Improving Glycemic Control in Patients with Type 2 Diabetes through Formal Education

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Abstract

Background and Purpose: Over 30 million people in the United States (U.S.) have diabetes mellitus, which comprises about 9% of the population, and about 90% of individuals with diabetes have type 2 diabetes (Centers for Disease Control and Prevention [CDC], 2017). Adults with type 2 diabetes at a local internal medicine clinic were consistently having high glycated hemoglobin (HbA1C) levels, demonstrated by data collected from the electronic health record (EHR), and there was no ordering process for referring patients to diabetes management education and support (DSMES) services. The purpose of this project was to improve glycemic control, demonstrated by lower HbA1C levels, and reach a diabetes education attendance rate of 62.5% at an internal medicine clinic in Chandler, Arizona.

Methods: An electronic health record (EHR) template was created and brief staff training was completed to connect patients with diabetes in the community to a local formal diabetes education program. HbA1C levels were measured before and three months after adults with type 2 diabetes mellitus (T2DM) received physicians' orders for a DSMES program, and rates of attendance to the program were calculated. Data was collected through the EHR and through feedback from the DSMES program. Descriptive statistics were used in data analysis.

Outcomes: The participants' results did not demonstrate significant differences in pre-referral and post-referral HbA1C results after they were ordered DSMES services ($p = .506$). The proportion of education attendance (30%) was lower than the project goal of 62.5%, but increased from the clinic baseline.

Conclusions: EHR template implementation for referral to DSMES may increase rates of formal diabetes education and improve glycemic control. Larger sample sizes, longer project periods,

alternative methods of communication, and increased follow-up of participants may be required to produce significant results.

Keywords: diabetes mellitus, HbA1C, glycated hemoglobin, group-based education, DSMES, type 2 diabetes

Improving Glycemic Control in Patients with Type 2 Diabetes through Formal Education

Uncontrolled type 2 diabetes mellitus (T2DM) can cause avoidable consequences such as cerebrovascular accident (CVA), myocardial infarction (MI), renal failure, visual disturbance, amputation of extremities, and death. Over 30 million people in the U.S. have diabetes, and approximately 90% of them are affected by T2DM, which can be prevented, delayed, and treated with healthy lifestyle modifications, such as healthy eating, weight loss, and exercise (CDC, 2017). Adults with diabetes at a local internal medicine clinic were having HbA1C levels that were higher than the recommended level. After synthesizing the evidence of potential effects of group-based education (GBE) on HbA1C levels and knowledge of disease (KOD), a project was initiated to implement a staff-training program and an EHR template, to connect patients with diabetes in the community to a local formal diabetic education program.

Background & Significance

Healthy People 2020 sets national goals to improve the outcomes for patients with diabetes. One of the high-priority objectives is to decrease the number of patients with diabetes who have HbA1C levels greater than 9% (Office of Disease Prevention and Health Promotion [ODPHP], 2014). The organization has also set the goal for the number of patients receiving formal diabetes education at 62.5%; this would be approximately 10% improvement from current trends. This project aligns with national goals to improve glycemic control by decreasing HbA1C levels in patients with T2DM at a local internal medicine clinic and strives to achieve a 62.5% rate of patients receiving formal diabetes education.

Quality improvement (QI) efforts by national organizations have spurred the creation of measurement tools in the EHR. These tools allow providers to measure their patients' progress in major national health initiatives. One component of the system at a local internal medicine clinic

displays patients with a diagnosis code for diabetes, between 18 and 75 years of age, who have an HbA1C level greater than 9, indicating poor disease control. Two hundred and forty patients met the criteria in that age range at Lifeline Internal Medicine. According to this quality indicator, approximately 60% of the 240 patients had poorly controlled diabetes. This indicates over one half of their patient population in that age range had blood glucose levels that were consistently at dangerous levels, putting them at risk for serious complications.

Soft data gathered from the staff at this internal medicine clinic echoed the statistic generated from their EHR. They expressed concern for a large portion of their patient population, which was not attaining adequate control of their diabetic disease processes. In addition to high HbA1C levels, the staff has witnessed several other trends in their patients with diabetes, which may be contributing to the lack of glycemic control. The patients presented to follow-up appointments without logs of their daily blood glucoses that the provider had requested, without knowledge pertaining to their disease processes and treatment plan, and did not adhere to lifestyle modification recommendations. Furthermore, providers at the clinic were not referring patients for any type of formal diabetes education. This data suggested that an intervention to improve care of patients with T2DM would be beneficial for the clinic and led to the initiation of this project.

The goals of this project were to lower HbA1C levels and increase rates of diabetes education attendance to decrease the risk of diabetic complications, improve patients' health statuses, and reduce their future healthcare costs. This led to the PICO question, "In adults with type 2 diabetes at Lifeline Internal Medicine, will formal group education, versus usual care, improve glycemic control?"

Evidence Synthesis

An exhaustive search was conducted in the Cumulative Index of Nursing and Allied Health Literature (CINAHL), PubMed, and JSTOR databases. Initial keywords in the search strategy were diabetic, diabetes, compliance, compliant, adherence, adherent, and adult with Boolean connectors. The keywords compliance, compliant, adherence, adult, and adherent were subsequently removed after the most promising, potential intervention became more apparent. The terms education, group, type 2, glycated hemoglobin, and knowledge were added as keywords. Additional filters included studies in the past five years, full text availability, and English language. After the search process was complete, pertinent studies were synthesized to analyze current evidence related to the project goals.

Summaries of essential characteristics of the synthesized studies can be found in the Evaluation Table (Appendix A). Many valid and reliable tools of measure were used for data collection, and bias could be considered minimal in most and moderate in a few of the studies. When referencing the Synthesis Table (Appendix B), the majority of the collected evidence can be recognized as Level II or III evidence, including primarily randomized controlled trials (RCTs). One systematic review was included. Only recent studies were included, with the oldest study published in 2013. The number of participants ranged from 82 to 77,824.

A diverse group of authoring countries was included in appraisal, evaluation, and synthesis of recent evidence. The synthesized components of the selected studies were focused areas examining interventions to improve glycemic control, measured by HbA1C, and increase KOD in patients with T2DM. Two of the studies also examined the effect of GBE on medication adherence. In all of the studies, the attrition rates were less than 50%, and 8 of the studies had attrition rates less than 30%. Most studies included an intervention consisting of GBE, and few of the studies included complementary interventions, such as telephone calls, individual based

education (IBE) and home visits. To address the population of the studies, only one study included patients with type 1 diabetes mellitus. All other participants were patients with T2DM.

As the resources spent on diabetic complications increase, researchers are working to identify low-cost interventions to improve glycemic control and health maintenance in patients with diabetes. Scripted phone calls to patients in a large randomized trial did not significantly improve diabetic control compared to usual care (O'Connor et al., 2014). However, group education has been an effective intervention, improving glycemic control more than home visits (Santos et al., 2017). A research study in Brazil was conducted to evaluate patients with diabetes mellitus (DM) "before and after" an educational program. The educational intervention significantly increased the participants' KOD, while also improving HbA1C levels and adherence to their medication regimens (Figueira, Boas, Coelho, Freita, & Pace, 2016).

Patients' attitudes toward their diabetes were investigated using questionnaires, revealing that many people with DM may not understand the HbA1C level, and may need simpler explanations of key diabetic concepts, with less medical jargon. Overall, participants were trusting of their providers, but may be given insufficient or incorrect education by such providers. Many patients revealed that they are using diabetic medication to avoid healthy lifestyle modifications (Elliott, Harris, & Laird, 2016). A cross-sectional study in St Louis, Missouri reported findings indicating most patients are unintentionally non-adherent to treatment plans, suggesting educational interventions may be helpful and should be designed for patients with limited health literacy (Fan, Lyons, Goodman, Blanchard, & Kaphingst, 2016).

Patients newly diagnosed with diabetes are not the only group who could benefit from educational interventions. If patients are not meeting their glycemic goals, educational reinforcement should be implemented, and patients with pre-diabetes may benefit from early

formal education. However, the best method for such education and the route to making educational interventions more widely available are not yet clear (Beverly et al., 2013).

The synthesis of evidence reveals improved glycemic control and KOD in patients with T2DM that received educational interventions, particularly GBE. With evaluation of the significant effects that the educational interventions had on HbA1C levels and KOD, the data suggests that patients with T2DM may benefit from GBE. The evidence supports the use of GBE for patients with T2DM, but roughly half of the patients in Arizona are receiving proper diabetes self-management education (ODPHP, 2014). A sustainable intervention to improve rates of diabetic education is essential for the health of our patients and to reduce healthcare costs.

By increasing availability of diabetes education programs to patients in a local internal medicine clinic, it was proposed that more of the clinic patients would receive formal diabetes education, decreasing their HbA1C levels. The goal of this project was to increase the availability of formal diabetes self-management programs to patients and significantly affect their HbA1C, making it a low-cost, sustainable intervention to improve diabetic outcomes for this clinic.

Theoretical Framework & Implementation Framework

Theoretical Framework

The Chronic Care Model (Figure 1) was selected as the theoretical framework to support this project (Wagner, 1998). In the Chronic Care Model, resources and policies from the community interact with health care organization to promote productive interactions between an informed, activated patient and a prepared, proactive practice team. Inspiration from the self-management support aspect of the Chronic Care Model spurred the desire to activate and inform patients with T2DM at Lifeline Internal Medicine. This project also focused on the clinical

information systems aspect of the model, incorporating an additional innovative model, to prepare the practice team at the clinic for project implementation and create an EHR template that would streamline the project delivery.

Implementation Framework

Tidd and Bessant's Process Model of Innovation (Figure 2) was chosen to apply the synthesis of evidence to current practice (Dawson & Andriopoulos, 2017). This model is concise and allows for customization. Four steps of the model were used to guide the project and intervention, displaying the rationale for the employees at the office and serving as a tool for potential barriers along the way. The first step of the model is search and assessment. In this step, the area needing improvement is identified. At Lifeline Internal Medicine, the opportunity was identified as diabetes self-management. The second step explores what the intervention will be and why it is being done. In this case, we wanted to improve glycemic control through GBE. The rationale for the intervention includes the soft data, including requests from patients and staff and is based on an ethical foundation. The third step includes implementation. Specifically, the staff received education regarding diabetes self-management programs, the new EHR template for ordering patient education, and network education options to improve the care of patients with diabetes. Participants' HbA1C levels were measured pre- and post- GBE. The final step of the framework captures the value in the innovation.

Methods

Human Subject Protection

Internal Review Board (IRB) approval was granted through Arizona State University (ASU) prior to the initiation of this project. All clinic staff members had access to the data of the project, through the password-protected EHR. The team leader extracted lab values and relevant

information for the project through the EHR. All paper information pertaining to the project was stored in a lockable bag. The project leader maintained a master list to link the name of the participant with a unique numerical study ID (participant 1, 2, 3, etc.,) and stored the master list in a lockable bag. All project information was kept confidential. Only de-identified data was retained after data collection. The master list connecting data with the participants' identities was destroyed at the end of data collection.

As consent for this project was in the pre-existing new patient paperwork for the participants, the paperwork was stored electronically in the patients' charts per clinic standard. All patients received and signed this paperwork prior to being treated at the clinic. No data was collected from the staff before or after staff training. There was no compensation or credit offered to staff or patients to participate in the project.

Testing a patient's HbA1C requires a blood draw. However, in this project, blood draws were ordered per usual care, and the patient did not require any additional lab work to what would have been ordered if the patient were not a participant in the project. The results that were delivered to the provider were accessed through the EHR. No psychological or legal risks were foreseeable for patients who participated in the events and data collection involved with this project.

By participating in the education, the participants learned about their disease and how to manage it. This could improve their glycemic control, improve their quality of life, and decrease their risk of mortality. A large community-based population study included over 11,000 participants and found that in the participants with diabetes, an increase of 1% in HbA1C concentration was associated with 40% increase in mortality from cardiovascular issues and 30%

increase in all-cause mortality (Sherwani, Khan, Ekhzaimy, Masood, & Sakharkar, 2016). A reduction in the HbA1C concentration of 0.2% could decrease the patient's mortality by 10%.

Population & Setting

This project took place at a local internal medicine clinic. The final study sample only included patients with T2DM. Although the incidence of diabetes diagnoses in children is increasing, only 0.18% of the U.S. population under 18 years old is diagnosed with diabetes (CDC, 2017). This statistic sheds light on the population of interest, adults 18 years of age and older, diagnosed with T2DM. Participants were required to speak English. Minors were excluded from the study, as this clinic does not treat pediatric patients. No other specific populations were targeted or excluded.

Since HbA1C levels can be affected by alterations in hemoglobin and other blood-related alterations, HbA1C data from patients with a diagnosis code in their chart of anemia, end-stage renal failure, or recent (last 3 months) blood transfusion were excluded from the analysis. However, they were not excluded from referral to the education program, and their participation was included when measuring the percentage of patients who completed the formal diabetes education program. Participants needed a recent (6 months or less) HbA1C level to be included in the project.

Project Description & Timeline

Practice and systematic changes were implemented to improve (increase) rates of formal diabetes education and improve (decrease) HbA1C levels in patients with T2DM at Lifeline Internal Medicine Clinic. A template was created in the existing EHR program to streamline the process of ordering group-based diabetes management education for patients who might benefit from formal diabetes education. Patients were referred to a local, established DSMES program,

which is recognized by the American Diabetes Association (ADA), to promote potential insurance coverage and limit or abolish costs to patients.

Brief staff training was conducted for the staff members of Lifeline Internal Medicine to inform them of an available community diabetes educational resource and how to order DSMES for eligible patients using the new EHR fax template. The training was less than twenty minutes and was scheduled when minimal patient appointments were scheduled. Each member of the team was addressed individually to make sure he or she did not have any further questions and all components of the project were clear.

The first outcome that was measured in this project was the HbA1C level of each participant. Upon entering the bloodstream, glucose binds to hemoglobin in red blood cells. The HbA1C level represents the percentage of red blood cells, containing hemoglobin that is coated in glucose. HbA1C level over 6.5% indicates diabetes. The standard goal for the HbA1C level is less than 7% (CDC, 2018). The World Health Organization (WHO) recognizes the HbA1C level as diagnostic for diabetes (Florkowski, 2013). National organizations, such as those overseeing government insurances and diabetic guidelines, have focused on the HbA1C level as a reliable measure of diabetic control. The HbA1C level was measured using a blood sample. The patient did not need to fast for the test, and it is routinely checked every 3 months in most patients with T2DM at Lifeline Internal Medicine. HbA1C levels of the patients referred by the clinic were measured prior to the referral for education, as this criterion is pertinent for the provider's consideration to refer the patient for education and for insurance coverage processes. Pre-intervention HbA1C levels were already on file, as they are used for the initial diabetes diagnosis and are monitored at regular quarterly intervals.

Once glucose binds to hemoglobin in the blood stream, it is attached permanently until the red blood cell dies. The average lifespan of a red blood cell is approximately 3-4 months, so this was the ideal time for their second blood draw. Since exact dates for lab draws and program activities were not the same for every patient, HbA1C levels collected in a timeframe of 2-4 months post-referral to the education program were allowed for inclusion in the data analysis. HbA1C levels as early as 2 months post-referral date were included, since HbA1C is based on weighted monthly averages. 50% of the HbA1C concentration is formed from glycaemia in the most recent month (Florkowski, 2013). 25% is formed in the month prior to that, and the final 25% is formed in the month before that. There is not a phlebotomist at the clinic, so per usual care, the patients were given an order from the provider for the tests, and they had samples drawn at their regular laboratory. Variability in lab sites could have affected HbA1C results. Variability in blood draw locations was considered an accepted risk for the project to be sustainable, and so unnecessary inconvenience was not created for the patient.

Additionally, the project evaluated whether training the staff on the community resource for diabetes education increased the number of patients receiving formal diabetes education. The goal of this project will align with Healthy People 2020's goal of 62.5% participation in formal diabetes education (ODPHP, 2014). Patients were referred to the nearest diabetes self-management education program at Mercy Gilbert Medical Center. Materials and education distributed at the program were independent of this project. If patients attended one or more hours of education, they were counted in the group that attended the education program. Follow-up consisted of usual care and two follow-up phone calls to remind patients to have their lab work completed.

Data Collection & Analysis

After the staff training, data collection began to track the patients who were referred to the community education program and the patients who attended the program. This was done by searching the EHR for electronic fax referrals sent from the start date of recruitment through October 31, 2019. All information was gathered through the EHR. Contact with the diabetes education program to determine whether or not the patient completed the educational program closed the loop. The ratio of participants who attended the program to number of participants who were referred was essential to the data analysis and conclusion portions of the project. The project attendance percentage was compared to the national goal percentage of 62.5%.

Budget

The proposed budget total for this project was $301.85 (Appendix E). Sources of funding for the project included personal funds and clinic funds. Clinic funds accounted for the productivity lost, and paper copies and equipment were purchased using personal funds. Other non-calculated costs included the cost of the education to patients, if their insurance did not cover the entire program. Efforts by the provider and community program were made to make sure the patient receives coverage for the services, if they were eligible. Since the local DSMES program provided pamphlets, the expense for printing pamphlets was avoided. Expenses for a locking receptacle for project materials were decreased by purchasing a lock for a container the project leader already had available for use.

Project Impact

On a local level, the patients, physicians, and staff at Lifeline Internal Medicine had stakes in the success of this project. If the intervention was successful in improving glycemic control, it could improve outcomes, decrease costs and complications, free up providers' time, and increase productivity in the workplace and the community. In the future, the results of this

project may be applicable when discussing potential interventions for patients who present with pre-diabetes, as well. In 2015, 33.9% of adults, and nearly half of the population above 65 years of age, had pre-diabetes (CDC, 2018).

In the state of Arizona, in 2010, only 51.4% of patients with diabetes received education regarding the disease process (ODPHP, 2014). By educating the staff on community resources available to their patients and increasing availability of diabetes education programs to patients in a local internal medicine clinic, it was proposed that more of the clinic patients would receive formal diabetes education, decreasing their HbA1C levels. If the training program increased the availability of formal diabetes self-management programs to patients or significantly affected their HbA1C, it would be a low-cost, sustainable intervention to improve diabetic outcomes for this clinic. This could lead to initiation of cost-effective strategies to decrease complications and healthcare costs from diabetes.

T2DM complications exhaust resources and contribute to significant healthcare costs globally. The cost of care for DM in the U.S. is $327 billion per year (ADA, 2018). The majority of the money is used for inpatient hospital care and prescriptions to treat complications of the disease. The majority of T2DM care in the U.S. is paid for by government insurances, such as Medicare, Medicaid, and the military (ADA, 2018).

In 2014, more money was spent on DM discharges than any other emergency department visit or hospital stay in Arizona (Arizona Department of Health Services [AZDHS], 2018). Over $8 million dollars was charged for DM for those hospital visits, more than six times the amount charged for CVA. Results of this project will contribute to the knowledge that could guide interventions to decrease complications of diabetes, increase rates of diabetes education, and decrease costs of care in patients with T2DM.

Results

Descriptive statistics were used to describe the sample and outcome variables. The physicians at an internal medicine clinic in Chandler, Arizona ordered DSMES services through the created EHR template for 10 patients during the recruitment period. The sample consisted of 10 participants (N=10). Twenty percent of participants who were referred for the DSMES program completed the 10-hour educational program. Ten percent of participants completed at least 1 hour of the educational program. Thirty percent of participants who were referred declined the program, 30% did not respond to two or more attempts at contact, and 10% of participants no-showed to the scheduled program.

The average age of the subjects was 61.10 (*SD* = 8.96). Ages ranged from 45 to 74 years. Each gender had an observed frequency of 5 (50%). Frequencies and percentages for insurance, race, and gender are presented in Table 1.

Table 1

Frequency Table for Gender, Race, and Insurance

Variable	*n*	*%*
Gender		
1	5	50
2	5	50
Missing	0	0
Race		
1	3	30
2	1	10
3	3	30
5	3	30
Missing	0	0
Insurance		
1	3	30
2	1	10
3	6	60
Missing	0	0

The observations for pre-referral HbA1C in the group that did not attend the DSMES program had an average of 9.56% (*SD* = 2.24). The observations for post-referral HbA1C in the group that did not attend the DSMES program had an average of 7.83% (*SD* = 1.00). The summary statistics can be found in Table 2.

Table 2

Summary Statistics Table for Pre- and Post-Referral HbA1C Variables in Participants who Did Not Attend Education

Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	Kurtosis
Post_HbA1C	7.83	1.00	3	0.58	6.70	8.60	-0.58	-1.50
Pre_HbA1C	9.56	2.24	7	0.85	7.00	12.90	0.38	-1.15

Note. '-' denotes the sample size is too small to calculate statistic.

The observations for pre-referral HbA1C in the group that attended the DSMES program had an average of 8.63 (*SD* = 2.42). There were insufficient observations to calculate summary statistics for post-referral HbA1C. The summary statistics can be found in Table 3.

Table 3

Summary Statistics Table for Pre- and Post-Referral HbA1C Variables in Participants who Attended Education

Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	Kurtosis
Post_HbA1C	7.70	-	1	-	7.70	7.70	-	-
Pre_HbA1C	8.63	2.42	3	1.40	6.90	11.40	0.64	-1.50

Note. '-' denotes the sample size is too small to calculate statistic.

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of pre-referral HbA1C and post-referral HbA1C results from the group that did not attend the education program were significantly different from zero. The result of the two-tailed paired samples *t*-test was not significant based on an alpha value of 0.05, $t(6) = 2.22$, $p = .068$, indicating the null hypothesis cannot be rejected. The results are presented in Table 4.

Table 4

Two-Tailed Paired Samples t-Test for the Difference between Pre-Referral HbA1C and Post-Referral HbA1C in the Group that Did Not Attend Education

Pre_A1C		Post_A1C_imputed				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
9.56	2.24	7.88	0.90	2.22	.068	0.84

Note. N = 7. Degrees of Freedom for the *t*-statistic = 6. *d* represents Cohen's *d.*

A two-tailed paired samples *t*-test was conducted to examine whether the mean difference of pre-referral HbA1C and post-referral HbA1C results was significantly different from zero in the group that attended the education program. The result of the two-tailed paired samples *t*-test was not significant based on an alpha value of 0.05, $t(2) = 0.90$, $p = .465$, indicating the null hypothesis cannot be rejected. The results are presented in Table 5.

Table 5

Two-Tailed Paired Samples t-Test for the Difference Between Pre-Referral HbA1C and Post-Referral HbA1C in Group that Attended Education Program

Pre_A1C		Post_A1C_imputed				
M	*SD*	*M*	*SD*	*t*	*p*	*d*
8.63	2.42	7.49	0.34	0.90	.465	0.52

Note. N = 3. Degrees of Freedom for the *t*-statistic = 2. *d* represents Cohen's *d.*

Effect of Group Education on HbA1C

A mixed model analysis of variance (ANOVA) with one within-subjects factor and one between-subjects factor was conducted to determine whether significant differences exist among pre-referral HbA1C and post-referral HbA1C between the group that attended the educational program and the group that did not attend the educational program, using imputed values for post-referral HbA1C missing values. The results were examined based on an alpha of 0.05. The main effect for education was not significant $F(1, 8) = 0.48$, $p = .506$, indicating the two education groups were similar. The main effect for the within-subjects factor was not significant $F(1, 8) = 3.96$, $p = .082$, indicating the values of pre-referral HbA1C and post-referral

HbA1C were all similar. The interaction effect between the within-subjects factor and education was not significant $F(1, 8) = 0.14$, $p = .719$, indicating that for all combinations of the within-subjects factor and the education groups, the strength of the relationship between the outcome and the interaction of education does not change significantly.

Comparison of Program Attendance to Goal

A one-proportion *z*-test was conducted to examine whether education attendance could have been produced by a probability distribution with a proportion of 0.625. The result of the one proportion *z*-test was significant based on an alpha value of 0.05, $z = -2.12$, $p = .034$, CI = [-0.63, -0.02], indicating the null hypothesis can be rejected. This suggests that education attendance is unlikely to have been produced by a distribution with a proportion of 0.625. The proportion of education attendance is most likely lower than 0.625. The confidence interval ($\alpha = 0.05$) for the proportions of education attendance is -0.63 to -0.02. Table 6 presents the results of the one sample proportion *z*-test.

Table 6

One Proportion z-Test for Education Attendance and a Test Proportion of 0.625

Samples	Responses	*n*	Proportion	*SD*	*SE*
Education Attendance	3	10	0.3	0.46	0.15

Note. $z = -2.12$, $p = .034$, CI for $\alpha = 0.05$: [-0.63, -0.02].

Discussion

Although the results were not considered significant after data analysis, when considering limitations, this project reinforces the findings of other studies that GBE may improve knowledge of disease and HbA1C levels in patients with T2DM. As other studies pointed out, the best method for such education and the route to making educational interventions more widely available are not yet clear (Beverly et al., 2013).

Limitations

The sample size was a limitation of the project, which was evident in the data analysis portion of the project. Since there were several missing values for post-referral HbA1C observations, missing values in both groups were imputed, since there were not at least three values for the group that attended the education program.

This project did not meet the goal education attendance rate of 62.5%. The proportion of attendees was found to be significantly different from the goal of 62.5%. Communication with patients was a barrier in the link to the education program for the clinic and the DSMES program. Forty-three percent of participants who did not attend the education program were left voicemails multiple times, but never responded, eventually resulting in a "send-back" to the provider. Forty-three percent answered, but declined the education program when contacted about attending. The final 7% of the group that did not attend the education program did not show up to the initial scheduled education session. In the future, an alternative method of contacting patients may be beneficial in increasing the attendance rate.

There was a significant decrease in one participant's HbA1C level in the group that did not attend the education program (33% decrease from pre-HbA1C level). It was noted that this participant initiated subcutaneous injections in their diabetes treatment plan at the time of referral to the diabetes education program, which could have had an effect on post-referral HbA1C levels in the group that did not attend the DSMES program.

Project duration could have limited the results of the study. A few participants were due for follow-up at the time of data collection, so they could have completed their lab work shortly after data collection took place. Project implementation took place during winter months, with data collection taking place just after the beginning of the new year. Since many people indulge

in carbohydrate-rich foods during this time and may defer follow-ups due to holiday obligations, a longer project period may be beneficial.

Strengths

This project used a technological modality to order diabetes education for participants. The National Diabetes Education Program, which was established in a partnership between the CDC and U.S. Department of Health and Human Services (HHS) National Institutes of Health (NIH) encourages self-management of diabetes that is sustainable and promotes technological advances to link patients, providers, and communities to strategies and support that encourage sustainable self-management (HHS, NIH, National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK], 2014).

Although no significant change was found in the pre- and post-referral means of HbA1C in patients that attended the group education program verses those that did not attend the education program, the participant who attended the program and completed lab work post-education did demonstrate a decrease in the HbA1C level of 3.7%, which was a 33% decrease from the pre-referral HbA1C level.

Although the project did not meet the national attendance goal, it did increase the number of patients at the clinic who attended a formal diabetes education program. Since there was no referral process for diabetes education in place for the project site, this project created a link between the provider, the patients, and the DSMES program, which resulted in 30% of participants attending at least 1 hour of the DSMES program they were referred to. Twenty percent of participants attended all 10 hours of the DSMES program.

Sustainability

The EHR template was implemented for ordering DSMES to simplify the process for providers and staff, and to promote sustainability. Providers will be able to use the template after program completion to create the link between patients and the DSMES program in the community. The template could also be used for additional DSMES sites in the future.

Implications for Practice

Medicare and Medicaid, along with many other insurance plans, will cover up to 10 hours of DSMES the first year (Warshaw, 2018). However, even if a person does not participate in all 10 hours, they may only receive coverage for up to two hours of education in the subsequent years. Healthcare providers must take advantage of these 10 hours of available education for their patients in their first year after diagnosis to help them learn how to manage their diabetes by linking patients to these services and encouraging them to follow through with them.

Insurance companies may require certain information to cover the services, so providers must make sure they are meeting all criteria when ordering educational services for patients with diabetes. Templates in the EHR can be used to remind providers of steps they should take with patients who have T2DM to address all significant areas of concern. Templates can also be used to make sure the pertinent information is included in orders and referrals to promote reimbursement for provider services, including other services or support they may order for the patient. To meet the demands of evolving reimbursement strategies and the increasing prevalence of patients with T2DM, providers will need to be more proactive, while utilizing the EHR's specialized features, such as templates to reduce documentation load, to encourage ongoing support for patients with T2DM. Providers will need to make more collaborative efforts to link patients to community resources to manage and support various aspects of those patients' care.

The results of this project suggest that alternative modalities for communicating with patients may be beneficial, as communication via telephone was a barrier to contacting patients for the clinic and the DSMES program. Subsequent studies could use other means of communication, such as text messages, e-mails, or cellular phone applications to coordinate care with patients. Finding a reliable means of communication will be essential. Since 70% of participants did not complete the recommended post-referral HbA1C, they may not be receiving optimal care for their T2DM, and successful alternatives for reminding these patients to follow up would benefit patients and providers.

Conclusion

Although comparisons of pre-referral and post-referral means of participants who attended DSMES and participants who did not attend DSMES were not significant, using imputed data for missing values, there was a decrease in post-referral HbA1C in the participant who attended DSMES and completed recommended post-referral HbA1C lab work. Patients may not be following up with lab work or providers for optimal treatment of their T2DM. Implementing an EHR template and training staff to use the template can streamline the ordering process for DSMES and increase the attendance of formal diabetes education in patients, but alternative methods to telephone calls need to be considered for patients with T2DM.

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Appendix A

Evaluation Table

Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**
Odgers-Jewell, K. et al. (2017). Effectiveness of group-based self-management education for individuals with type 2 diabetes: A systematic review with meta-analysis and meta-regression **Funding:** None **Bias:** Most studies classified as having mod risk of bias; performance	"Promoting and supporting positive self-management behaviors", self-efficacy inferred	**Design:** Systematic review of RCTs, cluster randomized trials, and controlled clinical trials **Purpose:** To determine the efficacy of GBE vs. IBE or UC for improving outcomes in patients with T2DM	**N**=8,533 **n**=4416 (IG) **n**=4117 (CG) **Setting**: 32 studies (68%) in primary care settings, 15 studies (32%) in secondary or tertiary settings **Inclusion:** ≥ 18 y/o, face-to-face GBE, T2DM, ≥ 4 participants, > 1 hour intervention **Exclusion:** pregnant	**IV:** GBE **DV1:** HbA1C **DV2:** DM knowledge Other DVs included FBG, body weight, WC, BP, lipid levels, self-efficacy	Various questionnaires (validated)-specifics not included, biometric measurements	RevMan, Excel, meta-analysis using DerSimonian and Laird, *I*-squared, meta-regression using stat statistical software	GBE is more effective than UC and IBE. 95% CI, Significant difference in reducing HbA1C (p=0.0002), significant difference in increasing diabetic knowledge (p=0.01)	**LOE:** LOE I **Strengths:** AMSTAR quality assessment: high quality review (10/11), statistically significant results, only included patients with T2DM **Weaknesses:** Most studies had mod risk of bias. 13/47 studies had possible conflict of interest. High

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bias, detection bias **Country:** 38% of studies from U.S., 13% from UK, 11% Italy			women, IBE, type 1 DM					heterogeneity of some meta-analysis **Feasibility:** Recommended for use in practice, supporting GBE use to improve HbA1C and DM knowledge.
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variables & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**
Merakou, K. et al. (2015). Group patient education: Effectiveness of a brief intervention in people with T2DM in primary health care in Greece: A CCT **Funding:** unknown	Inferred CCM with an emphasis on self-management	**Design:** CCT **Purpose:** To determine the efficacy of GBE using CMs sessions for people with T2DM vs. IBE by primary healthcare provider	**N**=193 **n**=55 (CG) **n**=138 (IG) **Setting:** Health Centre of the Primary Healthcare Clinic in Markopoulo, Greece **Demographics:**	**IV**: GBE using CM **DV1**: HbA1C **DV2**: BMI **DV3:** lipid levels *Conversation Maps: Learning About Diabetes* consists of educational tools that	Biochemical markers: HbA1C, LDL, HDL, Triglycerides, anthropometry	SPSS, chi-square and Fisher's exact, Student's *t*-test, paired *t*-tests, analysis of variance, analysis of covariance	Short education interventions using CMs may be more effective than IBE in controlling HbA1C. 95% CI, Significant difference in reducing	**LOE:** LOE II **Strengths:** measurement methods, T2DM only **Limitations:** small town, familiarity with research team, may not be representative of general

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Bias: selection, allocation of participants not concealed **Country:** Greece			MA of CG=63.8, 58.2% men, 41.8% women; MA of IG=67.2, 53.6% men, 46.4% women **Inclusion:** T2DM, regular patients in the setting, ≥ 18 y/o, **Exclusion:** HTN, other serious heart disease, stroke, kidney disease, mental disorder, insulin-use, complications	encourage interactivity in small GBE.			HbA1C (p=0.003)	population, exclusion criteria, excluded insulin-users **Feasibility:** Could be implemented for many people at low-cost with limited personnel, more applicable in primary care setting with established patient-provider relationships
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variable & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**
Reaney, M. et al. (2013). Impact of CM education tools versus regular	Inferred CCM with an emphasis on self-management	**Design:** RCT **Purpose:** To determine whether CM-	**N**=681 **n**=330 (IG) **n**=351 (CG)	**IV:** CM-based education **DV1**: DM knowledge **DV2:** HbA1C	ADKnowl questionnaire (validated), biometric testing	ANCOVA, Wilcoxon rank sum, mixed-model repeated measures,	DM knowledge and HbA1C improved in	**LOE:** LOE II **Strengths:** High retention rate, vague

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care on diabetes-related knowledge of people with T2 diabetes: A randomized, controlled study **Country:** Germany, Spain **Funding:** Eli Lilly & Company **Bias:** open-label study with potential recruitment bias and potential questionnaire result bias		based group education would increase DM related knowledge at 6 months vs. those who received UC	**Setting:** 19 sites in Germany, 14 sites in Spain **Demographics:** MA of CG=61.9, 52.4% male, 47.6% female; MA of IG=62.0, 54.2% male, 45.8% female **Inclusion:** 18-75 y/o adults, T2DM, poor disease management, in need of education	Other DVs included satisfaction with care, patient empowerment, self-care, lipid levels, goal attainment, emotional distress, and vital signs		Pearson's x^2, Fisher's exact	both groups. In Spain, scores for DM knowledge were higher for CM than UC (p<0.001). In Germany, the opposite was true (p<0.001). Note: 78.3% of those in Germany and 13.5% of those in Spain had non-CM structured education during the study.	inclusion criteria defined by provider **Limitations:** Open-label study, studied participants only 6 months after intervention, 2 countries studied, baseline low HbA1C levels **Feasibility:** CM could be more effective in areas where structured DM education is not already a major part of UC.
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variable & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**

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Santos, J. C. et al. (2017). Comparison of education group strategies and home visits in T2DM: Clinical trial **Country:** Brazil **Funding:** Federal University of Minas Gerais **Bias:** cluster stratification used to minimize bias	Inferred Self-management focused CCM	**Design:** RCT **Purpose:** To compare adherence and empowerment of self-care and glycemic control in HV and GBE strategies	**N=** 238 **n=** 34 (IG, HV) **n=** 93 (IG, GBE) **n=**111 (CG) **Setting:** 10 primary care sites in Brazil (clusters) **Demographics:** MA=57.8 y/o, 77.4% female **Inclusion:** T2DM, 30-80 y/o **Exclusion:** Chronic T2DM complications, **Discontinuing criteria:** <6 GBE meeting participation, <4 home meetings	**IV1:** GBE **IV2:** HV **DV1:** HbA1C **DV2:** ESM **DV3:** DES-SF Other variables included lipids, FBG, BMI	Self-care questionnaire (ESM) Diabetes Empowerment Scale-Short Form (DES-SF), HbA1C	SPSS, Shapiro-Wilk, Anova, paired Student's *t*-tests, Wilcoxon, Mann-Whitney	Similar results between HV and GBE for adherence to self-care and empowerment. Significant improvements in HbA1C in GBE (p=0.0000) vs. home visit (p=0.9900).	**LOE:** LOE 1I **Strengths:** Allows replication of educational strategies in primary care, demonstrates importance of structured education strategies **Limitations:** Intellectual capacity of participants not considered, inhomogeneity of disease time among groups, specific location of study (small area in Brazil) **Feasibility:** Cost-effective recommendations for primary

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								care health sites
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variable & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**
Hwee, J. et al. (2014). National diabetes education through group classes leads to better care and outcomes than individual counseling in adults: A population-based cohort study. **Country:** Canada **Bias:** Possible confounding bias	Inferred CCM	**Design:** Population-based cohort study **Purpose:** To determine if quality of care or DM complications differed between GBE and IBE.	**N**=77,824 **n**=12,234 (IG,GBE) **n**=55,761 (IG,IBE) **n**=9,829 (IG, both IBE and GBE) **Setting:** Ontario healthcare administrative databases used to extract info detailing utilization of self-management education programs by residents in Ontario	**IV1:** GBE **IV2:** IBE **DVs:** hospitalizations & ED visits for hypo/hyperglycemia, foot ulcers, cellulitis; claims for 2+ HbHb tests; claim for 1+ lipid test, claim for 1+ eye exam for retinal screening, Rx for anti-hypertension meds, oral-glucose lowering	Administrative claims extracted from databases, prescriptions	Chi-squared, ANOVA, Logit-based generalized estimating regression models, SAS version 9.3	Fewer ED visits/hospitalizations for DM complications ($p<0.001$), higher rates of adequate lab testing and statin use ($p<0.001$) among those in the GBE group	**LOE:** LOE IV **Strengths:** large sample size, majority of population had T2DM **Limitations:** many people not included with unknown educational formal (15,561), varying amounts of education, contained both type 1 and T2DM, intensity of education

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Funding: grant from Physicians' Services Inc. Foundation of Ontario and by Ontario Ministry of Health and Long-Term Care (MOHLTC)			**Demographics:** MA GBE=58.8 MA IBE=59.2 MA both=58.0 **Exclusions:** died in the same 1 year of study (1,682), <18 y/o, unknown educational format (15,561)	agents, and insulin				could have been underestimated as this study only accounted for 1 year **Feasibility:** Less resource intensive and cost effective interventions may be able to improve patient care with GBE.
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variable & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**
O'Connor, et al. (2014). Randomized trial of telephone outreach to improve medication adherence and metabolic control in adults with diabetes.	none stated or easily inferred	**Design:** pragmatic RCT **Purpose:** to determine the efficacy of phone calls to DM patients who were above recommended levels for lipids, BP, or	**N=**2378 **n=**1,220 (IG) **n=**1,158 (CG) **Setting:** several large multi-specialty medical groups **Demographics:** IG MA 61.67, 51.1% female;	**IV:** structured telephone interview contact **DV1**: PMA **DV2**: MP **DV3:** MPR **DV4:** HbA1C, BP, or LDL **PMA:** Fill of medication refill within 60	Prescription fills, HbA1C, BP, LDL, data extracted for EMR	Primary and secondary analysis performs; intent-to-treat analysis, per-protocol analysis, post-hoc analysis. Specific measures not provided.	The intervention failed to produce any significant changes in PMA, MP, MPR, HbA1C, BP, or LDL.	**LOE:** LOE II **Limitations:** Between 66-78% of participants had already filled their prescription prior to the intervention. Low power after post-hoc

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Country: USA **Bias:** none identified **Funding:** Agency for Healthcare Research and Quality		glucose and had been prescribed a new med to treat the elevation	CG MA 62.04, 52.3% female **Inclusion:** 18-75 y/o, 15 months care at center prior to enrollment, new medication that meets criteria in last 180 days	days of prescription date **MP:** 2 or more fills in 180 days of medication				analysis to detect significant changes in LDL and BP. **Feasibility:** Intervention not likely to produce significant changes, more resource-intensive than alternative options
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variable & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**
Figueira, A. et al. **(**2017). Educational interventions for knowledge on the disease, treatment adherence, and control of diabetes mellitus.**).**	SCT	**Design:** randomized intervention study with single comparison group **Purpose:** to analyze the effect of educational interventions	**N=**82 **n=** 82 **Setting:** outpatient clinic **Demographics :** 48 women (58.5%), Mage 60.43	**IV:** GBE using CM **DV1:** DM knowledge **DV2:** medication treatment adherence **DV3:** glycemic control	DKN-A, MAT, electronic system HbA1C	R version 3.02; Excel; paired Wilcoxon test, Komolgrow-Smirnov and Leven tests	All dependent variables improved significantly with GBE using CM including DM knowledge of disease (p<0.001), medication	**LOE:** LOE IV **Strengths:** There is a general lack of studies on CM as an education tool and SCT as a conceptual framework for diabetes education.

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Country: Brazil **Bias:** possible setting selection **Funding:** University of Sao Paulo		on knowledge of disease, medication treatment adherence, and glycemic control in patients with DM	**Inclusion**:≥40 y/o, diagnosed with T2DM **Exclusion:**<40 y/o, lesion on lower limbs, previous amputation of lower limbs, under hemodialysis, wheelchair, CBA, psych diseases, participating in another GBE, cultural factors affecting ability to understand instruments				treatment adherence (p=0.0318), and glycemic control (p=0.0321).	Significant results **Limitations:** small sample size, many excluding criteria for participants **Feasibility:** Allows active participation of group members using CM.
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variable & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**
Torres, H. C. et al. (2018). Evaluation of the effects of a diabetes educational program: A	Creating awareness through self-care	**Design:** cluster RCT **Purpose:** determine efficacy of an educational program of	**N**=341 **n**=170 (IG) **n**=171 (CG) **Setting:** primary healthcare units (8)	**IV:** educational program **DV1:** HbA1C **DV2:** lipid levels	HbA1C, lipid panels	SPSS, R version 3.0.1,Shapiro-Wilk, Box-Cox transformation, Bonferroni correction, chi-square with Yates correction,	There were statistically significant changes in the HbA1C over time in both groups. The	**LOE:** LOE II **Strengths:** Statistically significant results

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randomized clinical trial **Funding:** educational grants **Bias:** selection **Country:** Brazil		patients with DM	**Demographics:** Average age 60.6 Mostly female participants (69% of CG and 74.7% of IG) **Inclusion:** age 30-70, diagnosed with DM **Exclusion:** illiteracy, complications of disease	Note: educational program consisted of GBE, home visits, and phone calls		McNemar, *t*-Student test, *t*-Student-Welch test 5% significance level	means were significantly lower in the intervention group *(p*<0.05*)*.	**Limitations:** wide range of exclusion criteria, 27.3% attrition **Feasibility:** Flexible strategies for awareness and self-care for DM may be helpful for patients. May be difficult to replicate specific program, involving multiple methods.
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variable & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**
Imazu, M. (2015). Effectiveness of individual and group interventions for people with T2 diabetes.	Inferred CCM	**Design:** comparative, longitudinal and prospective study (non-randomized)	**N=150** **n=**75 (IBE) **n=**75 (GBE) **Setting:** private healthcare service	**IV1:** IBE **IV2:** GBE **DV1:** knowledge of disease questionnaire scores	DKN-A, SDSCA, PAID	SPSS, Kolmogorov-Smirnov, Shapiro-Wilk tests, Friedman's, Multiple Comparison, Mann Whitney	Significant improvements in scores related to knowledge of disease in both groups (IBE	**LOE:** LOE III **Strengths:** **Limitations:** non-randomized, high rates of

KEY: BMI-body mass index; **BP**-blood pressure; **CCT**-clinically controlled trial; **CCM**-Chronic Care Model; **CG**-control group; **CI**-confidence interval; **CM**-Conversation Maps; **DKN-A**-Diabetes Knowledge Scale; **DKQ**-Diabetes Knowledge Questionnaire; **DV**-dependent variable; **DM**-diabetes mellitus; **EMR**-electronic medical record; **FBG**-fasting blood glucose; **GBE**-group-based education; **HbA1C**-glycated hemoglobin; **HDL**-high-density lipoprotein; **HTN**-hypertension; **HV**-home visits; **IBE**-individual-based education; **IG**-intervention group; **IV**-independent variable; **LDL**-low-density lipoprotein; **LOE**-level of evidence; **MA**-mean age; **MAT**-Measure of Adherence to Treatments; **MP**-medication persistence; **MPR**-medication possession ratio; **PMA**-primary medication adherence; **RCT**-randomized clinical trial; **SCT**-Social Cognitive Theory; **SPSS**-Statistical Package for Social Sciences;**T2**-type 2; **UC**-usual care; **WC**-waist circumference

Country: Brazil **Funding:** not identified **Bias:** Selection bias due to convenience sampling		**Purpose:** Compare effectiveness of GBE vs. IBE on knowledge of disease, quality of life, and self-care practices	**Demographics:** MA 60 years, 56% female, 80% white **Inclusion:** enrolled in the "Chronic Patient Mentoring Program", >18 y/o, diagnosed with T2DM, with or without comorbidities	**DV2:** quality of life questionnaire scores **DV3:** self-care practices questionnaire scores **SDSCA:** Summary of Diabetes Self-Care Activities questionnaire (validated) **PAID:** Problem Areas in Diabetes questionnaire (validated)			p=0.003, GBE p=0.008). Significant improvements in quality of life in IBE (p=0.007). Significant improvement in self-care practices in GBE (p<0.01).	attrition, especially in GBE, presence of comorbidities as uncontrolled variables **Feasibility:** The use of combination of IBE and GBE may be beneficial for different areas in the DM management and education components.
Citation	**Conceptual Framework**	**Design/Method**	**Sample/Setting**	**Major Variable & Definitions**	**Measurement**	**Analysis**	**Findings**	**Decision for Use**
McEwan, M. M. et al. (2017). Effects of a family-based diabetes intervention on behavioral and biological	Self-efficacy	**Design:** RCT **Purpose:** Analyze effects of a family-based self-management	**N**=157 **n=**83 (IG) **n=**74 (CG) **Setting:** urban Hispanic neighborhoods	**IV:** family-based diabetes intervention **DV1:** Family-based intervention: 12-week	DKQ, Newest Vital Sign, weight balanced scale, Diabetes Self-Care Activities	SPSS; Chi-square and t-tests, ANOVA	Significant effect of family-based interventions on DM self-managemen	**LOE:** LOE II **Strengths:** Intervention increased self-management, similar

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outcomes for Mexican American adults **Bias:** Potential selection/recruitment **Funding:** grant from National Institute for Minority Health and Health Disparities **Country:** USA		support intervention	in Arizona border region **Inclusion:** Mexican American, T2DM at lest 1 year, 35-74 y/o, had 1 family member participating >18 y/o who lived with or saw weekly **Exclusion:** DM education in the past 1 year **Demographics:** MA=53.53 y/o, 85% female, 93.6% overweight Family members' MAs=47.27, 72.6% female	program including 12 hours of support group sessions, 3 weekly 2-hour home visits, and 3 weekly 20- minute phone calls	Questionnaire, Self-Efficacy for Diabetes Scale, Fat, Fruit, and Vegetable questionnaire International Physical Activity Questionnaire		t, exercise, self-efficacy, distress. No significant changes in HbA1C.	geographical region **Limitations:** More time-intensive and potentially costly interventions involved. Low-income sample **Feasibility:** Culturally relevant family-based education may be beneficial. However, grocery certificates were dispersed for incentive for participants at data collections. "Booster sessions" may be necessary to maintain glycemic control.

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Appendix B

Synthesis Table

	Odgers-Jewell et al.	Merakou, K. et al.	Reaney, M. et al.	Santos, J. C. et al.	Hwee, J. et al.	O'Connor, et al.	Figueira, A. et al.	Torres, H. C. et al.	Imazu, M.	McEwan, M. M. et al.
Year	2017	2015	2013	2017	2014	2014	2017	2018	2015	2017
LOE	I	II	II	II	IV	II	IV	II	III	II
Design	review	CCT	RCT	RCT	PBC	RCT	SCRI	CRCT	CLPS	RCT
T2DM only	yes	yes	yes	yes	T1DM included	yes	yes	yes	yes	yes
Attrition	N/A	0%	8.2%	0%	21%	12%	28%	27%	32%	45%
# of Participants	8,533	193	681	238	77,824	2,378	82	341	150	157
Country	Assorted	Greece	Germany/ Spain	Brazil	Canada	U. S.	Brazil	Brazil	Brazil	U.S. (Arizona)
Intervention	GBE	GBE	GBE	IBE, ME, GBE	TC	GBE	E	IBE, GBE	GBE, HV, TC	GBE, HV, TC
GBE effect on medication adherence	N/A	N/A	N/A	N/A	N/A	NSE	↑	N/A	N/A	N/A
GBE effect on hospital visits for diabetes complications	N/A	N/A	N/A	N/A	↓	N/A	N/A	N/A	N/A	N/A
GBE effect on KOD	↑	N/A	↑	N/A	N/A	N/A	↑	N/A	↑	N/A

Key: ↓-decreased; ↑-increased; **CLPS**- comparative, longitudinal, & prospective study; **CRCT**- cluster randomized controlled trial; **E**-education; **GBE**-group based education; **HbA1C**-glycated hemoglobin; **HV**-home visits; **IBE**-individual based education; **KOD**-knowledge of disease; **ME**-mixed GBE & IBE; **N/A**-not applicable in this study; **NSE**-no significant effect; **PBC**-population based cohort study; **SCRI**-single comparison randomized intervention; **T2DM**-type 2 diabetes mellitus; **TC**-telephone calls; **U.S.**-United States

GBE effect on HbA1C	↓	↓	↓	↓	N/A	NSE	↓	↓	N/A	NSE

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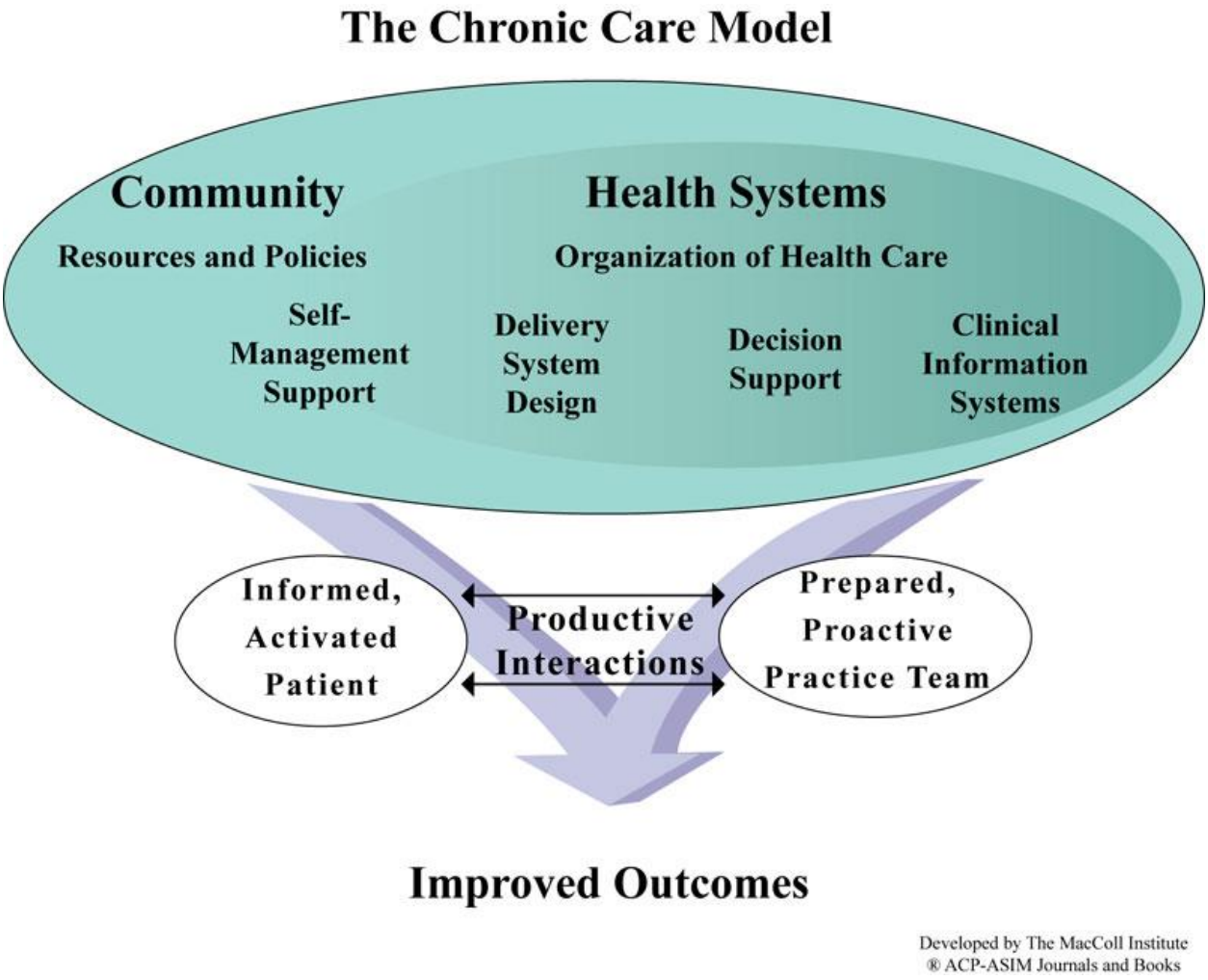
Appendix C

Figure 1



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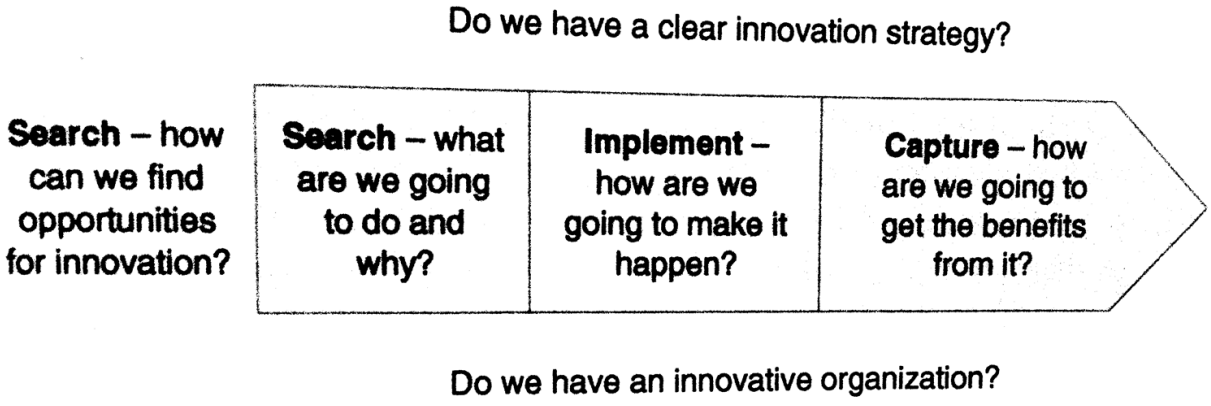
Appendix D

Figure 2



(Dawson & Andriopoulos, 2017)

Appendix E

Budget

Activities	**Cost**
Design and print pamphlets for education program (200)	$40
Design & print educational materials for staff meeting	$2
Related physician loss of productivity for staff meeting cost	$160
Related staff loss of productivity for staff meeting cost	$14.85
Food items for staff meeting	$25
Locking box and files for patient paper files related to project	$60
TOTAL	$301.85