

Continuous Glucose Monitoring in a Patient With Insulin-Treated Type 2 Diabetes

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PRESENTATION

J.B. is a 45-year-old white man with a medical history notable for type 2 diabetes for 12 years, dyslipidemia, coronary artery disease (status post–myocardial infarction [MI] and left anterior descending [LAD] stent placement in 2004), chronic sinus disease, and sleep apnea. His current pharmacological regimen includes atorvastatin, 40 mg daily; ezetimibe, 10 mg daily; clopidogrel, 75 mg daily; ramipril, 2.5 mg daily; metoprolol, 100 mg daily; levocetirizine, 5 mg daily; montelukast, 10 mg daily; extended-release metformin, 2 g daily; pioglitazone, 30 mg daily; exenatide, 10 µg twice daily subcutaneously; glargine, 20 units at bedtime; aspart, 0–4 units with meals; and fluticasone propionate nasal spray, as needed. He does not smoke or drink alcohol. He is 5'7.5" tall and weighs 209 lb. His BMI is 32 kg/m².

J.B. was able to control his blood glucose levels quite well for 6 years on diet, exercise, and metformin. His A1C values during that time ranged from 5.1 to 6.6%. In 2004, he was admitted to the hospital with an acute anterior wall MI. A stent was subsequently deployed in an occluded mid-LAD artery. His post-MI course was uncomplicated. At the time of his MI, his A1C was 6%, and he weighed 178 lb.

Immediately after his MI, his blood glucose levels averaged 300 mg/dl. Basal and prandial insulin was initiated during his hospital stay. One month later, his A1C was

9.5%. He remained on aspart insulin at meals and glargine at bedtime for the next several months. His blood glucose began to improve, and he was switched to glimepiride, 8 mg; pioglitazone, 30 mg; and metformin, 2 g daily. His A1C continued to improve and remained in the 6–7% range for the next year.

A job change requiring travel resulted in less exercise and more eating in restaurants. He began to gain weight, and his blood glucose levels gradually increased. Exenatide, 10 µg twice daily, was added, followed by basal and prandial insulin. His weight continued to increase, and his insulin requirements increased significantly. His A1C increased to 10.8%.

For the next 4 years, J.B. remained on a combination of metformin, pioglitazone, exenatide, and basal and prandial insulin. His A1C values ranged from 7 to 8.9%. His weight ranged from 212 to 229 lb. He tested his blood glucose 2–3 times daily. He felt he could not establish a consistent exercise program and control his food and calorie intake. J.B. was frustrated with his inability to maintain weight and glycemic control.

In March 2011, his A1C was 8.9%. He expressed concern for his long-term health and a desire to explore other options to manage his diabetes. Both insulin pump therapy and continuous glucose monitoring (CGM) were discussed as options. We recommended that he wear a

7-day real-time (RT) CGM device diagnostically for 7 days.

QUESTIONS

1. Is there evidence that CGM can improve glycemic control in patients with type 2 diabetes?
2. Does RT-CGM offer an advantage over blinded CGM?
3. What are the issues with RT-CGM that need to be considered when using it in the patient with type 2 diabetes?
4. What contributions to improved control can RT-CGM can provide?

COMMENTARY

The first report¹ of the use of a transcutaneous continuous glucose sensor for 7 days in patients with type 1 or type 2 diabetes (80.2 and 19.8%, respectively) demonstrated that subjects with an A1C > 6% were, on average, hyperglycemic 24 hours/day. Use of RT-CGM allowed study subjects with higher A1C levels (e.g., those with an A1C > 10%) to achieve improvements at all hours of the day. Daytime use of RT-CGM identified problem behaviors and treatments that contributed to hyperglycemia. Accessing nighttime glucose values along with alerts/alarms gave patients the opportunity to treat glycemic excursions of which they would otherwise have been unaware. Feedback from nocturnal glucose values gave patients confidence to increase their nocturnal insulin doses.

Current testing regimens for most patients with type 2 diabetes may not promote an understanding of

their disease and the effects lifestyle behaviors have on glycemic control. Historically, patients with type 2 diabetes, particularly patients on diet or oral medications, test blood glucose levels much less frequently than patients with type 1 diabetes. Patients with type 2 diabetes may test 1–2 times per day and rarely during the night, compared to patients with type 1 diabetes, who test at least 4 times per day. Furthermore, many patients with type 2 diabetes lack a structured testing protocol (pre- and postmeal testing) and frequently test at the same time of day (e.g., fasting blood glucose [FBG] levels). Postprandial blood glucose levels often are not part of the testing regimen, and many patients do not understand how to adjust their insulin or oral medications based on the content of their meals.

A study by Monnier et al.² of patients with type 2 diabetes who were not taking insulin or acarbose showed that the relative contribution of postprandial glucose (PPG) levels predominated in fairly well-controlled diabetes, whereas the contribution of fasting hyperglycemia increased as diabetes worsened. Improving PPG levels also increases the likelihood of improving FPG levels and overall glycemic control.

Knowing and understanding the effects of diet, physical activity, and stress on blood glucose levels can have a substantial impact on glycemic control. Identifying the relationships among these variables as they occur can help shape patients' behaviors, particularly as they relate to food choices. Traditional discussions of weight loss, calorie reduction, exercise, low-glycemic-index foods, and blood glucose monitoring, even implemented intensively, often are not effective. A 52-week study³ found that RT-CGM improved glycemic control better than self-monitoring

of blood glucose (SMBG) in patients with type 2 diabetes who were not taking prandial insulin.

A recent, short-term (professional) blinded CGM study in a private practice setting⁴ found it ineffective for improving A1C levels in adult patients with either type 1 or type 2 diabetes. It has been our experience that the graphic displays of data provided through RT-CGM have a powerful effect on patients with either type 1 or type 2 diabetes.

Our practice (an American Diabetes Association–recognized urban private practice with three endocrinologists working alongside a registered dietitian/certified diabetes educator) has been using RT-CGM in patients with type 1 diabetes for the past 5 years. Two years ago, we began offering this diagnostic tool to patients with type 2 diabetes on oral medications or oral medications with a GLP-1 receptor agonist and/or insulin. We quickly became aware of the benefits of real-time immediate feedback regarding the glycemic effects of food and exercise and how that feedback can potentially change behavior in patients with type 2 diabetes regardless of their medication regimen. In one study,⁵ intermittent RT-CGM for 12 weeks significantly improved glycemic control in patients with type 2 diabetes who were not taking prandial insulin, both during and for up to 1 year after the intervention.

RT-CGM allows patients to measure and track their blood glucose levels and analyze personal data as they are being measured. Trending arrows, patterns, and alerts/alarms allow patients to become much more actively involved in their daily diabetes care and confident about their ability to control their blood glucose levels. Fear of hypoglycemia lessens, and patients are more willing to adjust and increase their medications. The results from a randomized, controlled, multicenter

study indicate that real-time access to continuous glucose measurements, coupled with alerts/alarms for high and low glucose values, significantly reduced glycemic variability.⁶ It has been our clinical experience that the real-time component of the technology provides potential value for many patients with type 1 or type 2 diabetes.

There is, however, a subset of patients who do not generally have any added benefit from CGM. These patients include those who already perform very frequent SMBG, those who lack a level of literacy required to use the data, and those with early type 2 diabetes that is well controlled with noninsulin regimens. There is also a subset of patients who are frustrated by the lag time between blood and tissue glucose levels, have calibration challenges, or inappropriately “chase” tissue glucose values that may result in frequent and wide swings in blood glucose.

The use of RT-CGM provided the feedback J.B. was hoping for. Enhanced understanding of the cause and effect of his behaviors and their relationship to blood glucose fluctuations was the kind of information that resonated with him. He opted to purchase a personal RT-CGM system.

J.B.'s glycemic control improved remarkably within a very short period of time after he acquired his personal RT-CGM. His A1C after 8 weeks was 7.6%. Within another 8 weeks, his A1C dropped to 6.8%. At his most recent office visit (in July 2012), his A1C was 6.4%. He had also lost 15 lb.

Before using RT-CGM, J.B. was using ~ 30 units of insulin with meals and 50 units of glargine at bedtime. He currently uses 0–4 units with meals and 20 units at bedtime. His blood glucose averages within a 24-hour period are 80–150 mg/dl. His sensor data demonstrate that

in a 24-hour day, < 3 hours are spent > 130 mg/dl, and < 6 hours are spent > 120 mg/dl. He has avoided hypoglycemia by using the trending arrows and alerts/alarms.

J.B. reports that he is much more confident in his ability to manage his diabetes. Of interest, he improved his skill at matching carbohydrates to insulin and his awareness of glycemic index values, which together has resulted in substantially better glucose control with less insulin. He is also more engaged and consistent with his exercise regimen after witnessing the beneficial effect of exercise on his blood glucose levels, particularly after eating.

CLINICAL PEARLS

- Allowing patients with type 2 diabetes to see their blood glucose levels in real time and understand the interrelated effects of diet, exercise, and stress on their blood glucose levels can have a major

positive effect on their glyce-mic control.

- Wearing an RT-CGM device can guide food choices and insulin doses as they relate to carbohydrates and the glycemic index of foods.
- Patients with longstanding type 2 diabetes may become more engaged and take ownership of their diabetes after wearing an RT-CGM device.

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Note of disclosure: Ms. Joyce has served as a paid speaker for DexCom, which manufactures RT-CGM devices.

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