ORIGINAL RESEARCH

Continuous Glucose Monitoring vs Fingerstick Monitoring for Hemoglobin A_{1c} Control in Veterans

Kelsey Floerchinger, PharmD[a]; Kelley Oehlke, PharmD, BCACP[a]; Scott Bebensee, PharmD, BCPS[a]; Austin Hansen, PharmD[a]; Kelsey Oye, PharmD, BCACP, CDCES[a]

Background: Patients with diabetes have traditionally been required to use fingerstick testing to self-monitor their glucose levels. However, continuous glucose monitors (CGMs) collect glucose readings throughout the day and display daily trends, which allow clinicians to individualize treatment to achieve hemoglobin A_{1c} (HbA_{1c}) goals and simplify medication regimens. While studies have shown that CGMs improve HbA_{1c} levels compared to fingerstick testing, this research has focused on type 1 diabetes and excluded veterans and patients on insulin therapy.
Methods: This retrospective chart review used a crossover, self-controlled design conducted at the Veterans Affairs Sioux Falls Health Care System. Veterans with an active CGM prescription were included. The primary endpoint compared the change in HbA_{1c} before and after initiation of a CGM.
Results: The mean baseline HbA_{1c} for the 150 veterans included in this study was 8.6%. The change in HbA_{1c} before CGM use was 0.003 and change in HbA_{1c} after CGM use was −0.971. The primary endpoint of difference in HbA_{1c} associated with CGM use was −0.969 (P = .0001). The overall mean change in total daily doses of insulin was −22 units. Subgroup analysis of change in HbA_{1c} after CGM use by prescriber type was −0.97 for endocrinology, −0.7 for pharmacy, and −1.23 for primary care practitioners. The overall average HbA_{1c} post-CGM use was similar across all prescriber types at 7.64%.
Conclusions: This study found veterans with type 2 diabetes and on insulin therapy demonstrated a significant reduction in HbA_{1c} with CGM use compared with their baseline fingerstick monitoring. Use of a CGM may be beneficial in patients who require a reduction in HbA_{1c} by allowing more precise adjustments to medications to optimize therapy.

In the United States, 1 in 4 veterans lives with type 2 diabetes mellitus (T2DM), double the rate of the general population.[1] Medications are important for the treatment of T2DM and preventing complications that may develop if not properly managed. Common classes of medications for diabetes include biguanides, sodium-glucose cotransporter-2 (SGLT-2) inhibitors, glucagon-like peptide-1 (GLP-1) receptor agonists, dipeptidyl peptidase-4 inhibitors, thiazolidinediones, sulfonylureas, and insulin. The selection of treatment depends on patient-specific factors including hemoglobin A_{1c} (HbA_{1c}) goal, potential effects on weight, risk of hypoglycemia, and comorbidities such as atherosclerotic cardiovascular disease, heart failure, or chronic kidney disease.[2]

HbA_{1c} level reflects the mean blood glucose over the previous 3 months and serves as an indication of diabetes control. In patients with diabetes, it is recommended that HbA_{1c} is checked ≥ 2 times annually for those meeting treatment goals, or more often if the patient needs to adjust medications to reach their HbA_{1c} goal. The goal HbA_{1c} level for most adults with diabetes is < 7%.[3] This target can be adjusted based on age, comorbidities, or other patient factors. It is generally recommended that frequent glucose monitoring is not needed for patients with T2DM who are only taking oral agents and/or noninsulin injectables. However, for those on insulin regimens, it is advised to monitor glucose closely, with even more frequent testing for those with an intensive insulin regimen.[3]

Most patients with diabetes use fingerstick testing to self-monitor their blood glucose. However, continuous glucose monitors (CGMs) are becoming widely available and offer a solution to those who do not have the ability to check their glucose multiple times a day and throughout the night. The American Diabetes Association recommends that the frequency and timing of blood glucose monitoring, or the consideration of CGM use, should be based on the specific needs and goals of each patient.[3] Guidelines also encourage those on intensive insulin regimens to check glucose levels when fasting, before and after meals, prior to exercise, and when hypoglycemia or hyperglycemia is suspected. Frequent testing can become a burden for patients, whereas once a CGM sensor is placed, it can be worn for 10 to 14 days. CGMs are also capable of transmitting glucose readings every 1 to 15 minutes to a receiver or mobile phone, allowing for further adaptability to a patient's lifestyle.[3]

Author affiliations can be found at the end of this article.
Correspondence: Kelsey Floerchinger (kflo369@gmail.com)

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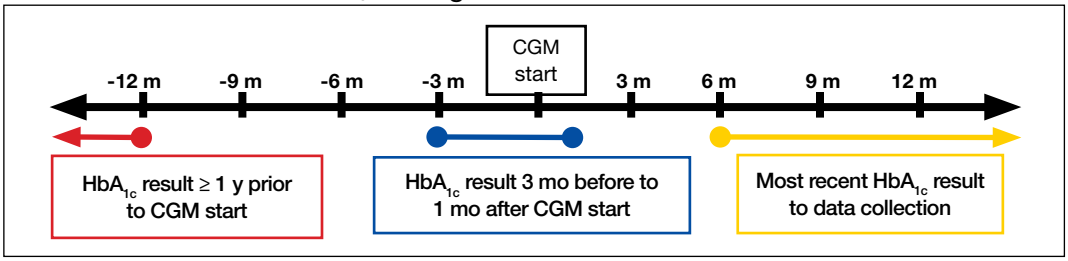
FIGURE 1. Timeline of HbA_{1c} Testing



Abbreviations: CGM, continuous glucose monitor; HbA_{1c}, hemoglobin A_{1c}.

TABLE 1. Baseline Characteristics (N = 150)

Characteristic	Results
Age, mean (SD), y	69.5 (9.7)
Sex, No. (%)	
Male	142 (94.7)
Female	8 (5.3)
Race, White, No. (%)	134 (89.3)
Medications, No. (%)	
Insulin	150 (100)
Sodium-glucose cotransporter 2-inhibitors	28 (18.7)
Glucagon-like peptide-1 inhibitors	17 (11.3)
Biguanides	70 (46.7)
Dipeptidyl peptidase-4 inhibitors	11 (7.3)
Thiazolidinediones	6 (4.0)
Sulfonylureas	4 (2.7)

CGMs work by measuring the interstitial glucose with a small filament sensor and have demonstrated accuracy when compared to blood glucose readings. The ability of a CGM to accurately reflect HbA_{1c} levels is a potential benefit, reducing the need for frequent testing to determine whether patients have achieved glycemic control.[4] Another benefit of a CGM is the ease of sharing data; patient accounts can be linked with a health care site, allowing clinicians to access glucose data even if the patient is not able to be seen in clinic. This allows health care practitioners (HCPs) to more efficiently tailor medications and optimize regimens based on patient-specific data that was not available by fingerstick testing alone.

Vigersky and colleagues provided one of the few studies on the long-term effects of CGM in patients managing T2DM through diet and exercise alone, oral medications, or basal insulin and found significant improvement in HbA_{1c} after only 3 months of CGM use.[5]

An important aspect of CGM use is the ability to alert the patient to low blood glucose readings, which can be dangerous for those unaware of hypoglycemia. Many studies have investigated the association between CGM use and acute metabolic events, demonstrating the potential for CGMs to prevent these emergencies. Karter and colleagues found a reduction in emergency department visits and hospitalizations for hypoglycemia associated with the use of CGMs in patients with type 1 DM (T1DM) and T2DM.[6]

There have been few studies on the use of CGM in veterans. Langford and colleagues found a reduction of HbA_{1c} among veterans with T2DM using CGMs. However, > 50% of the patients in the study were not receiving insulin therapy, which currently is a US Department of Veterans Affairs (VA) CGM criteria for use.[7] While current studies provide evidence that supports improvement in HbA_{1c} levels with the use of CGMs, data are lacking for veterans with T2DM taking insulin. There is also minimal research that indicates which patients should be offered a CGM. The objective of this study was to evaluate glycemic control in veterans with T2DM on insulin using a CGM who were previously monitoring blood glucose with fingerstick testing. Secondary endpoints were explored to identify subgroups that may benefit from a CGM and other potential advantages of CGMs.

METHODS

This was a retrospective study of veterans who transitioned from fingerstick testing to CGM for glucose monitoring. Each veteran served as their own control to limit confounding variables when comparing HbA_{1c} levels. Veterans with an active or suspended CGM order were identified by reviewing outpatient prescription data. All data collection and analysis were done within the Veterans Affairs Sioux Falls Health Care System.

The primary objective of this study was to

TABLE 2. Mean HbA_{1c} Level by Prescriber Type (N = 150)

Criteria	No. (%)	Baseline	Following CGM	
		Mean HbA_{1c} levels, %	Mean HbA_{1c} level, %	Change in HbA_{1c} level, %
All prescribers		8.61	7.64	−0.97
Endocrinology	80 (53.3)	8.60	7.63	−0.97
Primary care	36 (24.0)	8.84	7.61	−1.23
Pharmacy	34 (22.7)	8.39	7.69	−0.70

Abbreviations: CGM, continuous glucose monitor; HbA_{1c}, hemoglobin A_{1c}.

assess glycemic control from the use of a CGM by evaluating the change in HbA_{1c} after transitioning to a CGM compared to the change in HbA_{1c} with standard fingerstick monitoring. Three HbA_{1c} values were collected for each veteran: before starting CGM, at initiation, and following CGM initiation (Figure 1). CGM start date was the date the CGM prescription order was placed. The pre-CGM HbA_{1c} level was ≥ 1 year prior to the CGM start date or the HbA_{1c} closest to 1 year. The start CGM HbA_{1c} level was within 3 months before or 1 month after the CGM start date. The post-CGM HbA_{1c} level was the most recent time of data collection and at least 6 months after CGM initiation. The change in HbA_{1c} from fingerstick glucose monitoring was the difference between the pre-CGM and start CGM values. The change in HbA_{1c} from use of a CGM was the difference between start CGM and post-CGM values, which were compared to determine HbA_{1c} reduction from CGM use.

This study also explored secondary outcomes including changes in HbA_{1c} by prescriber type, differences in HbA_{1c} reduction based on age, and changes in diabetes medications, including total daily insulin doses. For secondary outcomes, diabetes medication information and the total daily dose of insulin were gathered at the start of CGM use and at the time of data collection. The most recent CGM order prescribed was also collected.

Veterans were included if they were aged ≥ 18 years, had an active order for a CGM, T2DM diagnosis, an insulin prescription, and previously used test strips for glucose monitoring. Patients with T1DM, those who accessed CGMs or care in the community, and patients without HbA_{1c} values pre-CGM, were excluded.

Statistical Analysis

The primary endpoint of change in HbA_{1c} level before and after CGM use was compared using a paired *t* test. A 0.5% change in HbA_{1c} was considered clinically significant, as suggested in other studies.[8,9] $P < .05$ was considered statistically significant. Analysis for continuous baseline characteristics, including age and total daily insulin, were reported as mean values. Nominal characteristics including sex, race, diabetes medications, and prescriber type are reported as percentages.

RESULTS

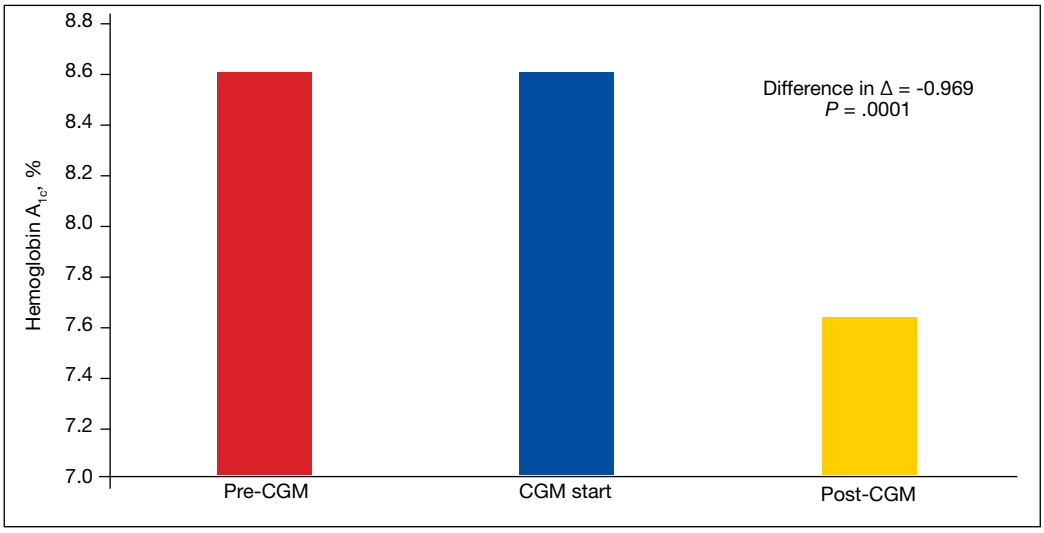
A total of 402 veterans were identified with an active CGM at the time of initial data collection in January 2024 and 175 met inclusion criteria. Sixty patients were excluded due to diabetes managed through a community HCP, 38 had T1DM, and 129 lacked HbA_{1c} within all specified time periods. The 175 veterans were randomized, and 150 were selected to perform a chart review for data collection. The mean age was 70 years, most were male and identified as White (Table 1). The majority of patients were managed by endocrinology (53.3%), followed by primary care (24.0%), and pharmacy (22.7%) (Table 2). The mean baseline HbA_{1c} was 8.6%.

The difference in HbA_{1c} before and after use of CGM was -0.97% ($P = .0001$). Prior to use of a CGM the change in HbA_{1c} was minimal, with an increase of 0.003% with the use of self-monitoring glucose. After use of a CGM, HbA_{1c} decreased by 0.971%. This reduction in HbA_{1c} would also be considered clinically significant as the change was > 0.5%. The mean pre-, at start, and post-CGM HbA_{1c} levels were 8.6%, 8.6%, and 7.6%, respectively (Figure 2). Pharmacy prescribers had a 0.7% reduction in HbA_{1c} post-CGM, the least of all prescribers. While most age groups saw a reduction in HbA_{1c}, those aged ≥ 80 years had an increase of 0.18% (Table 3). There was an overall mean reduction in insulin of 22 units, which was similar between all prescribers.

DISCUSSION

The primary endpoint of difference in change of HbA_{1c} before and after CGM use was found to be statistically and clinically significant, with a

FIGURE 2. Mean Change in Hemoglobin A_{1c} Level With CGM Use



Abbreviation: CGM, continuous glucose monitor.

nearly 1% reduction in HbA_{1c}, which was similar to the reduction found by Vigersky and colleagues.[5] Across all prescribers, post-CGM HbA_{1c} levels were similar; however, patients with CGM prescribed by pharmacists had the smallest change in HbA_{1c}. VA pharmacists primarily assess veterans taking insulin who have HbA_{1c} levels that are below the goal with the aim of decreasing insulin to reduce the risk of hypoglycemia, which could result in increased HbA_{1c} levels. This may also explain the observed increase in post-CGM HbA_{1c} levels in patients aged ≥ 80 years. Patients under the care of pharmacists also had baseline mean HbA_{1c} levels that were lower than primary care and endocrinology prescribers and were closer to their HbA_{1c} goal at baseline, which likely was reflected in the smaller reduction in post-CGM HbA_{1c} level.

While there was a decrease in HbA_{1c} levels with CGM use, there were also changes to medications during this timeframe that also may have impacted HbA_{1c} levels. The most common diabetes medications started during CGM use were GLP-1 agonists and SGLT2-inhibitors. Additionally, there was a reduction in the total daily dose of insulin in the study population. These results demonstrate the potential benefits of CGMs for prescribers who take advantage of the CGM glucose data available to assist with medication adjustments. Another consideration for differences in changes of HbA_{1c} among prescriber types is the opportunity for more frequent follow-up visits with pharmacy or endocrinology compared with primary care. If veterans are followed more closely, it may be associated with improved HbA_{1c} control. Further research investigating changes in HbA_{1c} levels based on follow-up frequency may be useful.

Strengths and Limitations

The crossover design was a strength of this study. This design reduced confounding variables by having veterans serve as their own controls. In addition, the collection of multiple secondary outcomes adds to the knowledge base for future studies. This study focused on a unique population of veterans with T2DM who were taking insulin, an area that previously had very little data available to determine the benefits of CGM use.

Although the use of a CGM showed statistical significance in lowering HbA_{1c}, many veterans were started on new diabetes medication during the period of CGM use, which also likely contributed to the reduction in HbA_{1c} and may have confounded the results. The study was limited by its small population size due to time constraints of chart reviews and the limited generalizability of results outside of the VA system. The majority of patients were from a single site, male and identified as White, which may not be reflective of other VA and community health care systems. It was also noted that the time from the initiation of CGM use to the most recent HbA_{1c} level varied from 6 months to several years. Additionally, veterans managed by community-based HCPs with complex diabetes cases were excluded.

TABLE 3. Change in Hemoglobin A_{1c} By Age Group

Age group	Change relative to continuous glucose monitor initiation	
	Hemoglobin A_{1c} before, %	Hemoglobin A_{1c} after, %
< 60 y	+ 0.27	– 1.07
60-69 y	+ 0.04	– 1.37
70-79 y	+ 0.80	– 0.89
≥ 80 y	– 0.90	+ 0.18

CONCLUSIONS

This study demonstrated a clinically and statistically significant reduction in HbA_{1c} with the use of a CGM compared to fingerstick monitoring in veterans with T2DM who were being treated with insulin. The change in post-CGM HbA_{1c} levels across prescribers was similar. In the subgroup analysis of change in HbA_{1c} among age groups, there was a lower HbA_{1c} reduction in individuals aged ≥ 80 years. The results from this study support the idea that CGM use may be beneficial for patients who require a reduction in HbA_{1c} by allowing more precise adjustments to medications and optimization of therapy, as well as the potential to reduce insulin requirements, which is especially valuable in the older adult veteran population.

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Author affiliations

[a]Veterans Affairs Sioux Falls Health Care System, South Dakota

Author disclosures

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Ethics and consent

This study was approved by The University of South Dakota Institutional Review Board as well as the Veterans Affairs Sioux Falls Research and Development Committee.

References

1. US Department of Veterans Affairs. VA supports veterans who have type 2 diabetes. VA News. Accessed September 30, 2024. https://news.va.gov/107579/va-supports-veterans-who-have-type-2-diabetes/
2. ElSayed NA, Aleppo G, Aroda VR, et al. 9. Pharmacologic approaches to glycemic treatment: standards of care in diabetes-2023. *Diabetes Care*. 2023;46(Suppl 1):S140-S157. doi:10.2337/dc23-S009
3. ElSayed NA, Aleppo G, Aroda VR, et al. 6. Glycemic targets: standards of care in diabetes-2023. *Diabetes Care*. 2023;46(Suppl 1):S97-S110. doi:10.2337/dc23-S006
4. Miller E, Gavin JR, Kruger DF, Brunton SA. Continuous glucose monitoring: optimizing diabetes care: executive summary. *Clin Diabetes.* 2022;40(4):394-398. doi:10.2337/cd22-0043
5. Vigersky RA, Fonda SJ, Chellappa M, Walker MS, Ehrhardt NM. Short- and long-term effects of real-time continuous glucose monitoring in patients with type 2 diabetes. *Diabetes Care*. 2012;35(1):32-38. doi:10.2337/dc11-1438
6. Karter AJ, Parker MM, Moffet HH, Gilliam LK, Dlott R. Association of real-time continuous glucose monitoring with glycemic control and acute metabolic events among patients with insulin-treated diabetes. *JAMA*. 2021;325(22):2273-2284. doi:10.1001/JAMA.2021.6530
7. Langford SN, Lane M, Karounos D. Continuous blood glucose monitoring outcomes in veterans with type 2 diabetes. *Fed Pract*. 2021;38(Suppl 4):S14-S17. doi:10.12788/fp.0189
8. Radin MS. Pitfalls in hemoglobin A1c measurement: when results may be misleading. *J Gen Intern Med*. 2014;29(2):388-394. doi:10.1007/s11606-013-2595-x.
9. Little RR, Rohlfing CL, Sacks DB; National Glycohemoglobin Standardization Program (NGSP) steering committee. Status of hemoglobin A1c measurement and goals for improvement: from chaos to order for improving diabetes care. *Clin Chem*. 2011;57(2):205-214. doi:10.1373/clinchem.2010.148841