Continuous Glucose Monitoring in Primary Care: Understanding and Supporting Clinicians' Use to Enhance Diabetes Care

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ABSTRACT

PURPOSE Diabetes affects approximately 34 million Americans and many do not achieve glycemic targets. Continuous glucose monitoring (CGM) is associated with improved health outcomes for patients with diabetes. Most adults with diabetes receive care for their diabetes in primary care practices, where uptake of CGM is unclear.

METHODS We used a cross-sectional web-based survey to assess CGM prescribing behaviors and resource needs among primary care clinicians across the United States. We used descriptive statistics and multivariable regression to identify characteristics associated with prescribing behaviors, openness to prescribing CGM, and to understand resources needed to support use of CGM in primary care.

RESULTS Clinicians located more than 40 miles from the nearest endocrinologist's office were more likely to have prescribed CGM and reported greater likelihood to prescribe CGM in the future than those located within 10 miles of an endocrinologist. Clinicians who served more Medicare patients reported favorable attitudes toward future prescribing and higher confidence using CGM to manage diabetes than clinicians with lower Medicare patient volume. The most-needed resources to support CGM use in primary care were consultation on insurance issues and CGM training.

CONCLUSIONS Primary care clinicians are interested in using CGM for patients with diabetes, but many lack the resources to implement use of this diabetes technology. Use of CGM can be supported with education in the form of workshops and consultation on insurance issues targeted toward residents, recent graduates, and practices without a nearby endocrinologist. Continued expansion of Medicare and Medicaid coverage for CGM can also support CGM use in primary care.

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INTRODUCTION

Diabetes affects approximately 34 million Americans, with 1.5 million Americans diagnosed every year.[1] Despite treatment advances, many patients with diabetes do not achieve glycemic targets.[2] Rapidly advancing diabetes technologies have the potential to address this gap. Continuous glucose monitoring (CGM) provides patients with clear readings and visualization of glucose levels which helps with diet and insulin dose decisions, and alerts them to hypoglycemia and hyperglycemia.[3,4]

Benefits of CGM

Continuous glucose monitoring is associated with improved health behaviors and outcomes, such as reductions in glycated hemoglobin (HbA_{1c}), hypoglycemia, body weight, and caloric intake, and increases in physical activity, treatment satisfaction, and adherence to a personal eating plan.[5-15] Use of CGM results in 0.4% to 0.6% greater reduction in HbA_{1c} compared to self-monitoring of blood glucose.[5,14] Sensor technology in GGM is inserted subcutaneously to measure interstitial glucose levels continuously, reducing or eliminating fingerstick glucose checks. Though CGM was first used primarily for patients with type 1 diabetes (T1D), growing evidence demonstrates potential value of CGM for patients with type 2 diabetes (T2D).[6-11,13,14,16-25]

Some patients and clinicians have concerns that CGM data may be overwhelming. However, CGM users report lower levels of information overload than nonusers

imagine.[26] Cost presents a barrier to CGM use for many patients,[27,28] but insurance coverage has expanded in recent years.[29,30] Patients may develop a rash to the adhesive, but use of wipes or bandages can improve this issue.[31,32]

Standard of Care

As CGM system accuracy, reliability, and evidence have increased, the American Diabetes Association (ADA) has expanded its Standards of Medical Care in Diabetes to recommend CGM more broadly each year since 2018. These standards first recommended CGM for people with T1D, who are all treated with intensive insulin therapy.[33] As of 2022, ADA standards include CGM for people with any form of diabetes and a variety of insulin regimens, and even for some people with T2D on non-insulin regimens.[34-38] Endocrine Society Clinical Practice Guidelines and the American Association of Clinical Endocrinology recommend CGM to help people with diabetes achieve glycemic targets.[39,40]

Although HbA_{1c} remains important, CGM metrics (eg, time-in-range), have been recognized by professional associations such as the National Committee on Quality Assurance, ADA, and Association of Diabetes Care & Education Specialists as important indicators for diabetes management and are being integrated into clinical care.[40-42]

Primary Care Use of CGM

The field of endocrinology has embraced CGM,[39,40] but most patients with diabetes do not receive their diabetes care from an endocrinologist. This is consequential for the approximately 90% of US patients whose diabetes is managed in primary care settings.[43] Subspecialty care is more difficult to access than primary care, especially in rural areas.[44] Of US counties, 75% have no endocrinologists, while primary care is available in 96% of US counties.[45] Where endocrinology is accessible, many patients endure long delays in obtaining appointments. Not all patients have the resources to seek such subspecialty care.[44] Prior to this study, CGM uptake in primary care had not been assessed. If there is a disparity in CGM use between endocrinology and primary care practices, this would represent a substantial disparity in access to diabetes treatment and management.

Study Overview

This study used a national online survey of primary care physicians and advanced practice clinicians to measure CGM prescription and awareness, and to explore factors associated with past and future CGM prescribing, clinician confidence using CGM to manage T1D and T2D, and resources to support prescribing CGM in primary care. We examined the following research questions: (1) What characteristics are associated with CGM prescribing? (2) What characteristics are associated with likelihood of future CGM prescribing? (3) What characteristics are associated with clinician confidence in using CGM to manage T1D and T2D? (4) What resources are needed to increase likelihood of prescribing CGM?

METHODS

This was a cross-sectional quantitative study using a web-based survey. It was determined exempt from human subjects review by the Colorado Multiple Institutional Review Board.

Survey Instrument

We developed a survey to assess barriers, facilitators, and current practices related to CGM among primary care clinicians (Supplemental Appendix). The survey inquired about professional background (professional role, medical specialty, years since training completion, and experience with CGM), practice characteristics (setting, payer mix, and access to diabetes education resources), and information sources used to learn about diabetes. Respondents were presented a visual display to briefly explain CGM. This explanation was intentionally placed after assessing experience with CGM to avoid influencing responses. Questions regarding likelihood and confidence to prescribe CGM were placed after the CGM description to ensure all respondents had a similar baseline understanding of CGM before indicating their likelihood to use it. Respondents rated confidence in their ability to perform clinical tasks for T1D and T2D using a 4-point scale. Tasks included prioritizing patients for CGM, providing CGM counseling and education, analyzing and interpreting CGM data, and making treatment adjustments using those data. Respondents rated likelihood to prescribe CGM for each of 7 assistive resources. They also rated the effectiveness of information channels for helping them learn.

Survey Recruitment & Administration

We recruited participants in collaboration with several practice-based research networks across the United States: the American Academy of Family Physicians (AAFP) National Research Network,[46] Meta-network Learning and Research Center,[47] State Networks of Colorado Ambulatory Practices and Partners,[48] and Wyoming Community and Practice-Based Research Network.[49] Recruitment channels were selected for maximum variation in geographic representation, practice setting, and medical specialty. Primary care physicians (medical doctor, doctor of osteopathy), including residents, and advanced practice clinicians (physician assistant, nurse practitioner) practicing at the time of survey were eligible to participate. Each network utilized an anonymous, network-specific distribution link to conduct survey recruitment via e-mail. A maximum of 3 contacts were made, including survey invitations and follow-up reminders. Eligible respondents were offered a $50 gift card upon survey completion. Surveys were collected from February through November 2020 using Qualtrics web-based software (Qualtrics International Inc).

Analysis

Summary statistics were calculated for each survey item. State was determined by practice ZIP code. States were categorized into US Census regions for reporting.[50]

Relationships between respondent characteristics and CGM prescribing behaviors and likelihood of future prescribing were examined using multivariable logistic regression. For all analyses, independent variables were categorical or binary to allow for non-linear associations with outcome variables. We categorized level of experience with CGM into ever or never prescribed as the outcome variable to analyze predictors of CGM prescribing. We dichotomized likelihood to prescribe CGM in the future as moderately/very likely vs not at all/somewhat likely to assess predictors of future prescribing.

Consistent with recommended model-building strategies,[51] variables were screened for inclusion in multivariable models at $P < .25$. Screening variables were respondent role, primary setting, full- or part-time employment, percent of time spent delivering primary care, years since training, distance from nearest endocrinologist, and payer mix. We also controlled for past prescribing when assessing predictors of future prescribing and confidence, given high correlation between these variables. To achieve final models, the variable with the highest P value was excluded at each step until all P values were below .15.[51] Statistical significance was defined as $P < .05$.

The analysis dataset was limited to respondents who could prescribe (attending physician, resident, nurse practitioner, or physician assistant) and were clinically active (not retired or unemployed). Responses with missing predictor variables were excluded from final multivariable models. No adjustments were made for multiple testing since this was primarily exploratory or occurred as part of screening variables for inclusion in multivariable models.

We used descriptive statistics (frequencies) to assess resources needed to support CGM prescribing.

All analyses were performed using SAS software version 9.4 (SAS Institute Inc).

RESULTS

Survey Respondents

Six hundred fifty-six respondents completed the survey. We excluded 24 ineligible respondents for a final analysis dataset of 632 respondents. Most respondents were attending, faculty, or community physicians. The majority specialized in family medicine. The most common practice settings were federally qualified health center or similar, hospital-owned practice, and private practice. About one-half of respondents practiced in the Western region of the United States, though 51 US states, districts, or territories were represented (Table 1).

Survey Results

Nearly one-half (46.6%) had seen patients with a CGM but never prescribed CGM. Nearly two-fifths (38.6%) had ever prescribed a CGM device. Just 1.0% had never heard of CGM. Most (89.5%) were at least somewhat likely to prescribe CGM in the future (Table 1).

Characteristics and CGM Prescribing

Professional role, part-time employment, greater percentage of time spent delivering primary care, and greater distance from endocrinologist were significantly associated with ever having prescribed CGM after adjusting for covariates. Residents (odds ratio [OR] = 0.30, $P < .001$) and advanced practice clinicians (OR = 0.36, $P < .001$) were significantly less likely to have prescribed CGM than non-resident physicians. Respondents located 40 miles or more from an endocrinologist were twice as likely to have prescribed CGM than those with an endocrinologist within 10 miles (OR = 1.94, $P = .026$). Part-time clinicians were less likely than full-time clinicians to have experience prescribing CGM (OR = 0.55, $P = .04$). Similarly, respondents who spent less than 75% of their professional time delivering primary care were less likely to have prescribed CGM than those who spent 75% or more time delivering primary care (OR = 0.60, $P = .03$) (Table 2).

Likelihood of Future CGM Prescribing

Previous CGM prescribing and higher proportion of Medicare-covered patients were significantly associated with greater likelihood of future CGM prescribing. Respondents with experience prescribing CGM reported 7 times greater likelihood to prescribe in the future than those who had not prescribed in the past (OR = 7.44, $P < .001$). Working in a practice with more than one-half of patients covered by Medicare predicted significantly greater likelihood to prescribe in the future than having 25% or fewer Medicare-covered patients (OR = 2.67, $P = .004$) (Table 3).

Confidence in Using CGM to Manage T1D and T2D

Previous CGM prescribing, years since training, and payer mix were significantly related to greater confidence using CGM to manage diabetes. Past CGM prescription experience significantly ($P < .001$) predicted confidence using CGM to manage T1D and T2D. Working in a practice site with more than 50% of patients on Medicare was significantly ($P < .01$) related to greater clinician confidence using CGM to manage T1D and T2D compared with those in practices with 25% or less patients on Medicare. Having 16 or more years since training was significantly related to greater confidence using CGM to manage T2D ($P = .01$), compared to those with fewer years since training (Supplemental Table 1).

Resources Needed to Increase CGM Prescribing

Most respondents indicated that they would be moderately or very likely to prescribe CGM with CGM education training/workshops (72.3%) or consultation on insurance issues (72.0%) (Table 1). The majority turn to the AAFP (91.6%), UpToDate (80.4%), ADA (68.4%), and continuing medical education (59.3%) for resources and information. Respondents reported conferences and meetings to be most effective for learning (Supplemental Table 2).

DISCUSSION

Continuous glucose monitoring is rapidly becoming standard of care for patients with diabetes managed with insulin, and evidence supports expanded use for more patients with diabetes.[33-35,37,38] Continuous glucose monitoring is associated with improvement in clinical, psychosocial, and behavioral outcomes.[3,5-14,16-25] Most patients with diabetes are managed in primary care.[43] It is important to know how to support CGM prescribing in these settings. This study is the first to identify factors associated with prescribing CGM in primary care practices and resources desired to help primary care clinicians prescribe CGM. This study's national sample and variation in respondents support generalizability across US primary care.

Over one-third of primary care clinicians in the study had prescribed CGM and nearly two-thirds reported being moderately or very likely to prescribe CGM in the future. Additionally, nearly three-quarters reported being moderately or very likely to prescribe with added resources such as CGM workshops or consultation on insurance issues. These findings indicate that primary care clinicians are open to using CGM to help their patients with diabetes, but they need resources and support. Past experience prescribing CGM was strongly associated with favorability toward prescribing CGM in the future. This suggests that once primary care physicians and advanced practice clinicians overcome the challenge of learning to prescribe and use CGM to manage diabetes, they are likely to continue doing it. When located farther from

Table 1. Sample Characteristics

Respondent Characteristic	No. (%)
Professional role (n = 642)	
Attending, faculty or community physician	460 (71.7)
Resident	122 (19.0)
PA or NP	50 (7.8)
Other	10 (1.6)
Medical specialty (n = 519)	
Family medicine	495 (95.4)
Other[a]	24 (4.6)
Primary setting (n = 607)	
FQHC or similar	165 (27.2)
Hospital-owned practice	161 (26.5)
Private practice	134 (22.1)
Academic medical center	83 (13.7)
Other	64 (10.5)
Years since training (n = 626)	
0	73 (11.7)
1-5	130 (20.8)
6-10	153 (24.4)
11-15	109 (17.4)
16-20	28 (4.5)
>20	104 (16.6)
NA	29 (4.6)
Payer mix	
>25% of patients have Medicare (n = 610)	403 (66.0)
>25% of patients have Medicaid (n = 609)	318 (52.2)
>25% of patients have private insurance (n = 609)	341 (55.9)
>25% of patients have no insurance (n = 590)	77 (13.0)
Practice region (n = 632)	
West	317 (50.1)
South	141 (22.2)
Midwest	107 (17.0)
Northeast	64 (10.2)
US Territory	3 (0.5)
Miles from endocrinologist (n = 614)	
≤10	405 (66.0)
11-40	102 (16.6)
>40	107 (17.4)
Diabetes care & education resource access	
Diabetes care and education specialist within practice (at least part-time) (n = 614)	221 (36.0)
Can refer to diabetes care and education specialist within 10 miles (n = 612)	498 (81.4)
Can refer to other diabetes education resources within 10 miles (n = 613)	454 (74.1)
Experience with CGM (n = 629)	
I have never heard of CGM	6 (1.0)
I have heard of CGM, but I have never had patients on it	87 (13.8)
I have had patients on CGM, but I have never prescribed it	293 (46.6)
I have prescribed a CGM	243 (38.6)
Likelihood to prescribe CGM (n = 603)	
Not at all likely	40 (6.6)
Somewhat likely	187 (31.0)
Moderately likely	168 (27.9)
Very likely	208 (34.5)
Moderately/very likely to prescribe CGM with access to resources	
Consultation on insurance issues (n = 603)	434 (72.0)
CGM education/training workshop (n = 603)	436 (72.3)
One-time consult with endocrinologist (n = 602)	380 (63.1)
Virtual specialty care center to refer patients for direct support (n = 602)	379 (63.0)
Educational website about CGM (n = 603)	375 (62.2)
Telementoring sessions with specialty team (n = 603)	372 (61.7)
Asynchronous e-consultations with an endocrinologist (n = 604)	324 (53.6)

CGM = continuous glucose monitoring; FQHC = federally qualified health center; NA = not applicable; NP = nurse practitioner; PA = physician assistant.

[a] General internal medicine, internal medicine-pediatrics, pediatrics.

Table 2. Respondent and Practice Characteristics and CGM Prescribing (N = 570)

Characteristic	OR (95% CI)	*P* Value
Respondent role		<.001
Physician	Ref.	
Resident	0.30 (0.16-0.58)	
PA or NP	0.36 (0.16-0.77)	
Primary setting		.13
Private practice	Ref.	
Academic medical center	1.42 (0.73-2.76)	
FQHC/similar	0.88 (0.50-1.53)	
Hospital-owned	1.39 (0.84-2.29)	
Other	1.82 (0.93-3.57)	
Employment		.04
Full-time or resident	Ref.	
Part-time	0.55 (0.30-0.98)	
Time primary care, %		.03
≥75	Ref.	
<75	0.60 (0.37-0.96)	
Miles from endocrinologist		.03
≤10	Ref.	
11-40	0.95 (0.58-1.53)	
>40	1.94 (1.17-3.21)	

CGM = continuous glucose monitoring; FQHC = federally qualified health center; NP = nurse practitioner; PA = physician assistant.

Note: C-statistic = 0.688. Years since training and payer mix did not meet threshold for inclusion in final model.

Table 3. Respondent and Practice Characteristics and Future Likelihood to Prescribe CGM (N = 570)

Characteristic	OR (95% CI)	*P* Value
Previously prescribed CGM	7.44 (4.80-11.53)	<.001
Miles from endocrinologist		.17
≤10	Ref.	
11-40	0.76 (0.46-1.25)	
>40	1.43 (0.83-2.46)	
Patients with medicare, %		.004
≤25	Ref.	
26-50	1.37 (0.89-2.10)	
>50	2.67 (1.50-4.78)	
Patients with medicaid, %		.08
≤25	Ref.	
26-50	0.63 (0.41-0.98)	
>50	1.04 (0.62-1.75)	

CGM = continuous glucose monitoring.

Note: C-statistic = 0.756. Respondent role, primary setting, part or full-time employment, years since training, percent of patients using private insurance, and percent of patients with no insurance did not meet threshold for inclusion in final model.

an endocrinologist, primary care clinicians are more likely to prescribe CGM. This aligns with the integrated, whole-person care approach intrinsic to primary care.

One of the most desired resources was assistance with insurance coverage, which aligns with concerns about cost as a barrier to CGM use.[27,28] This study was conducted prior to Medicare's 2021 expansion of CGM coverage, which eliminated the requirement of blood glucose checks (previously, at least 4 blood glucose tests per day were required for CGM to be covered).[52,53] Having a higher proportion of Medicare patients was associated with increased confidence in CGM-related tasks for both T1D and T2D. Medicaid CGM coverage varies by state, by diabetes type, and by age, but is steadily increasing. Primary care clinicians may be unaware of best practices or resources needed to obtain CGM approval for their patients with diabetes. As we identified, additional resources to address insurance barriers are likely to increase CGM use in primary care, and thus, reduce the extent to which cost presents a barrier.

Additionally, this study identified training in CGM as a resource to support increased use in primary care practices. The AAFP was identified as a top resource. The AAFP's Transformation In Practice Series online educational module on CGM[54] is designed to help clinicians and teams learn how to identify patients who would quality for and benefit from CGM, develop shared decision-making plans for those patients, and use CGM data to inform treatment. Given the prevalence of respondents who turn to the AAFP for information about diabetes, this may be a valuable tool to address this training need.

Limitations

This is a cross-sectional study and no conclusions about causation can be determined. Response rate could not be calculated as survey recruitment utilized anonymous links distributed to e-mail lists with an unknown number of recipients. This survey did not assess barriers to prescribing, and the resources needed to increase likelihood to prescribe may not address all of the factors that hinder CGM prescription in primary care. Finally, the invitation to participate described the purpose as better understanding factors related to CGM, so respondents may have had greater interest in CGM than non-respondents, potentially introducing nonresponse bias. This would be more likely to lead to an overestimate of CGM interest, and to an overestimate of CGM experience, which was relatively low at 38.6%.

CONCLUSIONS

More patients with diabetes could benefit from CGM if it was prescribed more in primary care. Expanded use can be supported with education targeted to residents, recent graduates, and practices without a nearby endocrinologist. Findings show workshops and consultation on insurance issues would be useful for primary care clinicians. Continued expansion of Medicare and Medicaid coverage for CGM could also support more widespread prescription in primary care.

Future mixed methods research will use qualitative findings to illustrate and expand upon clinicians' barriers and facilitators to CGM use in primary care and resources needed to support CGM for primary care patients with diabetes. Further work should identify ways to increase access to CGM for all patients with diabetes who may benefit from this technology to assure that insurance coverage, geography, and other barriers do not exacerbate disparities. Additional work is needed to better understand best practices for implementing CGM into varied primary care practices and models and to evaluate the resulting impact on clinical, psychosocial, and behavioral outcomes.

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Key words: primary care; type 1 diabetes; type 2 diabetes; wearable electronic devices

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Supplemental materials

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