

Use of Continuous Glucose Monitoring as an Educational Tool in the Primary Care Setting

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The prevalence of diabetes has increased dramatically world-wide in the past 30 years because of an increase in life expectancy, urbanization, changing population demographics, and increasing rates of obesity and physical inactivity.¹⁻³ The disease is considered a world-wide epidemic and major chronic health problem.^{3,4} According to the International Diabetes Federation, the United States has 23.7 million people with diabetes (27.7% of whom are undetected), and undiagnosed cases are responsible for an additional \$18 billion in annual health care costs.

Diabetes is recognized as a silent disease, and in 70% of patients with type 2 diabetes, cardiovascular problems and coronary disease are the main cause of death.^{5,6} Improvements in blood pressure, lipids, and blood glucose management reduce the risk of diabetes-related micro- and macrovascular disease,⁷⁻⁹ with a potential legacy effect as demonstrated with the U.K. Prospective Diabetes Study, which showed a reduced incidence of myocardial infarction in the intensively treated group after 10 years of follow-up.¹⁰

Long-term complications are preventable with a multi-interventional strategy addressing blood glucose, blood pressure, and lipid management.¹¹ Nevertheless, many patients experience difficulty achieving recommended care goals using the current approach.

Multiple options for diabetes treatment are available for patients, including diet and exercise regimens and 11 different drug classes. Several strategies are required for better management of diabetes, includ-

ing factors pertinent to patients, care providers, and the health care system, all of which affect the quality of diabetes care. Diabetes educators can support these care strategies by performing services such as counseling, medication management, monitoring of disease control and progression through self-monitoring of blood glucose (SMBG) results, and screening for microvascular complications, all of which can influence the delivery of health care to patients with diabetes.¹²

To evaluate the risk of diabetes complications, especially macrovascular complications, it may be necessary to consider not only patients' mean glycemic control, but also their mean amplitude of glycemic excursions such as postprandial glucose elevations.¹³ To assess daily blood glucose excursions, continuous glucose monitoring (CGM) and SMBG routinely record variations in blood glucose levels.^{14,15} CGM was developed to document patients' daily glucose profile in detail and can aid in identifying changes in blood glucose levels because it allows continuous recording over several days. CGM reports suggest that A1C levels are correlated with estimated average glucose values and also the extent of glucose fluctuations.¹⁶

The objective of this article is to share two case studies from our program that illustrate how CGM can be used in a primary care setting to help primary care providers (PCPs) and patients gain knowledge that is useful in facilitating care changes that can improve glycemic control in challenging clinical situations.

Background

The role of CGM in this setting is innovative in that PCPs are using the technology in coordination with diabetes educators for specific challenging clinical situations such as suspected nocturnal hypoglycemia and hypoglycemia related to increased activity, as well as for patients who are resistant to starting insulin and as a means of showing patients the relationship between their behaviors and elevated blood glucose readings. The purpose is to use CGM in patients with type 2 diabetes to reveal insights not possible through SMBG alone and to show patients the cause and effect of certain lifestyle behaviors.

The registered nurse certified diabetes educator (CDE) in our program sees patients at a HealthPartners Clinic in Maplewood, Minn., a clinic with ~ 720 known patients with diabetes. She is trained to use the iPro CGM, a blinded device (Medtronic Minimed, Northridge, Calif.). The CDE inserts the CGM sensor into a patient's subcutaneous tissue and teaches the patient how to use and calibrate the device. The patient uses the sensor for 3–5 days and is encouraged to keep a diary of food intake, type and duration of exercise, and medication taken for the period of the CGM study. Four to six days after sensor insertion, the patient returns to the clinic to talk with the CDE, who removes the sensor and connects the CGM device to a computer to download the glucose data. The results of the CGM are analyzed by both the PCP and the CDE, discussed collaboratively, and used cooperatively to educate the patient and to facilitate shared decision-making with patients on approaches to improve glycemic control.

Case Study 1

This case involves a 76-year-old man with type 2 diabetes of 10 years' duration. He takes extended-release glipizide, 5 mg in one pill daily; sitagliptin, 100 mg in one pill daily; and glargine insulin, 20 units subcutaneously at bedtime. He was checking blood glucose one or two times daily, usually in the morning, and all of his SMBG results were within his target range.

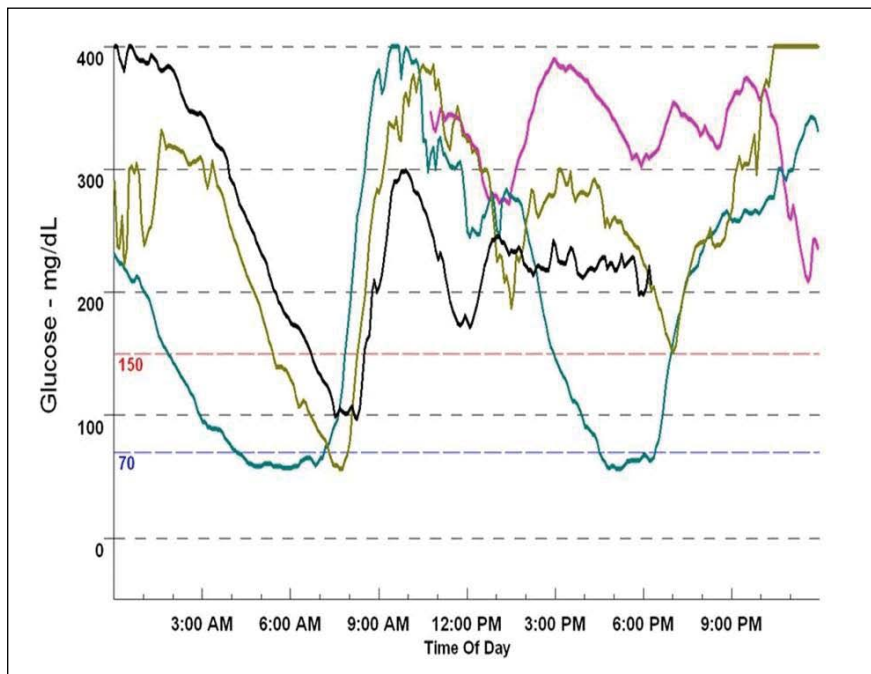


Figure 1. CGM trace from case study 1. Nocturnal hypoglycemia and elevated glucose levels after meals were demonstrated on 4 days of CGM. Different colors represent different days.

However, his A1C was 9.0%, and the PCP had increased his basal insulin dose despite the patient's objections that he was having frequent hypoglycemia and would wake up many times shaking in the middle of the night. The PCP felt that this patient could not be having significant hypoglycemia because there were no documented low SMBG results and his A1C was elevated at 9.0%.

The patient was referred for diabetes education and a 3-day blinded CGM study. The CGM results indicated that his blood glucose levels were dropping by 200 mg/dl every night, and he was experiencing blood glucose levels < 70 mg/dl. The patterns also revealed lower morning glucose levels with sustained elevated blood glucose after meals throughout the day.

The CDE reviewed and discussed the CGM results with the patient. Because the patient was checking his blood glucose only in the morning, he was surprised by the pattern of elevation after meals, the rise of his glucose level throughout the day, and the significant drop in blood glucose

values overnight related to his basal insulin and shown in Figure 1.

After the CGM study, the patient's basal insulin dose was decreased to 12 units and switched to mornings instead of bedtime, his glipizide was discontinued, and his sitagliptin was continued. He was started on 4 units of premeal rapid-acting insulin before supper because it is his biggest meal of the day, and he does not always eat breakfast or lunch.

After 3 months, the patient was free of hypoglycemia symptoms at night, and his A1C had dropped to 7.6%. He achieved his A1C target of < 8.0% (a less intense goal because of his history of comorbidities, including coronary heart disease and chronic kidney disease).

Case Study 2

This case involves a 62-year-old man with type 2 diabetes of 20 years' duration. He is currently managing his diabetes with metformin, 1,000 mg in one pill twice daily; glargine insulin, 26 units at night and 16 units in the morning; and rapid-acting bolus insulin, 3 units per carbohydrate choice (15 g of carbohydrate) before meals, and a

correction dose of 1 unit of rapid-acting insulin for every 25 mg/dl elevation in blood glucose above 150 mg/dl during the day and at night.

The patient has been checking his blood glucose before meals. His A1C is 9.8% and has never been in good control. From a glycemic control viewpoint, he says, “No one can figure me out.”

The patient was referred for diabetes education and blinded CGM. The CDE also instructed him on how to keep detailed records of the foods he eats, when he takes his medications, his activity level, and anything else he wants to share. His CGM results (Figure 2) showed that the patient was having frequent spikes in blood glucose levels by 100 mg/dl, with sustained high readings afterward.

A closer look at the patient’s records revealed that he was eating Salted Nut Roll candy bars as snacks between all of his meals and often before bed without using any rapid-acting insulin to cover their carbohydrate content. The patient thought that Salted Nut Rolls were just nuts and did not contain any carbohydrate. With the CGM results,

it was easy for him to see the blood glucose response he was having to the candy bars.

With the help of the CDE, the patient set a goal to substitute fruit or almonds as snacks and to limit Salted Nut Rolls to an occasional snack with some additional rapid-acting insulin coverage. His oral medication was continued, and his insulin-to-carbohydrate ratio was increased to 3.5 units of insulin per 15-g carbohydrate choice. He was also referred to the clinic dietitian for additional help with carbohydrate-counting skills.

The patient’s A1C target was < 7%. His A1C improved to 7.8% after 6 months, and through the increased education and support, he decided to begin using an insulin pump and was able to attain an A1C of 6.5% 6 months later.

Lessons Learned

Our diabetes health care team has learned that, with CGM data, it is possible to easily uncover discrepancies in glucose trends, verify patient medication adherence, and gain insight and understanding into a patient’s diet and activity. Although other methods could have identi-

fied these patient issues, CGM is an efficient tool to help patients readily understand the relationship between their behaviors (e.g., regarding diet, activity, and medications) and their glycemic control. In many situations, including the two case studies presented here, CGM helps both providers and patients to understand better why starting insulin (either basal or premeal) is necessary by giving them a clear and personalized visual image of the specific problem.

Much of type 2 diabetes treatment is founded on facilitative coaching and trying to convince patients to make lifestyle changes related to diet, activity, alcohol, stress, and other factors that directly affect their diabetes control. These case studies demonstrate the great potential for CGM as a shared decision-making tool for patients with type 2 diabetes in the primary care setting. The appropriate use of CGM in the primary care setting can help PCPs and patients efficiently identify and overcome barriers to improving care in challenging situations and can be useful in helping providers improve their diabetes performance measures.

The CGM/CDE referral process has been well received by PCPs for patients who are having difficulty achieving glycemic control targets. Clinical pharmacists trained in medical therapeutics management, who are helping to manage patients with diabetes, have also found it valuable to partner with the CDE to use CGM for similar reasons.

The clinic has ~ 720 identified patients with diabetes and is receiving referrals for two new patients per week for CGM exams. The CGM process is gaining recognition within the care system as an innovative means of helping patients with challenging situations achieve their diabetes care goals. Larger studies of CGM use by primary care teams may be warranted to further assess the potential benefits.

References

¹Bonadonna RC, Cucinotta D, Fedele D, Riccardi G, Tiengo A: The metabolic syndrome is a risk indicator of microvascular and macrovascular complications in diabetes:

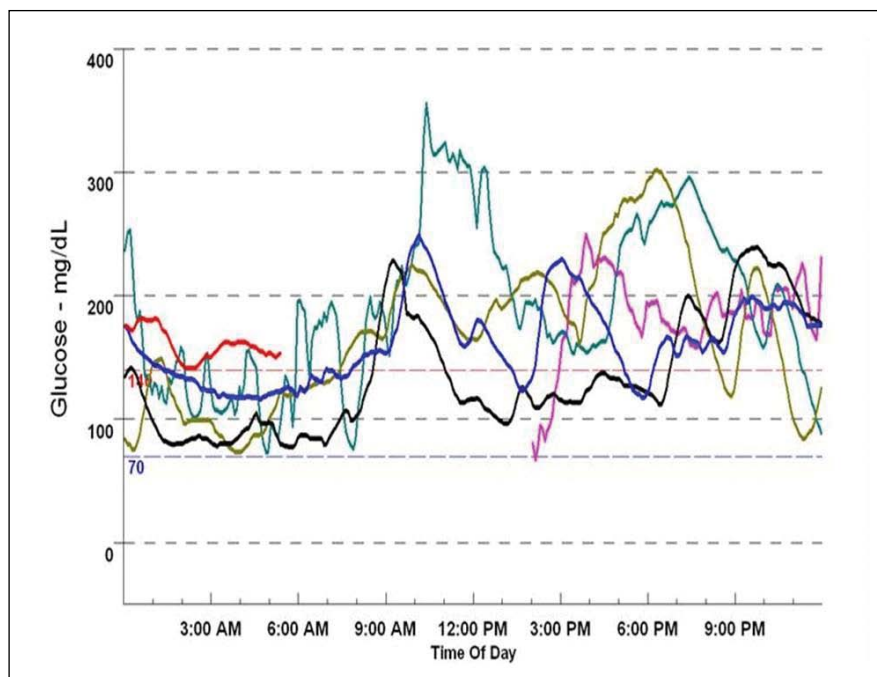


Figure 2. CGM trace for case study 2. High glucose excursions were observed after eating carbohydrate snacks without additional insulin boluses. Different colors represent different days.

results from Metascreen, a multicenter diabetes clinic-based survey. *Diabetes Care* 29:2701–2707, 2006

²Wild S, Roglic G, Green A, Sicree R, King H: Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care* 27:1047–1053, 2004

³International Diabetes Federation: *Diabetes Atlas 2011*. Brussels, Belgium, International Diabetes Federation, 2001. Available from www.idf.org/diabetesatlas. Accessed 4 September 2012

⁴Shamseddeen H, Getty JZ, Hamdallah IN, Ali MR: Epidemiology and economic impact of obesity and type 2 diabetes. *Surg Clin North Am* 91:1163–1172, 2011

⁵Nikolsky E, Holmes DR, Mehran R, Dargas G, Schampaert E, Morice MC, Schofer J, Sousa JE, Fahy M, Na Y, Donohoe DJ, Moses JW, Leon MB: Impact of platelet glycoprotein IIb/IIIa receptor inhibitors on outcomes of diabetic patients undergoing percutaneous coronary interventions using sirolimus-eluting stents. *Catheter Cardiovasc Interv* 71:896–906, 2008

⁶Campbell IW: Epidemiology and clinical presentation of type 2 diabetes. *Value Health* 3 (Suppl. 1):3–6, 2000

⁷UKPDS Study Group: Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* 352:837–853, 1998

⁸UKPDS Study Group: Tight blood pressure control and risk of macrovascular and microvascular complications in type 2 diabetes: UKPDS 38. *BMJ* 317:703–713, 1998

⁹DCCT Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med* 329:977–986, 1993

¹⁰Holman RR, Paul SK, Bethel MA, Matthews DR, Neil HA: 10-year follow-up of intensive glucose control in type 2 diabetes. *N Engl J Med* 359:1577–1589, 2008

¹¹Gaede P, Vedel P, Parving HH, Pedersen O: Intensified multifactorial intervention in patients with type 2 diabetes mellitus and microalbuminuria: the Steno type 2 randomised study. *Lancet* 353:617–622, 1999

¹²Barlow S, Crean J, Heizler A, Mulcahy K, Springer J: Diabetes educators: assessment of evolving practice. *Diabetes Educ* 31:359–372, 2005

¹³Temelkova-Kurktschiev TS, Koehler C, Henkel E, Leonhardt W, Fuecker K, Hanefeld M: Postchallenge plasma glucose and glycaemic spikes are more strongly associated with atherosclerosis than fasting glucose or HbA1c level. *Diabetes Care* 23:1830–1834, 2000

¹⁴Ferri S, Kojima K, Sode K: Review of glucose oxidases and glucose dehydrogenases: a bird's eye view of glucose sensing enzymes. *J Diabetes Sci Technol* 5:1068–1076, 2011

¹⁵Wagner J, Tennen H, Wolpert H: Continuous glucose monitoring: a review for behavioral researchers. *Psychosom Med* 74:356–365, 2012

¹⁶Nathan DM, Kuenen J, Borg R, Zheng H, Schoenfeld D, Heine RJ: Translating the A1C assay into estimated average glucose values. *Diabetes Care* 31:1473–1478, 2008

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