

# Utilizing CGM Ambulatory Glucose Profiles to Optimize Diabetes Management

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## CONTINUING MEDICAL EDUCATION

### LEARNING OBJECTIVES

At the end of the activity, participant will be able to:

- Identify patients who could benefit from continuous glucose monitoring (CGM) vs fingerstick blood glucose monitoring.
- List the types of information provided by CGM systems.
- Interpret CGM data using the ambulatory glucose profile (AGP) to assess if the patient is achieving targets established by the International Consensus on Time in Range.
- Modify the treatment plan based on CGM data to improve patient outcomes.

### KEY TAKEAWAYS

- Continuous glucose monitoring (CGM) overcomes some of the limitations of glycated hemoglobin and fingerstick self-monitoring of blood glucose.
- The standardized AGP and time in range have been established to serve as an actionable format for presenting and interpreting CGM data.
- For most healthy adults with type 1 or type 2 diabetes, the desired target for time in range is  $\geq 70\%$ .
- The AGP provides glycemic patterns that facilitate the identification of glucose variability, hyperglycemic episodes, and individuals at high hypoglycemic risk.
- The AGP is particularly useful for individuals treated with insulin, but benefits of CGM and AGP are not limited to individuals using insulin.
- The AGP provides an excellent opportunity for shared decision-making.

### TARGET AUDIENCE

Family physicians and clinicians who wish

to gain increased knowledge and greater competency regarding primary care management of diabetes.

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## BLOOD GLUCOSE MONITORING

The control of blood glucose at levels close to physiologic levels in humans is well established as conferring numerous benefits,

such as weight control and reduced risk for cardiovascular events.

The glycated hemoglobin level (A1c) has been widely used as a surrogate measure of glycemic control as it is

strongly predictive for diabetes complications.<sup>1,2</sup> However, the A1c has many limitations that preclude its use as the sole measure of glycemic control.<sup>3</sup> Among these is that the A1c is an aggregate measure of the blood glucose level over approximately 3 months,<sup>3</sup> with no indication of fluctuations in the blood glucose level, ie, glycemic variability. It is unreliable in anemia, renal failure, and pregnancy. In contrast, fingerstick self-monitoring of blood glucose (SMBG) provides a measure of the blood glucose level at the time testing is done. However, SMBG is subject to its own limitations, including user technique and the impractical demands of performing it multiple times a day every day. In addition, SMBG does not provide a clear picture as to glycemic variability or overall control.<sup>3-5</sup>

A third option for monitoring the blood glucose level is continuous glucose monitoring (CGM). CGM is recommended by the American Diabetes Association for individuals with diabetes on multiple daily injections and continuous subcutaneous insulin infusions and other forms of insulin therapy.<sup>4</sup> Other candidates for CGM include individuals with frequent hypoglycemia, hypoglycemia unawareness, or varying and/or intensive activity, as well as those who have a desire to improve glycemic control.<sup>6-8</sup>

## CONTINUOUS GLUCOSE MONITORING

### Benefits

The use and impact of CGM have been investigated in a wide variety of clinical trials involving individuals with type 1 diabetes (T1D) or type 2 diabetes (T2D). CGM overcomes many of the shortcomings observed with A1c and SMBG, with numerous real-world benefits shown in clinical studies (**TABLE 1**).<sup>9-16</sup> Of key importance is that CGM provides an early warning of high, low, and/or rapidly changing blood glucose levels, which allows for early intervention, thereby improving glycemic control and avoiding complications such as hypoglycemia. CGM has the added benefit of allowing an individual to observe a clear association between action (eg, exercise, eating) and consequence (eg, hypoglycemia, hyperglycemia), thereby enabling more appropriate adjustments in nonpharmacologic and pharmacologic treatment. In the author's experience, these benefits often help to increase patient engagement in disease management, reduce clinical inertia, reduce diabetes distress, and improve treatment adherence. To achieve the full benefits of CGM, patients and clinicians should no longer consider CGM as a different kind of glucose meter, but rather should view it as the retrospective and predictive tool that it is. Background information about CGM, including devices, may be found at <https://pro.aace.com/pdfs/diabetes/AACE-DRC-CGM-Slides.pdf>.

### Potential barriers

Patient education is vital for success with CGM devices and

**TABLE 1. Real-world benefits of continuous glucose monitoring<sup>9-16</sup>**

- Fewer episodes of hypoglycemia
- Reduced hospital admission for hypoglycemia and/or diabetic ketoacidosis
- Improved glycemic control
- More frequent insulin dose adjustments
- Better understanding of blood glucose level fluctuations
- Reduced treatment costs
- Fewer work absences
- Reduced treatment burden
- Increased patient satisfaction
- Reduced family worry

must be provided on a routine basis. Individuals with diabetes, as well as family members, must learn the fundamentals of sensor insertion, calibration, and setting of alerts and alarms. It is important that the individual be educated that fingerstick SMBG can still be used as a backup to CGM to measure the blood glucose level, eg, when a CGM result does not correlate with symptoms.

By providing hundreds of blood glucose readings per day, CGM devices generate an enormous amount of data internally, and interpretation of these data may seem challenging. To overcome this situation, the ambulatory glucose profile (AGP) was developed.

## AMBULATORY GLUCOSE PROFILE

The AGP is a software application that aggregates CGM data to statistically characterize glycemic exposure, variability, and stability. The time period of the report is determined by the user and can be as short as 2 days and as long as 90 days (depending on the CGM device). A 14-day report is considered adequate for pattern recognition and is generally viewed as being statistically similar to a 90-day report.<sup>17</sup> For billing, Medicare requires a minimum of 72 hours of data. For individuals with greater glycemic variability, exhibited by wide fluctuations or variability in the blood glucose level, eg, coefficient of variation >36%, longer CGM collection periods may be required.

To facilitate interpretation and shared decision-making, the AGP is presented visually as a modal day plot according to time as if the data points collected over 7, 10, or 14 days occurred over 24 hours (**FIGURE 1**). The AGP includes 3 key CGM measurements: time within target range (TIR), time above target range (TAR), and time below target range (TBR) (**FIGURE 2**).<sup>17</sup> Other helpful metrics include the average blood glucose, which is used to calculate the glucose management indicator (GMI), or approximate A1c level.

FIGURE 1. Ambulatory glucose profile

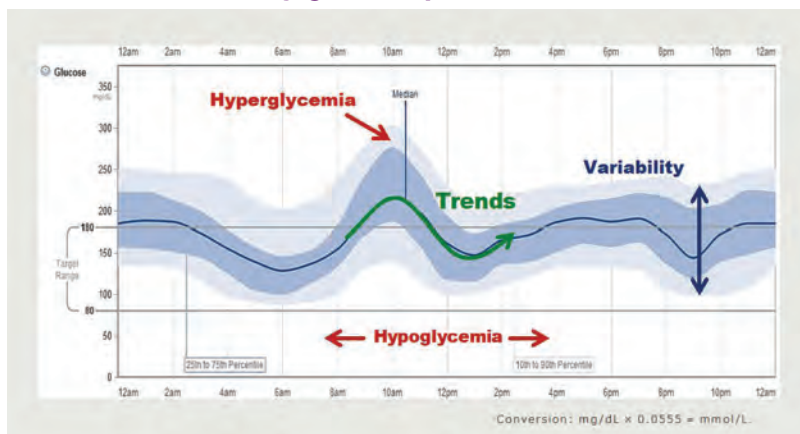
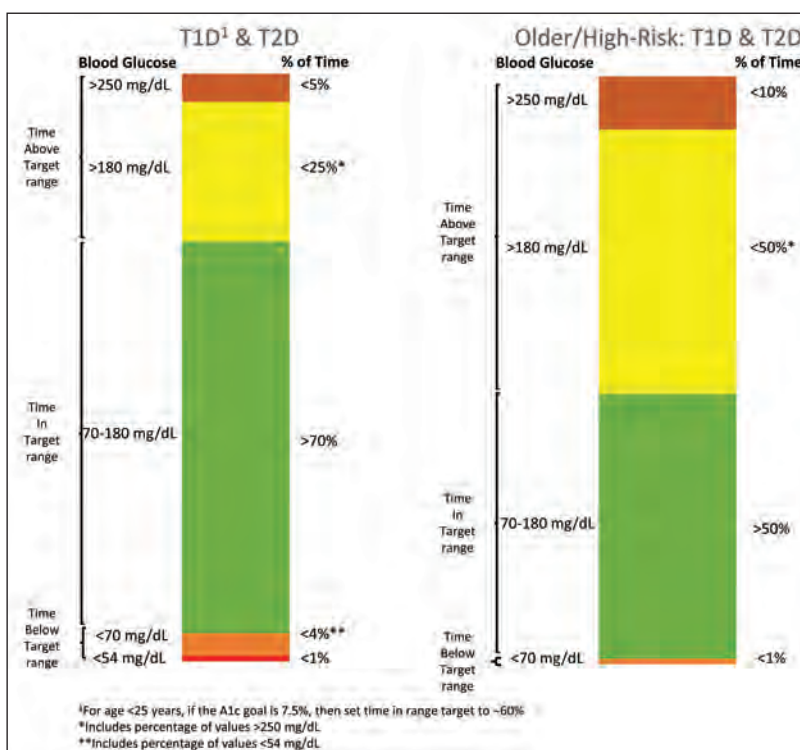


FIGURE 2. CGM targets for different populations with diabetes<sup>17</sup>



American Diabetes Association. Clinical targets for continuous glucose monitoring data interpretation: recommendations from the International Consensus on Time in Range. American Diabetes Association. 2019. Copyright and all rights reserved. Material from this publication has been used with the permission of the American Diabetes Association.

The primary goal for effective and safe glucose control is to increase the TIR while reducing the TBR and TAR, ie, glycemic variability. For many individuals with T1D or T2D, the TIR should be  $\geq 70\%$ , as this correlates with better glycemic control, ie, A1c  $< 7.0\%$ . TIR  $> 50\%$  may be appropriate for individuals who are

older or who have comorbidities, eg, cognitive deficit, renal disease, joint disease, osteoporosis, fracture, and/or cardiovascular disease, that place them at higher risk of complications.<sup>17</sup> TIR recommendations for women who are pregnant are not available due to limited experience in this population.

**Interpreting the ambulatory glucose profile**

Interpreting the AGP provides an opportunity to collaborate with the patient to identify situations where the blood glucose level is and is not well controlled. Discussion may then focus on reinforcing behaviors contributing to good glycemic control, as well as challenges that may contribute to poor glycemic control.

A systematic process to optimize the time spent with the patient in this process has been suggested by Richard Bergenstal, MD, of the International Diabetes Center (TABLE 2). To better interpret an individual’s AGP, it is helpful to mark up the AGP, noting factors such as times meals are eaten, insulin is administered, and exercise is done. This can be especially valuable to identify factors contributing to wide glycemic variability.

TABLE 2. Key steps to interpreting the AGP

1. Check for adequate data.
2. Mark up the AGP, noting factors affecting management.
3. Ask the patient, “What do you see?” Listen.
4. Look for patterns of low blood glucose levels.
5. Look for patterns of high blood glucose levels.
6. Look for areas of wide glycemic variability.
7. Compare current AGP to past AGPs; reinforce successful strategies.
8. Agree on an action plan with the patient.
9. Copy the AGP for the patient and place copy in the electronic medical record.

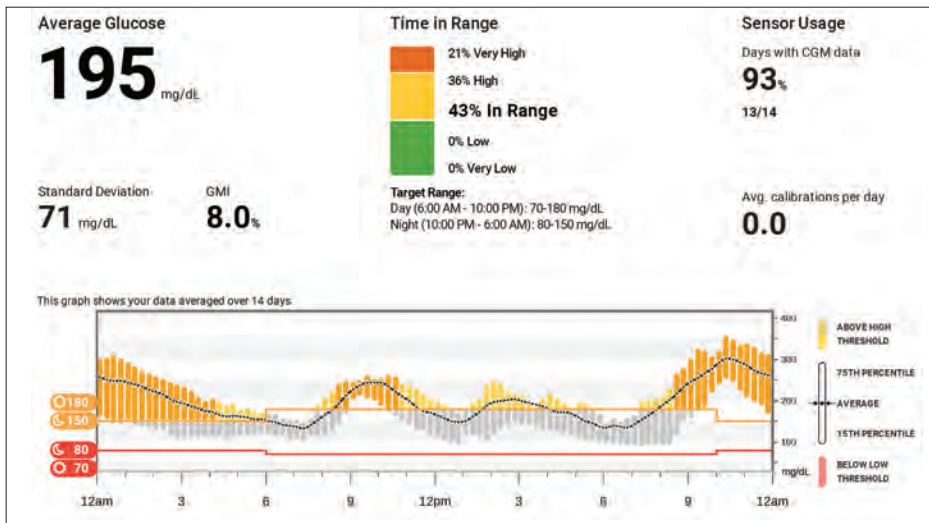
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CASE STUDIES

CASE #1

- 71-year-old man with T2D
- Current treatment:
  - Rapid-acting insulin 8 units with breakfast, 6 units with lunch, 10 units with dinner
  - Basal insulin 52 units at bedtime

**Discussion.** The patient’s GMI, which is an approximation of A1c, is 8.0% and average blood glucose is 195 mg/dL (standard deviation, 71 mg/dL). Both indicate poor glycemic control. Moreover, 57% of his day is spent with hyperglycemia, particularly after breakfast and dinner. In addition, his TIR of 43% is below the 50% recommended for older adults. His breakfast and dinner doses of rapid-acting insulin need to be increased with appropriate monitoring. He should be reminded to take his rapid-acting insulin shortly

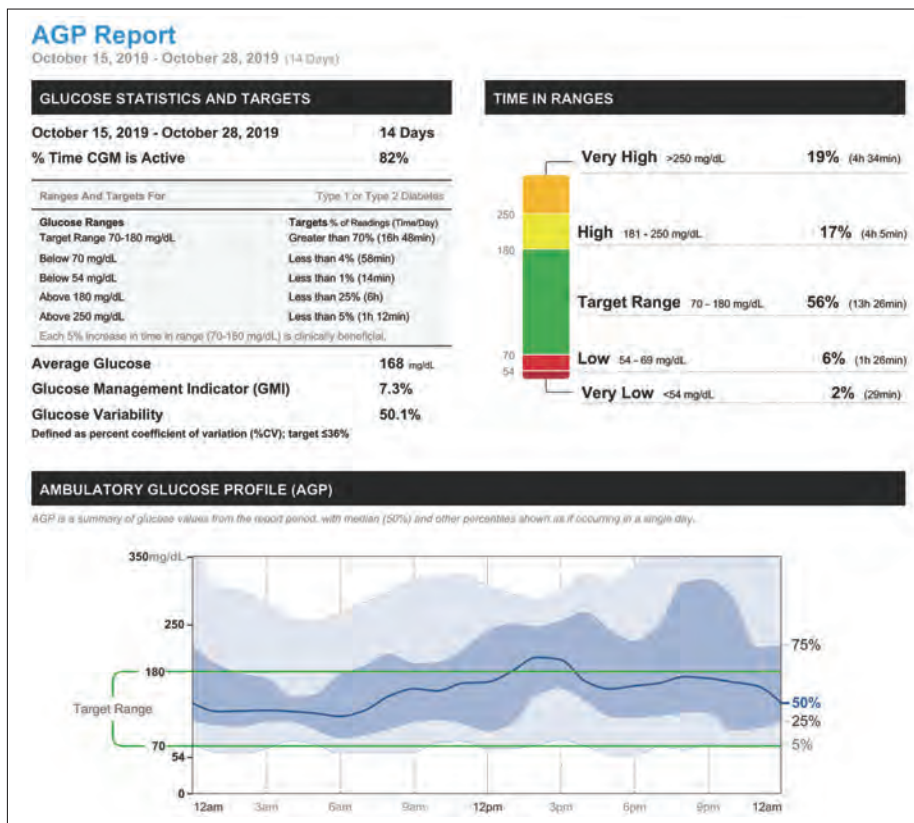


before or at the beginning of each meal, particularly because he is at risk of hypoglycemia after lunch and dinner. Consideration may be given to reducing his dose of basal insulin since his blood glucose level is low from 3 am to 9 am.

CASE #2

- 66-year-old woman with T2D for 9 years
- Medical history:
  - Class 2 obesity body mass index [BMI], (36.9 kg/m<sup>2</sup>)
  - Chronic obstructive pulmonary disease
  - Gastroesophageal reflux disease
- Current treatment:
  - Metformin 1000 mg twice daily
  - Basal insulin 0.64 units/kg with dinner
- A1c 7.2% 2 months ago

**Discussion.** While the patient’s GMI of 7.3% suggests that her blood glucose level is close to target, her average blood glucose of 168 mg/dL, with one-third (36%) of her day spent with hyperglycemia, indicates that her blood glucose is poorly controlled. This is further



demonstrated by her glycemic variability of 50.1%, which is well above the 36% threshold recommended for good glycemic control. She experiences hypoglycemia about 2 hours over the course of a day, although she is at risk for hypoglycemia during most of the day. She needs further education about the consequences of prolonged hyperglycemia. Her treatment clearly needs to be intensified, but this must be done cautiously to avoid increasing her risk for hypoglycemia. One option is to reduce the dose of basal insulin and

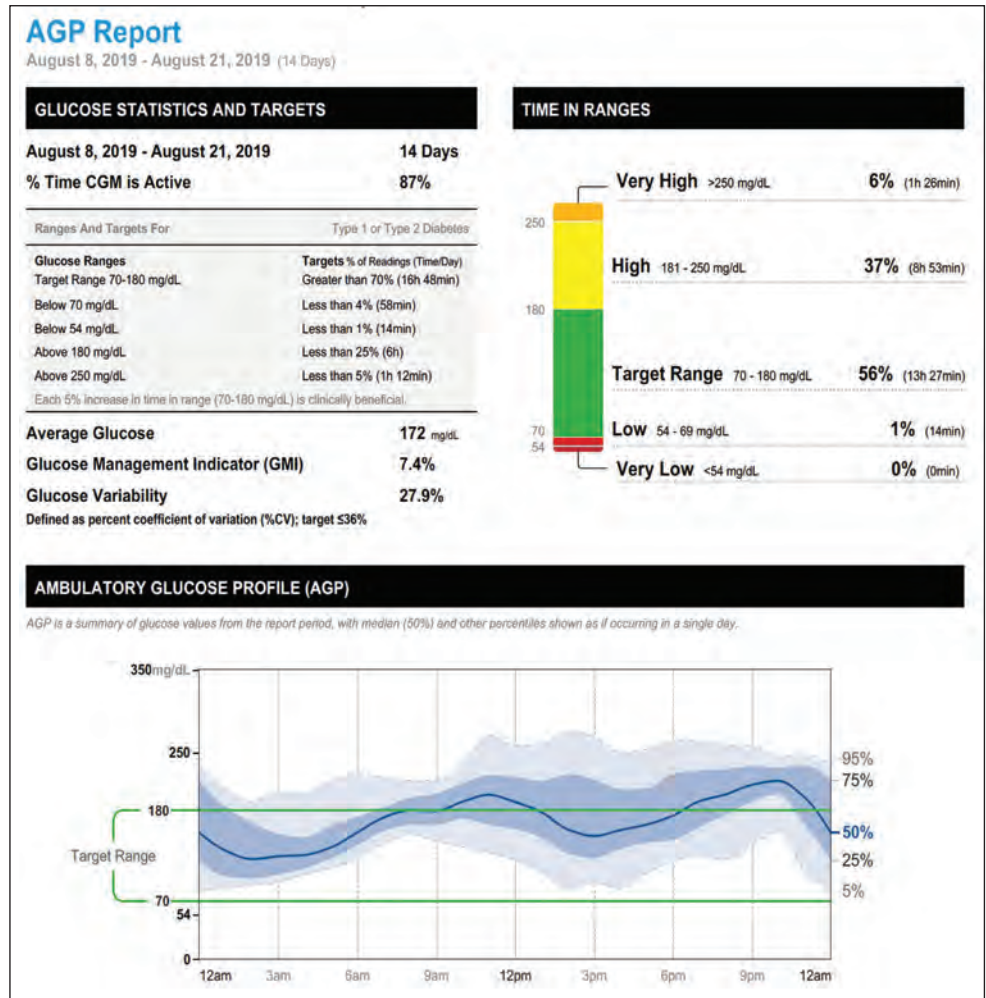
begin rapid-acting insulin only with dinner, which would reduce the significant glycemic spike around 9 pm. Since her blood glucose level rises after breakfast and continues to rise throughout the day, another option would be to give the basal insulin twice daily with breakfast and dinner and reduce the total daily dose by 10% so as to minimize the risk for hypoglycemia. A shared decision-making process would be helpful to develop the revised treatment plan.

**CASE #3**

- 45-year-old man with T2D for 13 years
- Medical history:
  - Hypertension
  - Hyperlipidemia
  - Class 3 obesity (BMI, >40 kg/m<sup>2</sup>)
- Current treatment:
  - Metformin 1000 mg twice daily
  - NPH insulin twice daily; total daily dose >60 units
- Rarely performs fingerstick SMBG
- A1c 7.9% 6 months ago

**Discussion.** The patient's GMI of 7.4%, average blood glucose of 172 mg/dL, and TIR of 56% all indicate suboptimal glycemic control. His glycemic variability of 27.9% is below the maximum of 36% that is recommended and reflects the fact that only 1% of his time is spent with hypoglycemia. To gain better glycemic control, a glucagon-like peptide-1 receptor agonist (GLP-1 RA) could be added with concomitant dose reduction of NPH to achieve blood glucose <140 mg/dL in the morning. A short-acting GLP-1 RA may

be preferred, as it would target postprandial hyperglycemia, although this would add to treatment complexity. Asking the patient his preferences should be helpful.



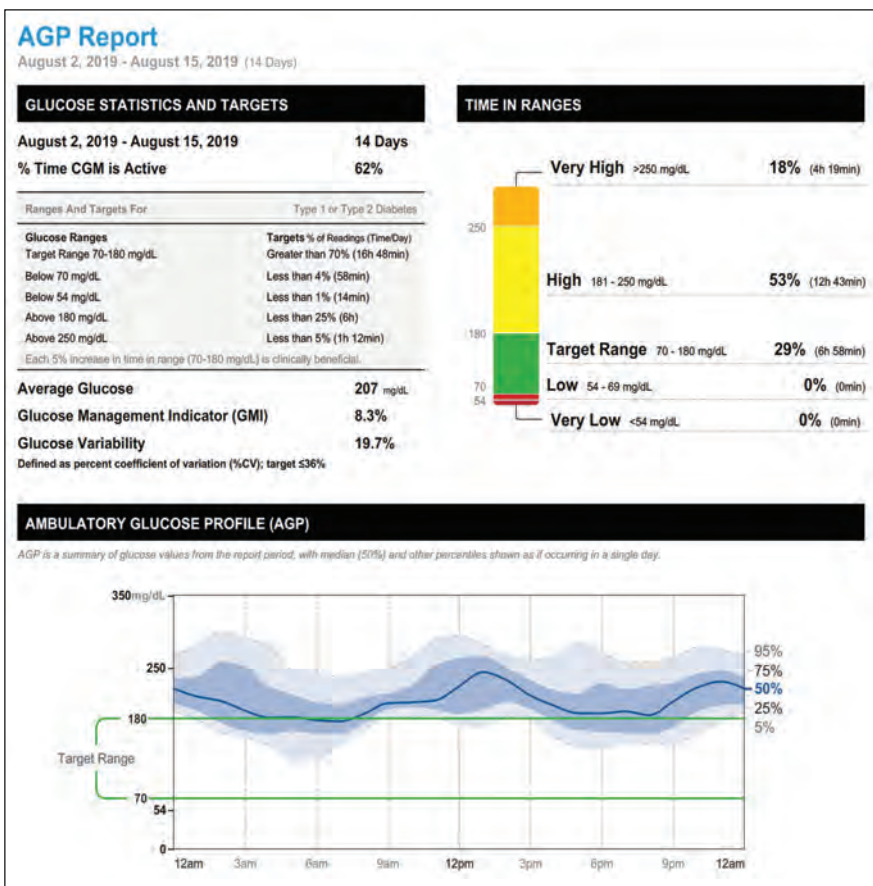
CONT'D

**CASE #4**

- 43-year-old woman with T2D for 3 years
- Medical history:
  - Hypertension
  - Hyperlipidemia
  - Class 2 obesity (BMI, 35.4 kg/m<sup>2</sup>)
- Current treatment:
  - Metformin 1000 mg twice daily (poor adherence)
- Personal CGM provided to increase patient engagement and create awareness of blood glucose values
- A1c 8.4% 2 months ago

**Discussion.** This patient has poor glycemic control, as demonstrated by her GMI of 8.3%, average blood glucose of 207 mg/dL, TIR of 29%, and 71% hyperglycemia. Her AGP reveals no hypoglycemia and low glycemic variability (19.7%). She reports that when using the CGM device, she is significantly more aware of the effect that food, stress, activities, and poor medication adherence have on her blood glucose levels. Personal CGM was prescribed because she expressed a desire to continue CGM monitoring, or, as she calls it, “her diabetes accountability partner.” Upon questioning, the patient indicates that she has not taken metformin as prescribed because she often feels nauseous for a few hours after taking it. Conse-

quently, metformin is discontinued and a long-acting GLP-1 RA is initiated. The long-acting GLP-1 RA will help lower her fasting blood glucose level and promote weight loss. At every visit, treatment adherence will be reinforced through patient education and patient concerns will be identified and worked through via shared decision-making. ●



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