Type 2 Diabetes Mellitus

Principal Investigator
Vanessa Silverio, Family Nurse Practitioner, Post-Master’s DNP Student - Valparaiso University
vanessa.silverio@valpo.edu

Faculty Supervisor
Scarlet Spain, DNP

Purpose of EBP Project
You are being asked to take part in an evidence-based practice (EBP) project. Before you decide to participate, it is important that you understand why this EBP project is being done and what it will involve. Please read the following information carefully. Please ask the principal investigator if there is anything that is not clear or if you need more information.

The purpose of this EBP project is to determine a cost-effective and efficient intervention for improving medication adherence in patients with Type 2 Diabetes Mellitus (T2DM). Interventions have been selected based on the best available evidence.

Project Procedures
During appointments at the health and wellness center, the principal investigator will determine if you are eligible to participate in the practice change. Adults between the ages of 18-65 years old, with diagnosis of T2DM, on oral anti-diabetic medications (OADs), and with a hemoglobin A1C greater than 7%. During your first visit with the nurse practitioner, you will be asked to fill out a questionnaire about medication adherence, diet and exercise, and again after 12 weeks to see if there has been any improvement after receiving daily medication reminders and lifestyle focused text messages on healthy eating habits, exercise, and/or topics discussed during your one-on-one session with the nurse practitioner. You will have to download the free secure SPRUCE application on your mobile phone in order to receive text messages. This EBP project will last approximately 12 weeks.

Risks
There are no potential risks for participating in this EBP project. The SPRUCE app is a secure platform to communicate with the nurse practitioner, all of the information shared with the provider will be private and follow HIPPA guidelines.

Benefits
There are multiple benefits of participating in this EBP project. You will be receiving daily text message reminders to take your medications at the right dose and at the right time. Additionally, you will be receiving tailored text messages to remind you of healthy eating habits, increasing exercise, strategies to improve medication adherence to ultimately improve glycemic control of your diabetes. These simple interventions are based on recommendations from the best available evidence. The goals of using text messaging reminders for medications and lifestyle changes is to improve glycemic control while
being cost-effective. The results from this EBP project may help to advance nursing practice and knowledge as well, in addition to implementing the intervention to other health and wellness centers within the organization.

**Confidentiality**

All efforts will be made by the primary investigator to keep your personal information confidential. All records containing your personal information will be kept in a locked box with access permitted only to the primary investigator. To further increase confidentiality, a code will be assigned to you for your questionnaire forms. Any information stored on a computer will be password protected and accessed only by the primary investigator.

**Contact Information**

If you have any questions at any time about this EBP project, or you experience adverse effects as the result of participating in this EBP project, you may contact the primary investigator who contact information is provided on the first page. If you have any questions regarding your rights as a project participant, or if problems arise which you do not feel you can discuss with the primary investigator, please contact the Valparaiso University Institutional Review Board at [valpoirb@valpo.edu](mailto:valpoirb@valpo.edu) or 219-464-5798.

**Voluntary Participation**

Your participation in this EBP project is voluntary. It is up to you to decide whether or not to take part in this project. If you decide to take part in this EBP project, you will be asked to sign a consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this EBP project will not affect the relationship you have, if any, with the health care provider or staff at the wellness center. If you withdraw from the EBP project before data collection is completed, your data will be destroyed.

You may decline to answer any or all questions and you may terminate your involvement at any time if you choose.

I have read and I understand the provided information and have had the opportunity to ask questions. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost. I understand that I will be given a copy of this consent form. I voluntarily agree to take part in this EBP project.

Participant’s Signature _________________________________ Date ______________

Investigator’s Signature ________________________________ Date ______________
MMAS ENTITLEMENT CERTIFICATE

This certificate evidences the Morisky Medication Adherence Research, LLC grant to customer of licenses for the following purchase. The product(s) listed below include single license study, as such term is defined in the MMAS License Agreement, for an initial license period. In order to obtain MMAS License Studies for any subsequent license, you will need to purchase an additional license from Morisky Medication Adherence Research, LLC.

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<th>Product</th>
<th>Description</th>
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<tr>
<td>MMAS-8</td>
<td>“The Efficacy of Tailored Text Messages to Improve Medication Adherence and Lifestyle Changes in Patients with Type 2 Diabetes Mellitus</td>
<td></td>
</tr>
</tbody>
</table>

Customer Information:
Vanessa Silverio, MSN, FNP-C
Valparaiso University, Valparaiso, Indiana

www.moriskyscale.com
Appendix F

Medication Adherence and Lifestyle Questions

The Efficacy of Tailored Text Messages to Improve Medication Adherence and Lifestyle Changes in Patients with Type 2 Diabetes Mellitus

Pre/post-questionnaire

Age _________ Gender _________
Race: White _____ African American _____ Asian _____ Hispanic _____ Other _________
Number of oral anti-diabetic (OAD) medications currently taking ______________________
PreHbA1C _________ Post HbA1C ___________

(© 2006 Donald E. Morisky)

1. Do you sometimes forget to take your oral anti-diabetic (OAD) medications?
   No_______ Yes_______

2. Thinking over the last 2 weeks, were there any days when you did not take your OAD medicine?
   No_______ Yes_______

3. Have you ever cut back or stopped taking your medication without telling your provider, because of the side effects causing you to feel worse?
   No_______ Yes_______

4. When you travel or leave home, do you sometimes forget to bring along your OAD medication?
   No_______ Yes_______

5. Did you take your OAD medicine yesterday?
   No_______ Yes_______

6. When you feel like your diabetes is under control, do you sometimes stop taking your medicine?
   No_______ Yes_______

7. Do you ever feel annoyed about sticking to your diabetic treatment plan?
   No_______ Yes_______
8. How often do you have difficulty remembering to take all your medications?
   a. Never/rarely _______________
   b. Once in awhile _________________
   c. Sometimes _________________
   d. Usually _________________
   e. All the time _________________

9. How would you rate how often you exercise per week?
   a. Never/rarely _______________
   b. Once in awhile _________________
   c. Sometimes _________________
   d. Usually _________________
   e. All the time _________________

10. How would you rate your current diet?
    a. Not good _______________
    b. Decent _______________
    c. Moderate _______________
    d. Great _______________
    e. Excellent _______________

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Appendix G

Examples of Tailored Text Messages

Vanessa Silverio NURSE PRACTITIONER
10/10/21
Time to prep for the week, try meal planning and bring your lunch to work every day this week! Make it colorful - fruits and vegetables, lean meats.

Vanessa Silverio NURSE PRACTITIONER
10/11/21
It’s Monday! Goal is to increase HDL’s (good fats), lower LDL’s (bad fats). Remember to take your meds.

Vanessa Silverio NURSE PRACTITIONER
10/12/21
Reminder to take your oral anti-diabetic medications.

Vanessa Silverio NURSE PRACTITIONER
10/13/21
Portion control is key! An open palm, not including fingers and thumb, is about 3 oz. of cooked boneless meat. This should be the size of your protein portion.

Vanessa Silverio NURSE PRACTITIONER
10/14/21
A fist is about the size of 1 cup or 30 grams of food. This is a good portion of cereal, bread, or starchy vegetables such as potatoes or corn. It is ok to eat carbs, but in moderation and in portions.

Vanessa Silverio NURSE PRACTITIONER
10/15/21
Finally the weekend is here! Time to make a list of healthy grocery items including lean meats (boneless chicken breasts, Turkey slices, ground turkey), any type of fish, vegetables (celery sticks, carrots, or red/yellow/orange peppers to munch on for snack during the week), fruits (berries have less sugar than bananas), apples are in season now (slice them up and eat as a snack...
throughout the day next week). These are just ideas to get you thinking healthy the next time you go to the grocery store.

VS
Vanessa Silverio NURSE PRACTITIONER
10/16/21
It’s the weekend and it is dry out; go out and exercise! The American Diabetes Association (ADA) recommends 120 minutes per week of moderate-intensity exercise such as brisk walking.

VS
Vanessa Silverio NURSE PRACTITIONER
10/17/21
Time to prep for the week, bring your lunch & healthy snacks to work every day this week! Make it colorful - fruits and vegetables and one high protein-rich food item. Remember to take your diabetic medications.

VS
Vanessa Silverio NURSE PRACTITIONER
10/18/21
A new week! Let’s try to exercise at least 30 minutes three times a week this week; it can be 10 minutes in the morning before heading to work or during a break, another 10 minutes walking around after lunch, and 10 minutes when you get home before eating dinner.

VS
Vanessa Silverio NURSE PRACTITIONER
10/19/21
Reminder to take your oral anti-diabetic medications. If you didn't get a chance to exercise yesterday, do it today. No excuses, think of the long term goal and preventing complications of Type 2 DM.

VS
Vanessa Silverio NURSE PRACTITIONER
10/20/21
The secret of getting ahead, is getting started...start with small changes every day then eventually the positive change will become a routine/habit.

VS
Vanessa Silverio NURSE PRACTITIONER
10/21/21
Make your plate colorful with a variety of fruits and vegetables, lean proteins (turkey, chicken, or fish). Increase your plain water intake, avoid drinking sugary drinks.
Vanessa Silverio NURSE PRACTITIONER
10/22/21
Remember to bring extra medications if you are going out of town, don’t forget to take your medications!

Vanessa Silverio NURSE PRACTITIONER
10/23/21
Prioritize 20-30 minutes of brisk walking today!

Vanessa Silverio NURSE PRACTITIONER
10/24/21
It’s not too late to get a 20 minute exercise in, get that heart rate up and sweat!

Vanessa Silverio NURSE PRACTITIONER
10/26/21
It finally feels like Fall weather! There may be puddles of water on the street, but it should not stop you from exercising today. Bundle up and go for a 20 minute brisk walk.

Vanessa Silverio NURSE PRACTITIONER
10/27/21
IT’S OK TO EAT CARBS. Carbs are an important part of a healthy meal plan. Watch portion sizes and getting carbs from fruits, vegetables, whole grains, low-fat milk, and yogurt is important. Balance out the amount of carbs you are taking in by the amount of exercise you are doing.

Vanessa Silverio NURSE PRACTITIONER
10/28/21
HEALTHY FAT LIST: Avocado, organic and grass fed butter/ghee, extra virgin unrefined coconut oil and extra virgin olive oils, fish like salmon, sardines, and anything wild-caught, nuts like walnuts, cashews, and macademia, grass fed beef from trusted farmers, seeds like chia, pumpkin, flax, and sunflower, eggs with yolk.

Vanessa Silverio NURSE PRACTITIONER
10/29/21
Avoid Trans fat and some saturated fats also known as processed foods which raises LDL cholesterol and lowers good HDL cholesterol. Think LDL is LETHAL, HDL is HEALTHY. Good
fats are long lasting fuel source for metabolism, improves cognitive function, balances hormone production, healthier organs and tissues (eye health).

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**Vanessa Silverio NURSE PRACTITIONER**  
10/30/21  
Halloween weekend! It is tempting to eat a piece of chocolate when it is everywhere in sight. It is OK to have a small treat from time to time. If you have been following my daily suggestions, and have exercised at least 30 minutes today, then go ahead and treat yourself.

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**Vanessa Silverio NURSE PRACTITIONER**  
11/8/21  
Daylight savings time can be a benefit for you. Instead of sleeping in for that extra hour, why not start your day earlier and prepare a healthy breakfast or do a quick 20 minute cardio to get your day started!

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**Vanessa Silverio NURSE PRACTITIONER**  
11/9/21  
Reminder to take your oral anti-diabetic medications.

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**Vanessa Silverio NURSE PRACTITIONER**  
11/10/21  
Now that you have been eating less or being more physically active, your glucose levels are lowering which is the goal. However, it is important to learn your own signs and symptoms of when your blood glucose is too low, or you have a glucose reading of less than 70 mg/dl. Symptoms of hypoglycemia include feeling shaky, being nervous or anxious, sweating, chills, clamminess, mood swings, feeling "hangry," fast heartbeat, numbness/tingling to lips, tongue, cheeks, feeling sleepy, blurry vision, etc. Low blood glucose can happen if you've skipped a meal, even if you have no time to eat a full breakfast, grab a healthy snack to eat on your way to work.

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**Vanessa Silverio NURSE PRACTITIONER**  
11/11/21  
Still on the subject of hypoglycemia...if you think your glucose is low, check your blood glucose. If your reading is less than 70 mg/dl, have 15 grams of carbohydrates to raise your blood glucose. Examples are glucose tablets (read instructions), 1/2 cup of juice or regular soda, 1 tablespoon of sugar, honey, or corn syrup, 1 cup of nonfat or 1% milk, hard candies, jellybeans. After 15 minutes, recheck your blood glucose and repeat if readings are still less than 70 mg/dl. Make a note of your episode and let your provider know.
Prioritize 20-30 minutes of brisk walking today!

It’s wet, windy, and cold outside…you may have had a long day and this weather is making you even more tired…I get it. Try doing at least 5 minutes of some type of cardio when you get home, if you complete 5 minutes, try going longer for at least 10 minutes. Goal is 20 minutes of any type of cardio. You Can Do It!!

Reminder to take your oral anti-diabetic medications.

If you already have an exercise routine then you are ahead of the game, kudos to you! Tips to increase your activity would be taking the stairs instead of the elevator, parking your car at the far end of the parking lot, taking a 30 minute walk, most days of the week, work in the yard (those leaves aren't going to disappear on its own), do some housework, get up and move every 90 minutes if you sit for long periods of time.

Time to redeem yourself if you have not worked out yet this weekend…start your Sunday right by exercising at least 30 minutes. Meal prep for the week and don’t forget to take your medications.

"Weight lifting is a smart way for people of any fitness level to include anaerobic exercise in their routine. Resistance training improves blood glucose control and helps the body use insulin more efficiently. It also decreases fat mass, increases muscle mass and improves strength. People with diabetes should aim for two or three resistance-training sessions per week" (ADA, 2021).
Vanessa Silverio NURSE PRACTITIONER
11/23/21
Thanksgiving is in 2 days! You can still enjoy your typical Thanksgiving meal, just think PORTION Control! When you are wanting to go up for seconds, drink a tall glass of water and wait a few minutes after, or walk around the house or restaurant before considering seconds. Bonus points for you if you exercise at least 30 minutes that day.

Vanessa Silverio NURSE PRACTITIONER
11/24/21
If you are planning on cooking for Thanksgiving, why not try alternative healthier dishes such as cauliflower mash instead of mashed potatoes, quinoa or brown rice instead of white rice, no bread rolls at the dinner table, and lots of vegetable side dishes! A slice of pumpkin pie is about 320 calories...if you workout for at least 30 minutes that day, you will burn about 300 calories, as if you've never eaten that slice of pie!

Vanessa Silverio NURSE PRACTITIONER
11/25/21
Happy Thanksgiving! I am grateful for you being a part of my evidence-based practice project and hoping you are benefiting from these daily texts. Enjoy the day with family and friends, but don’t forget to take your medications!