Using Professional Continuous Glucose Monitoring to Modify Eating Behavior in Patient on 'Heart Healthy' Diet

Howard Wolpert, MD

Senior Physician, Joslin Diabetes Center, and Assistant Professor, Harvard Medical School, Boston, Massachusetts, US

Abstract
Diabetes management is often complex and requires the involvement of various team members and technology for behavior change and successful outcomes. This paper shows how one provider utilized a team approach and the use of professional continuous glucose monitoring to help this patient identify needed behavior change to improve outcomes.

Keywords
Type 2 diabetes, professional continuous glucose monitoring, diabetes therapy management software

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Correspondence: Howard Wolpert, MD, Joslin Diabetes Center, 1 Joslin Place, Boston, MA 02215-5306, US. E: Howard.Wolpert@joslin.harvard.edu

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Professional continuous glucose monitoring (CGM) is an effective tool that helps identify glucose variability in patients with diabetes. Minute-by-minute variability is not revealed by glycated hemoglobin (HbA_{1c}) measurements and is often missed by fingersticks. The result is that patients are unaware of their individual glucose variability and how their daily activities (exercise, eating habits, and general lifestyle) affect their blood glucose and may put them at risk for short-term problems as well as long-term complications. Professional CGM continues to improve over time and provides data in formats that are easy to access, interpret, and share with patients. Providing this data to patients can assist them to modify behaviors and see successes in their management of this complex disease.

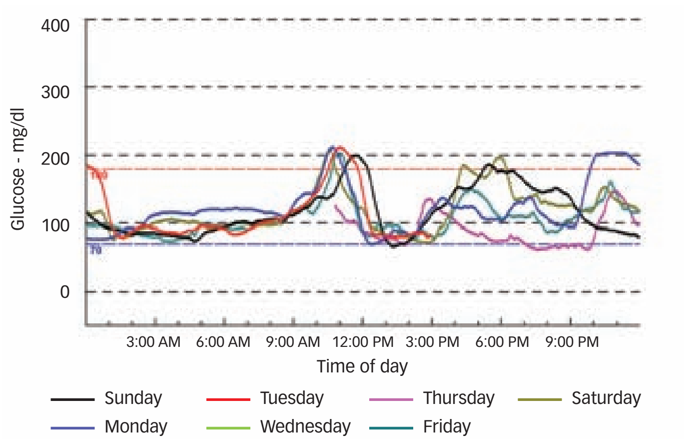
Case Study
Henry is a 67-year-old vice president of sales and marketing at a large telecommunications company. Diagnosed with type 2 diabetes 23 years ago, he has sought to keep his blood glucose, weight, and other cardiovascular risk factors in check through the following measures:

- using a basal-bolus insulin regimen:
  - bed time insulin glargine (20 units); and
  - pre-meal insulin lispro, dosed according to an Insulin:Carbohydrate ratio of 1:15 and correction factor of 50 (1 unit of insulin for every 50 mg/dl above his target blood glucose of 120 mg/dl).
- taking atorvastatin (10 mg) with low-dose aspirin (81 mg) daily;
- maintaining a 'heart-healthy' diet, containing large quantities of fruits and vegetables;
- checking his blood glucose every morning and evening; and
- walking 90 minutes per day.

Despite these healthy habits, Henry's HBA_{1c} is 8.2 %, higher than the widely accepted target of 7.0 %. At the same time, his self-monitoring of blood glucose (SMBG) logbook indicates pre-breakfast and pre-dinner average of 90–110 mg/dl, consistent with published guidelines.[1,2] The handwritten entries also reveal regular breakfasts of cold cereal with a banana each morning, followed by frequent 'pick-me-ups' of fruit throughout the day. Scanning the pages, the physician notes the lack of mid-day readings compared with other time periods. Henry explains that he often takes clients out for extended lunch meetings and feels uncomfortable checking his blood glucose in these situations. He adds that because carbohydrate counting is 'hit-or-miss' in restaurants, he deliberately restricts his orders to lean meats and vegetables. Furthermore, with lunch as his major meal of the day, his dinner often consists of a salad, with fat-free dressing, prepared after a 5-mile 'speed walk' every evening.

Recommendation
Commending Henry's generally healthy regimen of diet, exercise, and pharmacotherapy, the physician asks whether he would like to address his out-of-target HbA_{1c} level. Although this is a matter of some concern to Henry, he expresses doubt about the feasibility of changing his carefully structured routine. The physician suggests that a reasonable first step might be identifying and, if necessary, treating early post-meal hyperglycemia. To capture post-meal glucose values missed by twice-daily SMBG, he asks whether: Henry would consider a blood glucose check

Figure 1: Sensor Modal Day



Henry's initial professional continuous glucose monitoring Sensor Modal Day report reveals post-meal hyperglycemia, which is often missed by intermittent or pre-meal self-monitoring of blood glucose.

after a different meal each day for two weeks, while adding a pre-lunch check at least until the next visit. He suggests, too, that he cut back on his fruit intake since certain types, such as bananas and watermelons, have the potential to sharply raise blood glucose.[3] Henry nods and then, glancing at his smart phone, mentions that while he would certainly like to lower his HbA_{1c}, he feels generally healthy and can make no promises about increasing his SMBG during busy workdays.

Six-month Follow-up

When Henry returns six months later, his HbA_{1c} is still 8.2 %. Indeed, he has not been able to check his blood glucose more than before due to his demanding schedule, but again reports SMBG results of 'less than 110 most of the time.' Also, his fairly detailed food log continues to show numerous snacks of fruit. Henry's weight of 143 pounds (BMI 22.4) has not changed and both his medication and exercise regimens remain the same. The physician acknowledges the difficulty of frequent SMBG in Henry's situation and asks him if he would still like to address his out-of-target HbA_{1c}. When Henry replies that he would, he explains that short-term CGM, called professional CGM, used in conjunction with SMBG, might help identify 'hidden' post-meal hyperglycemia—that is, spikes that occur soon after eating and resolve prior to the subsequent pre-meal blood glucose check. Once recognized, these fluctuations could be proactively treated to bring Henry's HbA_{1c} level more in line with his SMBG results. Another advantage of professional CGM for Henry is that, unlike real-time personal CGM, it requires minimal training (see *Table 1*).[4] Nevertheless, he would need to wear the device for three days, monitor his blood glucose four times daily during this period, and keep careful food and activity records to maximize the data analysis. Henry expresses confidence in his ability to do this as long as it is for three days only. After receiving confirmation that Henry's insurance will cover the procedure, a staff member arranges for him to return to the office for device set-up and sensor insertion. He is instructed to maintain normal food, activity, and medication routines and to return with the sensor, recorder, and filled-in log sheets within a week.

Professional Continuous Glucose Monitoring Follow-up

For general guidelines for reviewing Professional CGM see *Table 2*.[5] *Figure 1* shows Henry's downloaded and printed-out Sensor Modal Day report. The report confirms that he experiences glucose excursions immediately following meals. His logbook (see *Figure 2*) indicates he had his usual 'heart-healthy' breakfast, containing 80–90 grams of carbohydrate, for which he dosed 4–5 units of lispro immediately prior to eating. Although this regimen produced glucose values from 80 to 90 mg/dl just before lunch, a marked glucose spike of 100 mg/dl

Figure 2: Sample Page from Henry's Logbook, Used in Conjunction with Professional Continuous Glucose Monitoring

Breakfast Time		Lunch Time		Dinner Time	
Food	Carb (grams)	Food	Carb grams	Food	Carb grams
Oatmeal		Steak		Soup (vegetable)	
Egg		Salad		Salad Mix	
1/2 Bread		Cola light			
Tea and Milk		Berry Mix			
Strawberry					

Table 1: Professional Continuous Glucose Monitoring

- Owned by healthcare professional, clinic, or hospital
- Minimal patient training/set-up time
- Worn temporarily (3 days) by patients when they are:
  - Not meeting HbA_{1c} goals
  - Have recurrent hypoglycemia/hypoglycemia unawareness
  - Pregnant
- Data not seen by patient in real time
- Reimbursement:
  - Subject to national and local payer policies for CGM
  - Current Procedural Terminology (CPT) codes 95250 for data collection and 95251 for interpretation
  - Cannot be billed more frequently than every 30 days
- Therapy management software (CareLink® iPro® Medtronic):
  - Accessible from clinician's computer only
  - Data downloaded and interpreted by clinician

CGM = continuous glucose monitoring; HbA_{1c} = glycated hemoglobin.
Source: Adapted from Blevins et al., 2010.[4]

Table 2: General Guidelines for Physicians when Looking at Professional Continuous Glucose Monitoring Therapy Management Software Reports with Patients

- Emphasize positives by noting strengths and improvements in control or behavior
- Identify patient's stated treatment goals and challenges, being mindful of common problem areas:
  - General: overtreating hypoglycemia, insulin stacking, timing of insulin delivery with respect to meals, meal composition, insulin sensitivity, hypoglycemia post-exercise, intentionally 'running high' during the night, infrequent self-monitoring of blood glucose
  - If using an insulin pump: suspending pump, overriding bolus calculator, need for combination bolus, entering incorrect carbohydrates to get desired dose of insulin, infusion site integrity
- Initiate actions, starting with the overnight period, moving to pre-prandial glucose levels, and then post-prandial data
- Identify and treat hypoglycemia first
- Focus on one or two behavior changes at a time

Source: Adapted from Rubin et al., 2011.[5]

occurred soon after breakfast. Normally missed by SMBG, this information causes Henry to take a closer look. He wonders aloud whether he should change his breakfast routine, prompting the physician to ask if he would like to meet with a registered dietitian to learn about the variables affecting post-meal glucose response. Henry requests an appointment the following week. The dietitian assures Henry that he has not done anything 'wrong' and that carbohydrate absorption is influenced by numerous factors, including the type of carbohydrate ingested, cooking method, ripeness, and the presence of protein or fat. In many cases, for example, combining carbohydrates with healthy fats, such as those contained in nuts, will slow down absorption.[6] She suggests that if Henry does not want to add healthy fats to his usual breakfast, he could try injecting lispro 15 to 30 minutes before eating, depending on his pre-breakfast glucose level, to better match insulin action to his carbohydrate metabolism.[7] She adds that certain foods, such as steel cut (unprocessed) oats and apples, have a lower glycemic index, i.e., they are metabolized more gradually, which may help mitigate post-meal hyperglycemia in some people. Henry accepts a list of common foods with their glycemic index values before ending the session.[3]

Upon returning to the physician's office six months later, the only change in Henry's generally good condition is a reduced HbA_{1C} of 7.5 %. Although still not monitoring his lunchtime blood glucose, Henry has adjusted his carbohydrate consumption and insulin lag time (the time between injecting insulin and eating) at breakfast. His log shows that most days he was eating a lower glycemic-index breakfast of two slices of 100 % whole-grain toast with two tablespoons natural peanut butter, and a small-to-medium apple or one cup of berries. On the few occasions he ate cold cereal for breakfast, he injected lispro 15 minutes beforehand. Sometimes, if he remembered, he administered lispro 15–20 minutes before eating high-glycemic index fruits in the evening. To confirm the effectiveness of this strategy, he requests another professional CGM study. This one reveals an average post-breakfast glucose rise of only 40 mg/dl resulting from his changed breakfast regimen. Encouraged by this progress, he tells the doctor he will think about applying his knowledge further to reduce hyperglycemia after his evening snack. ■

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