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Continuous Glucose Monitoring in Prediabetic and Type II Diabetic Mellitus Patients: A Rapid Review

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ABSTRACT

***Background**: COVID changed healthcare modalities and we found out that needed services were not met for diabetic patients. Continuous glucose monitoring (CGM) has been a technology used for Type 1 diabetic patients for years. With the rising numbers of both Type 2 diabetic (T2DM) and prediabetic patients, expanding the use of this technology could be beneficial in this population.*

***Methodology**: A review of nursing and medical literature was completed using search engines from the Simmons library, CINAHL, Medline databases, and Google Scholar. The key terms that were used in combinations were Diabetes Mellitus Type 2, T2DM, Prediabetes, Continuous Glucose Monitor, CGM, benefits/advantages, prevention, nursing, and challenges. This is a rapid review of the literature.*

***Findings:** After reviewing the literature, three themes emerged including findings that indicated that the use of CGM is an important tool for prediabetic and T2DM patients; as lifestyles changed, HbA1C results lowered, and these patients had less hypoglycemic episodes.*

Keywords

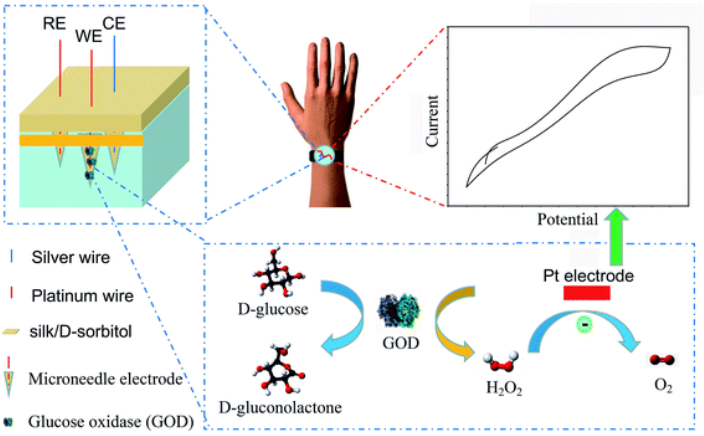
Type II diabetic mellitus, Glucose Monitoring.

Introduction

Type 2 Diabetes Mellitus (T2DM) is an epidemic in the United States and worldwide. The Centers for Disease Control and Prevention (CDC) [1] states the growth of prediabetes, diabetes is projected to increase, and 8.5 million people are undiagnosed in the United States. According to the (CDC) [1], 37.3 million people have diabetes which is just over 11% of the population in the US, with 96 million adults over 18 years old having prediabetes. T2DM can increase risk of cardiovascular disease, retinopathy, nephropathy, and death [1]. Nurses and healthcare providers have increasing challenges when providing care of diabetic patients. The challenges in caring for diabetic patients consist of increased risks for hypoglycemia, hyperglycemia, infections, obesity, vascular disorders, sensory disorders, and nutritional imbalances. The medical management of prediabetes and T2DM is with oral medication, injectable medication, and/or insulin. Medical management is used in combination with monitoring blood glucose levels with finger sticks or a lab draw of a Hemoglobin A1C every three months. Non-compliance with glucose monitoring and lifestyle changes creates large barriers to managing prediabetes and diabetes.

Continuous glucose monitoring (CGM) is a newer technology originally just used by Type I Diabetes Mellitus (T1DM) patients. CGM is a tiny sensor inserted in the skin that measures blood glucose levels continuously. CGM is constantly recording and transmitting data to a monitor, this allows the ability to provide real-time data, and alerts when blood glucose is elevated or low [2]. NIH [2] states that CGM allows the patient to input notes such as physical activity and diet to be placed alongside blood glucose. This provides useful information on the body's response. This information can be used to implement lifestyle and medical changes. With the advancement in technology in CGM the accessibility is expanding to the general population, prediabetics and T2DM. This systematic literature review will explore the non-

compliance factors of diabetes and evaluate the effectiveness of CGM for the management of prediabetic and T2DM patients.



Scholarly Question

In the adult population who are diagnosed with being prediabetic or T2DM, is the use of continuous glucose monitoring (CGM) as effective as monitoring their HbA1C every three months?

Problem Statement

Diabetes is an epidemic in the United States, it is a common diagnosis for nurses and healthcare providers. T2DM has become an epidemic because of physical inactivity, obesity, and large consumption of processed foods, sugar, and simple carbohydrates. These lifestyle factors over time create insulin resistance, decrease insulin production, and cause hyperglycemia. According to the Centers for Disease Control and Prevention (CDC) [1], 37.3 million people have diabetes which is just over 11% of the US population, with 96 million adults over 18 years old having prediabetes, and 8.5 million people are undiagnosed. Diabetes is the seventh leading cause of death in the US and is the number one cause of adult blindness, kidney disease, and lower limb amputations [1] Noncompliance is a growing problem among patients that have diabetes and prediabetes with the risk of further complications such as cardiac, eye, neuropathy, or kidney disease [3].

Education for patients is a vital component in the management of both diabetes and prediabetes patients. Diabetes is a complex lifelong illness and the majority of care is self-managed by the patient at home at the direction of a healthcare professional. About 50% of patients with diabetes fail to reach their goal of a hemoglobin A1C of less than 7% [4]. Patients with diabetes are taught to self-monitor their glucose levels at home using a home glucometer and incorporate lifestyle changes of diet and exercise. Many times patients are not checking their glucose levels appropriately, which is a central part of managing their diabetes and prediabetes [5]. Continuous glucose monitors would provide patients with a real-time view of their glucose levels that could influence patients to make better decisions concerning their diabetes management [5].

Nursing Theorist

Nola Pender, is a nursing theorist who focuses her work on disease prevention and health promotion. Pender et al. [6] states that nurses are the foundation of healthcare because they provide a bridge between individual health promotion and promoting the health of families, communities, and population to help them reach their full potential. There are four key elements for nurses to implement and support health promotion: individual perspective, philosophy of empowerment, knowledge of social and health policy, and community orientation [6]. Pender approaches the view of health promotion on what significant factors influence health behaviors and how nurses utilize the four key elements to implement positive change. Health behaviors are influenced by an individual's perception of the benefits to behaviors and those perceptions are influenced by demographics, interpersonal relationships, cultural aspects, biological characteristics, and situational factors [6]. Nurses are responsible to demonstrate and collaborate their knowledge of health promotion in all practice settings. Pender et al. [6] also states how nurses should be prepared to take leadership roles as new challenges arise with evolving healthcare.

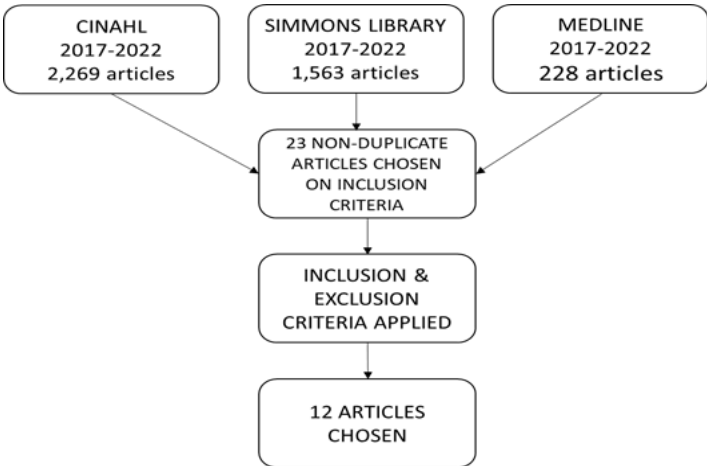
The evolution of technology has created rapid change in healthcare. Advancements of electronic health records, telehealth, and mobile apps have allowed for health promotion strategies, program delivery, and research [6]. Pender recognizes the importance of utilizing evolving technology to provide health promotion opportunities. Continuous Glucose Monitoring is a technology that can be a beneficial health promotion tool among prediabetic and T2DM adults. Patients that use CGM are using Pender's health promotion theory because their glucose numbers can motivate an individual's lifestyle changes.

Systematic Literature Review

The different search criteria and databases used allowed us to find the most current research, which resulted in over 4,000 articles found. The articles were narrowed down by the type of article focusing on original research, focused on our specific population, and pertaining to the use of CGM and the benefits/challenges. After a thorough search of the literature, 12 articles were chosen based on the level of evidence and subject pertaining to the research question.

The literature review was focused on the most current research with the years searched from 2017-2022. Three themes were derived from the 12 articles. These themes consisted of CGM and its lifestyle impacts on prediabetic and T2DM adults, a comparison use of CGM and conventional use of standard glucose monitoring (SGM), and challenges in implementing CGM.

Table 1: PRISMA Diagram.



Lifestyle Impacts

The cornerstone of diabetes care is centered on self-management, which encompasses lifestyle modifications and self-monitoring of blood glucose levels. Choe et al. [7] conducted a randomized control trial over a 12-week period of 126 participants with T2DM and monitored the effects of CGM and self-evaluation of the impact of unhealthy foods. The study applied The Self-Evaluation of Unhealthy foods by Looking (SEOUL) at postprandial glucose. The researchers deemed that there are variations among individuals of diet and glucose response, therefore adding to the complexity of diabetic management. Choe et al. [7] hypothesized postprandial glucose response from CGM readings could elicit patterns for the individual of proper eating habits. The intervention group was provided CGM along with education support and behavior modification. Whereas the control group continued with their conventional diabetes care. The results of the study showed an improved HbA1c level among the intervention group (7.3 plus or minus 0.6%) versus the control group (7.8 plus or minus 0.9%) [7]. There was even more reduction of fasting glucose levels in the intervention group and more improvement of HbA1c with patients not on intensive insulin therapy. The study was only conducted over a 12-week period and there was no significant change with waist circumference, blood pressure, and LDL cholesterol. The use of the SEOUL program to provide education based on nutrition and glucose response with CGM provides data-based patient driven lifestyle modifications [7]. This study provided useful data on how CGM can affect nutritional changes in diabetic patients.

In contrast to the Choe et al. [7] study, the mixed-method study conducted by Yost et al. [8] incorporated CGM among prediabetics and a low carbohydrate diet. Yost et al. [8] focused their study of 15 participants that were prediabetics with a HbA1c between 5.7% and 6.4% and provided education on eating a low carbohydrate diet of 100g per day. The study was divided into three in-person visits over 22 days and two qualitative phone interviews at three weeks and six months post-intervention. Visit one focused on a food log and cravings for 10 days while wearing a CGM. Visit two consisted of low-carbohydrate diet coaching and learning to record and interpret glucose trends with the CGM. The quantitative results of the study showed a weight reduction of 1.4lb and a reduction of HbA1c levels by 0.71% [8]. Along with the improvements in quantifiable results, the interviews offered insights into CGM use. The researchers recognize how patients with prediabetes lack sufficient motivation and support and how CGM provides real-time feedback supporting behavioral changes. The qualitative data from interviews used a Likert scale and results showed participants reported no major barriers to CGM use, all participants attempted a low-carbohydrate diet, and CGMs helped participants visualize the impacts of carbohydrates and glucose trends. The study had a small sample size but showed that the use of CGM and dietary changes is a feasible modality for behavior change and improved health outcomes [8].

Dehghani Zahedani et al. [9] conducted a 10-day observational study in a heterogeneous cohort of 665 individuals with non-insulin-dependent treated T2DM, prediabetes, and no history of diabetes spanning across the United States. The participants used CGM and a food logbook, with glucose drinks and two different types of nutritional bars. This study contrasts from Choe et al. [7] and Yost et al. [8] because it focuses on T2DM, prediabetics, and no diabetic history participants who are not using insulin for diabetic treatment. It also contrasts with Yost et al. [8] with no influence of a set diet. The study is similar to Choe et al. [7] with allowing participants to visualize the glucose curves from CGM and adjust their diet accordingly except for the outlier of an oral glucose challenge and mixed meal challenge with two nutritional bars. Results of the CGM were quantified as a time in range (TIR), in non-diabetics and prediabetics the TIR was a blood glucose of 54-140 mg/dl and diabetic's TIR was 54-180 mg/dl [9]. Results of the study showed TIR improved significantly with CGM use, with results of 22.7% improvement for T2DM and 23.2% for nondiabetic individuals [9]. An interesting result of the study was that 5.8% of self-reported healthy participants had post-prandial glucose dysregulation and fasting glucose measurements consistent with prediabetes [9]. This result shows that there is a significant portion of the population who unknowingly have glucose dysregulation and are at risk of diabetes. Dehghani Zahedani et al. [9] highlight glucose dysregulation stating 15% of healthy and 36% of prediabetics demonstrated glucose values exceeding 200 mg/dl. The study also highlighted blood glucose exceeding 200 mg/dl among 25.9% of T2DM taking antidiabetic medications when ingesting the nutritional bars. The results of the study bring awareness to the use of CGM for non-insulin T2DM, prediabetics, and non-diabetics for identifying glucose dysregulation with nutrition and lifestyle habits. The study demonstrates how real-time CGM data can influence activity and food for all individuals, improve their TIR, and recognize earlier stages of glucose dysregulation.

Cuevas et al. [10] provides a mixed-method study of using CGM for diabetes self-management, blood glucose and cognitive function, and glucose variability in older adults. The study highlights the fact that CGM allows for the realization of glucose variability and clinical outcomes in regard to self-management behaviors and cognitive function. Cuevas et al. [10] differentiate

from the other studies in this literary review because it addresses how CGM is used as a behavior modification tool not just in the self-management of blood glucose but how blood glucose can affect cognitive function. The study was conducted among 30 participants with T2DM for at least two years and age 65 years and older. The study collected data from three sources: online questionnaires, CGM reports, and semi-structured interviews [10]. Quantitative results were placed in mean percentages where hyperglycemia was at 39% and perceived cognitive function 36.86%. These quantitative results were triangulated with the qualitative results [10]. The qualitative results regarding CGM use were significant in improving the self-management of diabetes. Cuevas et al. [10] states participants cited the use of CGM allowed them to monitor blood glucose more closely, make better food choices, have less fear of hypoglycemia when engaging in physical activity, and feelings of comfort and security. Some participants also noted the ease of use of CGM and preference over constant finger stick checks [10]. Another qualitative result demonstrated that participants with dissatisfaction with cognitive function had higher levels of glucose variability [10]. This mixed-method study, despite its small sample size demonstrated positive behavior change for T2DM management and the correlation of glucose variability and association with perceived memory.

CGM vs SGM (standard glucose monitoring)

Diabetes requires a different approach for each person and daily management. Currently the gold standard for monitoring glycemic control long-term is hemoglobin A1C (HbA1C) [11]. There are different ways to monitor a patient's diabetes from daily fingerstick blood glucose readings (BG) to using a continuous glucose monitor (CGM) and treatment differs between type 1 and type 2 diabetic patients. Comparing CGM and the standard fingerstick glucose when using Pender's health promotion theory both of these focus on the patient's managing their health factors that if controlled can both make a positive change and start to influence better health behaviors. Many patients even when using insulin find it difficult to get to their HbA1C goals of <7.0% if these same patients had the CGM they could see a real-time glucose and could make decisions for their diabetes based on that real-time reading which is one fundamental focus on Pender's theory [12]. Using standard blood glucose monitoring can lead to having long periods between readings for a variety of reasons such as: the patient might forget to check their glucose numbers, or during the overnight hours when patients can have hyper/hypoglycemia, or they might not want to check their glucose numbers in public because of the inconvenience [12].

HbA1C is vital to the management of a patient's diabetes plan and is used to monitor and lower the risk of developing complications from diabetes. Elevated HbA1C levels are seen in over half of diabetic patients, what this shows us as providers is that patients are not getting proper care or they might not be following their diabetes plan as ordered/taught. Al Hayek et al. [13] conducted a cross-sectional study that focused on exploring HbA1C and point of care (fingerstick glucose) compared to self-monitored/intermittent glucose monitoring devices. This study was conducted in Saudi Arabia with HbA1C and fingerstick glucose readings on day 30 and day 90, and the CGM downloaded glucose readings on days 28 and 90 as well as how many times they scanned per day with a study sample size of 81 total patients between the different groups [13]. Using the CGM it would eliminate the need for the patient to have multiple finger sticks each day which can be a reason for many patients to not be compliant with monitoring their glucose levels either because it hurts or it takes extra time during their day. For patients that have diabetes that are not well-controlled or labile that needs closer monitoring this study has shown that using CGM is an alternative method to the standard lab monitoring/fingerstick glucose monitoring [13]. This study also found that using CGM provides more detailed blood glucose data that are used to create better care plans for patients with uncontrolled blood glucose and patients on intensive insulin therapy [13]. Another finding is that point-of-care HbA1C levels are just as accurate compared to the standard laboratory HbA1C and it could be used for screening in the office setting when a result is needed [13].

The study by Bergenstal et al., [11] showed that using a CGM and a strict blood glucose monitoring showed lower HbA1C results and longer times with the patient in the target glucose range. Another finding that differed from the rest of the studies was that Bergenstal et al., [11], found that even in the CGM group not having a good training on how to make self-care adjustments based on the glucose readings can be an obstacle that needs to be addressed when implementing a CGM.

Basal Insulin Use Only and CGM Use

CGM has been studied for patients with type 1 diabetes and intensive insulin therapy (basal and prandial) but its use has not been well studied with patients with type 2 diabetes using basal insulin therapy [5]. The study done by Martens et al. [5] was a randomized control trial with 175 participants that could be using basal insulin 1-2 times daily with other antidiabetic medication (no prandial insulin) in 15 clinics across the US that wanted to evaluate if using CGM was effective in comparison to blood glucose monitoring. Over the 8 months, the goals of the study were to monitor HbA1C levels and to see if using CGM would provide patients with the ability to stay in a glucose range of 70-180 mg/dL more than fingerstick blood glucose monitoring [5]. The statistical results from the study were that at baseline the CGM group the A1C was 9.1% and the blood glucose monitoring was 9.0%, after the 8 months the CGM group's HbA1C is 8.0% and the blood glucose group was 8.4% [5]. This had a larger improvement in the CGM's HbA1C level over the group that did the standard blood glucose monitoring as well as the CGM group had a high level of satisfaction with using this technology [5]. Even with the decrease in the CGM HbA1C level the end result was still over 8.0% which is still elevated and could mean the patient would need additional medication management to get their HbA1C lower [5]. This study can be applied in practice for patients that need closer glucose monitoring because of a high HbA1C and taking both oral anti-glycemic medications and basal insulin. These patients would still benefit from using the CGM with the possibility of needing to add prandial insulin if they are not meeting their HbA1C goals.

Another study on treating patients with CGM that are on basal insulin is Bao et al. [12], the difference is that the focus of this study was on adults older than 65 compared to see if CGM was effective as in the younger/middle adults (<65 years old). One of the obstacles in using CGM with this specific population is that the Centers for Medicare and Medicaid Services (CMS) is an example of a provider that has restrictions for patients with the diagnosis of T2DM for payment coverage for this technology [12]. This trial had 175 participants with 42 being over 65 years of age and 133 being in the under 65-year-old age group. This could be a weakness in the interpretation of the results of this study if they wanted to focus on the effectiveness of CGM in the older adult age group [12]. Similarly, to the study done by Martens, Bao et al. [12] found that there was a greater decrease in the A1C levels of the group that used the CGM monitor compared to the standard blood glucose monitoring. One finding that was specific for Bao et al. [12] was the use of CGM resulted in a greater decrease in HbA1C levels among the group over age 65 when compared to the under 65 age group. Their glucose range stayed between 70-180mg/dL and had overall less time with their blood glucose over 180mg/dL. The older population of diabetic patients start to have more comorbidities because diabetes puts them at greater risk for vascular complications if they do not get better control of their blood glucose numbers. Bao et al. [12], suggested that this data should be used to help both healthcare providers and CMS to show the efficacy and safety of using CGM in patients over age 65 and that they show similar benefits to patients younger than 65.

Intensive Insulin Therapy and CMG Use

According to Beck et al. [14], insulin use is more in patients with T2DM than compared to T1DM with less research being done on the use of CGM in this population using more insulin who has a greater risk of hyper/hypoglycemia readings. This study was done in a similar fashion to the other trials by having a group of 170 participants that were divided into 2 different groups one being the control group and using standard fingerstick blood glucose monitoring 4 times a day and the other group having CGM with each group having had lab HbA1C drawn at 4, 12, and 24 weeks during the study [14]. This study found that at the 12-week mark both groups had a drop in the HbA1C level. Between weeks 12 to 24 both of the groups had a slight increase in the HbA1C levels but overall, the CGM group had a larger drop in their HbA1C levels as compared to the control group [14]. This data could be interpreted that the study did not have a high level of compliance towards the end of the study with participants managing their blood glucose levels. The researchers stated that the trial had good compliance and even with the slight increase in the HbA1C in the last 12 weeks the group using CGM had more glucose readings in the target range with fewer hyperglycemia readings than the control group [14].

The second study looking at intensive insulin therapy focuses on both T2DM and T1DM using CGM compared to point-of-care capillary glucose testing in the hospital setting [15]. This study differed from Beck et al. [14] by the setting of the patients and that the CGM was linked to the computer so the nurses were able to access the continuous readings from the monitors [15]. One outcome was that the use of CGM and point-of-care glucose monitoring had similar improvements in the patient's blood glucose readings but the use of the CGM was better for monitoring for glucose readings trending up or down [15]. This would allow healthcare professionals to monitor and prevent hyperglycemia and hypoglycemia events allowing for a safe alternative to the standard of point-of-care capillary glucose readings done every day in hospitals [15].

Challenges to CGM

There are challenges to CGM despite several advantages to using CGM for diabetes management. These challenges range from user preferences, to education, and implementation of CGM. Pender's nursing theory can be applied to recognizing challenges incorporating CGM to address changes that will benefit health promoting behaviors.

One of the most prominent challenges with CGM is the barriers and associated factors of implementing CGM. Modzelewski et al. [16] conducted a retrospective cohort study of 271 patients with diabetes who received either a CGM prescription or durable medical equipment request from clinicians at an endocrine clinic during a three-year period. Results showed that obtaining CGM through pharmacy benefits was an average of 78 days, which is faster than the durable medical equipment companies taking an average of 152 days [16]. Of the 63 participants that did not start CGM, 93.6% did not start because of cost/insurance coverage, 4.8% did not like wearing the device, and 1.6% did not want something attached to their body [16]. Patients who stopped using CGM, 61.5% stopped because of cost. Further results of the study revealed 70% of the prescribed CGM users were private health insurance carriers [16]. Delays of CGM initiation ranged from paperwork issues with blood glucose logs, HbA1c results, clinical notes, and proving medical necessity. This reflects Kruger and Anderson [17] article citing the rationale of eligibility criteria for Centers of Medicare and Medicaid Services (CMS) is unclear and requires extensive documentation from clinicians and hospital staff. Kruger and Anderson [17] also state how a compounding problem of CMS is the lack of clarification regarding medical necessity when submitting CGM for durable medical equipment. CMS health plans vary extensively on eligibility criteria, which also add to the many obstacles to prescribing CGM and many busy clinics, are unable to comply with the requirements. Cuevas et al. [10] study concurs with the other studies stating that even when CGM is covered by CMS the eligibility and cost are still prohibitive to some individuals. CGM is still mostly an out-of-pocket expense despite the recommendation of its use by the American Diabetes Association.

Bergenstal et al. [11] study also recognize another barrier to implementing CGM and how it can strain clinics because of the workflow alterations for data downloads to import CGM into electronic medical record systems. Clinics incorporating CGM need to provide patients with education on how to use the technology and analyze glucose fluctuations. Beck et al. [14] recognize

the challenges of educating T2DM because when compared to T1DM they lack the knowledge for diabetic management such as knowledge of carb counting, appropriate correction timing, and insulin sensitivity factors.

Other barriers of CGM use are based on the individual's preferences. Cuevas et al. [10] had 35% of participants who complained of skin irritation from adhesive and 23% of participants complained of sensor discomfort. In Modzelewski et al. [16] study 7.7% stopped CGM because of discomfort, lack of trust, difficulty to get working, and sensors falling off. Even with the challenges in implementing CGM, there are still more benefits to its use. Diabetes is a worldwide epidemic and there is compelling evidence that CGM is effective for diabetes management and has the potential to improve patients with diabetic outcomes.

Discussion

Life Styles

CGM provides real-time feedback of glucose and response to diet, cognitive function, and activity. The real-time results and visualization of glucose levels provide more motivation to make lifestyle changes such as diet, exercise, sleep, and stress. The results of the research studies all showed positive behavior changes in prediabetics and T2DM in the groups using CGM. Cuevas et al. [10] conducted a qualitative study and participants cited the use of CGM allowed them to monitor blood glucose more closely, make better food choices, less fear of hypoglycemia when engaging in physical activity, and have feelings of comfort and security. Results of studies helped to identify glucose dysregulation even among non-diabetics and help to improve blood glucose levels. Dehghani Zahedani et al. [9] study showed improved blood glucose levels with CGM use, with results of 22.7% improvement for T2DM and 23.2% for non-diabetic individuals. Cuevas et al. [10] study utilized CGM to assess cognitive function and showed that participants with dissatisfaction with cognitive function had higher levels of glucose variability.

CGM vs SGM

When looking at the comparison between CGM and the standard fingerstick glucose or point-of-care testing all of the studies reviewed during the literature review showed that the patients' glucose readings and their HbA1C levels were lower in the CGM sample groups. Al Hayek et al. [13], found that using point-of-care HbA1C levels were also shown to correlate with the laboratory results and that the use of CGM provided patients with more personalized glycemia information that provided more data for their diabetes plan. CGM use provides patients with a higher level of satisfaction of being able to manage their glucose levels, helping providers to promote for their patients to have more autonomy over their care. One of the major results in the studies reviewed for this section is that the CGM provided a greater decrease in a patient's HbA1C levels. In elderly patients over the age of 65, the CGM provided better glycemic control and lowered the risk of hypoglycemic events [12].

Challenges of CGM

The largest challenge of implementing CGM is the lack of insurance coverage and the difficulty of the approval process with CMS requirements. Delays and inconsistencies of billing as a pharmaceutical or DME with correlating insurance coverage become a significant barrier for clinicians and patients. Implementing CGM has workflow challenges of providing proper chart note documentation to insurance entities and incorporating the data technology into the clinical setting. A small portion of the participants complained of skin irritation, sensor discomfort, or issues with the sensor falling off. Beck et al. [14] also identifies the challenge of lack of education with T2DM compared with T1DM, noting an additional educational component that would be needed for CGM initiation.

Implications for Practice for Nurses and Health Care Providers

Pender's nursing theory was founded on the role of nurses and their influence of health promotion. Nurse and health care providers have more of an influence of promoting health because of the responsibilities in the management of patient care with diagnosing and prescribing medications. Diabetes is a disease that affects the whole body and is so endemic in our healthcare system that all health care providers encounter patients with diabetes. CGM is a beneficial resource for management of T2DM and prevention of the progression of glucose dysregulation. The data from CGM on patient populations with prediabetes and T2DM can be used as a motivational tool for lifestyle changes, improve provider management, and prevent hypoglycemic events. The main challenge of CGM implementation is insurance coverage, most CGM for prediabetics and T2DM is from out-of-pocket expenses [17]. Nurse practitioners should advocate for CGM to insurance providers. This can be done by establishing evidence-based practice (EBP) and conducting more randomized research studies of larger size, and longitudinal duration. There is evidence correlating CGM with overall decreased health cost as a preventative tool of the progression of diabetes complications and hospitalizations.

Incorporating CGM data into the primary care clinic is reliant on the feasibility of the technology and the ability of interpreting the data [18]. Adapting technology into clinical practice can be difficult but planning and knowing the steps can help providers give better care for their diabetic patients that use a CGM.

Conclusions

This systematic literature review focused on an increasingly larger patient population of individuals being diagnosed with both prediabetes and T2DM and how both healthcare providers and nurses can make a change. The use of CGM has been proven beneficial in prediabetics, labile T2DM patients, and patients that are at risk of hypoglycemia. Lifestyle changes in both T2DM and prediabetic patients are just as important for an intervention in the management of elevated glucose levels as with pharmacologic treatments. CGM use showed that patients using this technology benefit by having lower HbA1C levels but even with the decrease many of the patients do not meet the standard American Diabetes Association of an HbA1C goal of <7% [14]. However, most of

the studies were short in duration and more evidence would be needed to establish that over a longer period of time if CGM would show more benefit of decreasing HbA1C levels. Even though many patients did not meet the ADA's goal for an HbA1C level <7%, using CGM provided real-time glucose monitoring which impacted decisions for better daily lifestyle changes such as diet and exercise. Insurance coverage can be challenging but CGM can decrease the cost of hospital admission and all-cause morbidity and mortality from diabetes. Clinicians and insurance providers should look into prioritizing accessibility with use/coverage of the CGM; because of the proven benefits of impacting lifestyle changes, lowering HbA1C levels, and fewer hypoglycemic episodes. Diabetes management is impacted by an individual's actions; CGM is a health promotion tool and is a reflection of Pender's theory of individual behaviors affecting their health. After reviewing the literature, nurses should be advocating CGM use among prediabetics and T2DM as a health promotion tool for diabetes management and prevention of the progression of this epidemic disease.

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