Continuous Glucose Monitoring and Behavior Change

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Abstract

Clinical usage of continuous glucose monitor (CGM) devices has started to become a novel way to integrate glucose control with improvement in lifestyle with behavior change by seeing blood glucose levels in real-time. CGM and real-time data predicts what is happening with blood glucose levels and when people wearing the device views the data it allows the person with diabetes to guide lifestyle changes to better assist in blood glucose levels and less variability of blood glucose levels.

The study aim was to determine whether using CGM had an impact on behavior change with lifestyle choices consisting of activity or nutritional changes and to explore why this was the case. The data collected supported the usage of CGM with real-time glucose readings having an impact on behavior changes that were made by the participants in this study. The first ten participants to sign up for the study completed fourteen days of wearing CGM.

Feedback on the CGM and behavior change was overwhelmingly positive. One participant data was not included as this participant contracted COVID during the wear period of time and unable to make any changes to activity or nutrition. The basic themes that were identified included more activity, smaller portion sizes, and or smaller amounts of carbohydrates ingested. The study showed an overall positive response on glycemic control, the study participants showed behavior change with lifestyle changes while wearing CGM.

Keywords: continuous glucose monitor, CGM, real-time data, behavior change

Continuous Glucose Monitoring and Behavior Change

Blood sugar control can impact microvascular and, macrovascular complications; affecting the quality of life in individuals with a diagnosis of Diabetes Mellitus. One tool used to significantly reduce risk factors is a continuous glucose monitor (CGM). Utilizing diabetes technology with continuous glucose monitoring (CGM) allows a person in real time to evaluate the relationship between, food, activity, or stress and the impact to glycemic control. There are over 42 different factors that can impact a person's blood sugar control (Zeevi et al, 2015). Using the behaviors, a person can control factors such as nutritional choice, activity choice, or smaller portion sizes impacting a person's overall glycemic control.

Overview

Problem Description

Diabetes management and control can be very costly and debilitating if blood sugars are not in target range. Elevated blood sugar levels can lead to macrovascular and microvascular complications including heart attacks and strokes. Hypoglycemia or low blood sugars can be very dangerous and cause seizures, deleterious side effects, or even death if not treated promptly. Having a tool to help engage in diabetes self-management with projections from continuous glucose monitoring can not only help with hyperglycemia and hypoglycemia prevention, but also give the person using CGM a perspective to see how choices and/or behaviors have on blood sugar ranges.

Therapeutic inertia can result in poor glycemic control and may stem from a disconnect between the provider and patient on the importance of glycemic control (Edelman et al., 2020). It is important to understand an individual's motivation in seeking preventative or maintenance healthcare to achieve optimal healthcare.

It is known, many individual patients delay routine and acute care, but the reason is not completely understood or consistent from individual to individual (Edelman et al, 2020). Some reasons for the delay in care could include work demands, financial insecurity, lack of understanding, and/or minimal to no engagement in the care process. In individuals with diabetes, the care process often includes diabetes self-management. Much still remains unknown as to why diabetes care is not on the forefront of an individual's mind, therefore understanding and meeting a person where they are at in their own disease process is a start to removing barriers to care. Impacting behavior change is a crucial element for impacting overall glycemic control which can reduce complications and death for a person who has unstable glycemic control.

The clinical question guiding this project was in patients diagnosed with diabetes currently wearing a continuous glucose monitor (CGM), what was the effect of behavior change on glycemic control compared with no behavior change in one-week time period? It was believed the outcome of this project would be better glycemic control for those patients who implement a behavior change during the one-time period defined by a reduction in blood glucose levels. The behavior changes implemented could include changes in nutritional choices, more activity, or less caloric intake.

Available Knowledge

Intervention

The participant was asked to use the first week as a control and not changing any behaviors until week two if they decide to change any of the included behaviors as listed above. Persons wearing CGM therapy did discuss how food choices impacted glycemic control, as well as portion sizes or low glycemic index foods (Ehrhardt & Al Zahal, 2020). As in the Ehrhardt & Al Zahal, 2020 study behavior changes in activity level, such as increases in physical activity, can impact blood glucose control, assist with weight reduction, and insulin resistance, making glucose stability easier with usage of CGM therapy. Motivation of glycemic control is a strong driver of having improvements in overall stability of glucose in target range glucose levels. Patients with diabetes wearing CGM also showed increase in the amount of testing frequency by scanning of CGM therapy as opposed to traditional self-measured blood glucose (SMBG) where glucose levels were not checked as frequently. Patients demonstrated the ability to monitor levels more frequently with CGM as opposed to SMBG for fear of pain, scarring or just not wanting to check with traditional SMBG (Overend et al., 2019). The patients wearing CGM had behavior change that was multiple in areas such as more frequent glucose levels that were monitored, change in the amount of food that was ingested or the type of food such as lower glycemic index, higher protein or even just consistency in carbohydrates. Continuous Glucose Monitoring can also assist patients with prevention of hypoglycemia that may have been impacted by the amount of activity that was previously one or the person decided to increase without the fear of hypoglycemia. Patients wearing CGM have an overall improvement in quality of life by evidence of decreasing microvascular and macrovascular complications while promoting self-management skills and a sense of wellbeing in patients with Diabetes. Patients wearing CGM have an overall improvement in quality of life by evidence of decreasing microvascular and macrovascular complications while promoting self-management skills and a sense of wellbeing in a patients' with Diabetes (Soo et al., 2020).

Outcomes

Real time continuous glucose monitoring (CGM) is considered a truer measurement of blood glucose level than traditional self-measured blood glucose (SMBG) checking by finger stick measurements (Soupal et al., 2020). CGM is able to reduce hypoglycemia, hyperglycemia, and show reduction in hemoglobin A1C lab values. CGM can be considered an alternative to sensor-augmented insulin pump therapy, which uses an insulin delivery system and continuous glucose monitoring system for blood sugar control. Time in range for blood glucose control was defined by ranges 70-180 mg/dl for CGM which was measured 70% of the time as opposed to SMBG being measured four times a day over a three year period (Soupal et al., 2020). Questionnaire or surveys were given to participants at baseline and specific time periods during studies to evaluate problem areas such as hypoglycemia, diabetic ketoacidosis, treatment satisfaction and also a history of how the person treated their own self-diabetes management previously to studies (Charleer et al., 2020). Results of the study included improved quality of life, less admissions for severe hypoglycemia and also diabetic ketoacidosis over one year period n=63 participants out of 1,913; 3.3% (Charleer et al., 2020). Also, participants missed less work hours, spent less time in hypoglycemia, more time in range blood glucose target levels and less time in hyperglycemia periods which has a significant impact on the quality of life in a person with Diabetes (Charleer et al., 2020). Documentation from multiple surveys were able to differentiate that outcomes were specifically based on the persons using CGM by understanding patterns and behavior changes for their overall quality of life. Scoring from participants who enroll in telehealth services as well for assistance with adjustment of medications and insulins were seen to increase adherence to CGM in particular individuals (Soo Ting et al., 2020). In adherence to CGM, evaluations included the amount of times a participant viewed scanned results, how often a participant-experienced time in range, hypoglycemia and hyperglycemia levels (Soo Ting et al., 2020). In reporting the results for CGM wearing during this capstone, participants will include diary for any changes including activity and or nutritional changes, with the CGM being uploaded for the results concerning the first week and second week of wearing the CGM.

Rationale

The clinical issue of blood sugar control in prevention of microvascular and macrovascular complications from uncontrolled blood sugars will be explored using the Iowa Model (Iowa Model Collaborative, 2017). Appendix A. The impact of in target range blood sugar control affects the quality of life in individuals with a diagnosis of Diabetes. One tool used to significantly reduce risk factors is a continuous glucose monitor (CGM). Utilizing diabetes technology with continuous glucose monitoring (CGM) allows a person in real time to evaluate the relationship between, food, activity, or stress and the impact to glycemic control. Using the behaviors, a person can control factors such as nutritional choice, activity choice, or smaller portion sizes impacting a person's overall glycemic control. By utilizing the Iowa Model, a plan to implement the proposed practice change can be developed.

The first step in using the Iowa Model is identifying if this topic is a priority. The issue of uncontrolled blood sugars is a part of addressing the institution's strategic plan; which includes increasing patient compliance with diabetes self-management and achieving goals set forth by the rural accountable care organizations standard of care with measuring A1C's, hyperglycemia, and also hypoglycemia. The institution promotes patient safety, prevention, and also changing reimbursement to improve best practice in high-risk populations served in the rural hospital service area.

The next step in the model consists of forming a team to address the topic of uncontrolled blood sugars and identifying how utilizing diabetes technology with continuous glucose monitoring (CGM) can illicit behavior change to impact an individual's glycemic control. Usage of CGM may improve the quality improvement measurements growing compliance in diabetes self-management and behavior change in regard to a patients' in target range blood sugar control. Traditional measurements of using hemoglobin A1C (HgbA1C) testing alone can place a person at great risk for hypoglycemia if too strict of a goal, or even place a burden of having hyperglycemia with unreliable HgbA1C measurements not true in target range blood sugar control. Knowing that hypoglycemia can cause immediate death and hyperglycemia can increase oxidative stress and increase risk for long-term complications is one of the motivating factors to help patients use CGM therapy to encourage behavior change. Assisting people in usage of newer technologies such as CGM allows a patient to not have to prick their fingers several times a day to monitor blood sugars. Also, having readily available CGM allows real-time blood sugar evaluation with trend arrows to assist a patient in making decisions that can influence diabetes management (Palmer, 2019).

Research conducted provides sufficient evidence in the utilization of CGM programs to impact a person's behavior in regard to blood glucose levels. The question becomes how to engage the patient in new CGM diabetes technology, evaluate resources, and overcome constraints that may present as barriers to CGM implementation. Development of protocols and plans for CGM usage with patients will help with engagement. Implementation of a plan on education for clinicians, patients, and staff to promote adoption of CGM integration in clinic operations will be necessary, including how we collect and report data with evaluation for behavior change in patients using CGM.

After research, the model directs a plan for implementation to be developed. Integration of practice change for patients using CGM will require interventions including education for specific key personnel on usage of CGM technology for patients and the clinic. Education on how the CGM practice will integrate with behavior change into a successful system for patients and providers to use, report, and understand the impact to patients while developing a best practice. Once the implementation is completed, it will be important to understand how quality improvement indicators are impacted, specifically blood sugar stability and safety, for CGM program patients. Sharing this information with providers and patients can be useful in the promotion of diabetes self-management.

Purpose

The purpose of this evidence-based practice project was to reduce blood glucose levels in participants from a rural Southwest Iowa clinic through implementation of an ambulatory continuous glucose monitor program (CGM).

Methods

Context

Participants were recruited from a participant population treated by a rural Southwest Iowa clinic co-managed by a physician who had a vested interest in diabetes and a diabetes nurse educator. Approval to perform the project was provided by the facility. The primary care practice was located inside of a rural Southwest Iowa hospital which is a 25 bed hospital, which serves as both a clinic and a critical access hospital. In this rural Southwest Iowa clinic, which had thirteen providers, each provider has a private nurse. The provider involved in this capstone project was motivated to create practice change surrounding the use of new therapies and technology with patients diagnosed with diabetes. The provider was specifically interested in the use of a CGM compared to traditional blood glucometers and a focus on patient empowerment. In the past, there had been limited success in engaging those patients in diabetes self-management and blood sugar control.

Individuals seen at the clinic were all ages, ranging from newborn to geriatric. The providers focus was primary care and therefore saw a range of patients with Type 1 and Type 2 Diabetes. The CGM program was implemented in this rural Iowa clinic setting.

Intervention(s)

The CGM was in place over a 14-day period where the first week was considered a control week with expectations of no behavior changes. The second week of wearing CGM, participants were asked to make a type of behavior change to illicit a glycemic response over the additional 7 day period. After the end of the 14-day period, a follow up meeting was completed with the participant. The follow up consisted of in person, telehealth, or telephone review including the downloaded CGM data with the participant. In this follow up meeting, the facilitator verified if the behavior modification was made during the second week. If no modification was made, the participant data was not included in the overall results.

The goal was to change glycemic control, showing improvements in blood sugar control with behavior change. The facilitator educated participants on the types of possible behavior changes to be made in the final 7 days of the project. These behavior changes included nutritional changes such as smaller portions, higher protein intake, and or consistency in carbohydrates. Another behavior change could be increasing activity minutes from the previous 7 days of the project. Comparison of the CGM data over the 14-day wearing period, week one with no change and week two including the behavior modification, showed how behavior change can impact glycemic control with the goal of improvements in overall blood sugar stability and/or control.

All subjects were provided written informed consent before enrollment. Inclusion criteria included participants previously diagnosed with Type 2 Diabetes greater than two years, have a recent HbgA1C >7.0 mg/d, be 18 years of age or older, and existing patients of the diabetes clinic. Recruitment was done in the clinic area until ten participants agreed to participate. Participants were asked to make at least one behavior modification, either a nutritional and/or activity change during the last seven days of the 14-day period (Ehrhardt & Al Zahal, 2020).

Using a variety of quantitative methods, data collection was used to help define components on behavioral change with CGM usage. Striving to understand how CGM implementation was used can help address behavior change in individuals diagnosed with diabetes and a HgbA1C greater than 7.0 mg/dl. Blood glucose levels were compared before and after implementation of the evidence-based ambulatory continuous glucose monitor program.

Study of the Intervention(s)

As behavior change has been shown to improve blood glucose stability and control with reducing microvascular and macrovascular risk factors, the approach of studying behavioral change with implementation of wearing CGM for behavior change on the impact of blood glucose control was evaluated. Blood glucose data collected via the CGM was downloaded and reviewed after the 14-day period. The blood glucose control from the first seven days of the project was compared with the last seven days, after the participant engaged in a behavior modification. A follow-up visit occurred to review the CGM data and collect information on what behavior modification(s) the participant selected and maintained in the last seven-day period of the project. The follow up was performed in-person, telehealth including virtual visit or a telephone follow up.

Measures

Data from the CGM was collected during the 14-day project. The participant were able to view the CGM data, as was the facilitator throughout the project. The only change made during the project was made in the final seven days using specific behavior modification. It was believed that viewing the data by the participant from the CGM during behavior modification would provide instant feedback for the participant. Using a variety of quantitative methods data was compared from the first seven-day period and the last seven-day period. Demographic data was not collected, only behavior modification and CGM data, which included blood glucose levels.

Analysis

Microsoft Excel was used to analyze the data from the CGM. Quantitative data correlating with the blood glucose results was observed and compared. Data collected from the CGM included the average blood glucose levels from the first week compared to the average blood glucose levels from the second week. Behavior change was made in the second week. The type of change was collected, for example activity or nutritional change. Average blood glucose results were compared using percentage of change from the first week to the second week of wearing CGM. Outliers, such as illness and or stopping CGM before the 14 day period, was not included as part of descriptive statistics. Using descriptive statistics, the facilitator was able to determine behavior change alongside the ability to view blood glucose results engaged participants and resulted in tighter glycemic control.

Ethical Considerations

Participants were given a full explanation of the project prior to informed consent being obtained. Participants were informed that the facilitator of the project and the clinic had no personal or financial conflict of interest. Participation was optional and at any time, one could choose to stop during the 14-day period. Non-participation did not exclude the individual from participating in the diabetes clinic as per normal. Institutional Review Board approval was obtained prior to the implementation of the project. Collected data remained in the patient chart until time to perform data analysis. At that time, data was extracted from the chart but de-identified to provide anonymity. De-identified data was stored in an excel spreadsheet on a password protected computer located in a locked office.

Results

CGM participant data retrieved indicated nine participants implemented a behavior change. The type of behavior change collected was increase in activity or nutritional change. One participant did not implement a behavior change during the CGM wear period due to a COVID diagnosis. The participant's results were excluded from the study due to illness and inability to implement a behavior modification. . Of the nine remaining participants, 100% made at least one behavior change using the CGM during the two-week period of the study. Though only one behavior modification was required, some participants implemented more than one behavior modification. From the nine participants, 100% of participants implemented more activity and 89% reported smaller portion sizes. During week, one the mean glucose level was 168 mg/dl. During week two, the mean glucose level was 140 mg/dl. The average blood glucose during the two-week wear period was 154 mg/dl with a standard deviation of 34.45 mg/dl. The overall reduction of blood glucose levels of all participants during the two-week wear period was 16.52%. The relationship between CGM wearing and engagement in behavior change suggest a positive result from this project. The total participants included 10 patients, 7 male subjects and 3 female subjects.

Discussion

Summary

It was demonstrated that wearing the CGM for the 14 day wear period, in conjunction with identifying and implementing a behavior modification, strengthened a person's ability to identify blood glucose patterns and positively impact blood glucose control. The strength and key finding in this study was that most persons documented behavior change before the second week of the study, which helped with blood sugar stability over the duration of the study.

Interpretation

In this study, using CGM real-time readings for behavior change this was associated with higher percentage of persons using CGM to have behavior change as opposed to traditional blood glucose measurements. After the intervention, the percentage of patients who wore CGM and had behavior change significantly improved blood glucose measurements. The goal of the project was achieved by meeting 100% of lifestyle change either by increasing activity or nutritional changes was met. Participants were very eager and pleased with the positive results and documented better control of blood glucose levels was due to the heightened awareness of CGM and the lifestyle change that was made with the real-time results that could be viewed. The impact of this project for participants will allow this result data to be shared with the facility to include opportunities for future growth in CGM at this clinic.

Limitations

The study had limitations that included performance controls from participants. One limitation was being unable to adjust for illness. Second limitation would include unmeasured results with persons who would choose not to make lifestyle change for reasons of not making any change. Another limitation of this study included being performed in a small rural clinic with a limited budget and no quality improvement process for outcome based care initiatives. The growing interest in CGM and behavior change may be a contributor to a broader use of this intervention. The sample size and length of study were also limitations that are included in the limitations.

Conclusion

Providing feedback in real time surrounding behavior modification using CGM in patients with diabetes can promote the necessary lifestyle changes to ultimately stabilize blood glucose. Wearing the CGM demonstrated the desired immediate feedback versus traditional blood glucose records. When a person can identify quickly how behavior influences blood glucose, lasting changes can be made over time to predominately improve diabetes blood glucose control. Using readily available and actionable data with remote patient monitoring allowed patients to evaluate how diabetes self – management practices with behavior change had an impact on blood glucose levels now and in the future. There is great potential for sustainability. Because this rural facility had multiple providers, 15 in total, the expansion of the CGM program will be pursued as it demonstrated successful behavior change in engagement from patients wearing CGM.

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