Glucose Variability and the Use of Continuous Glucose Monitors in People With Type 1 and Type 2 Diabetes

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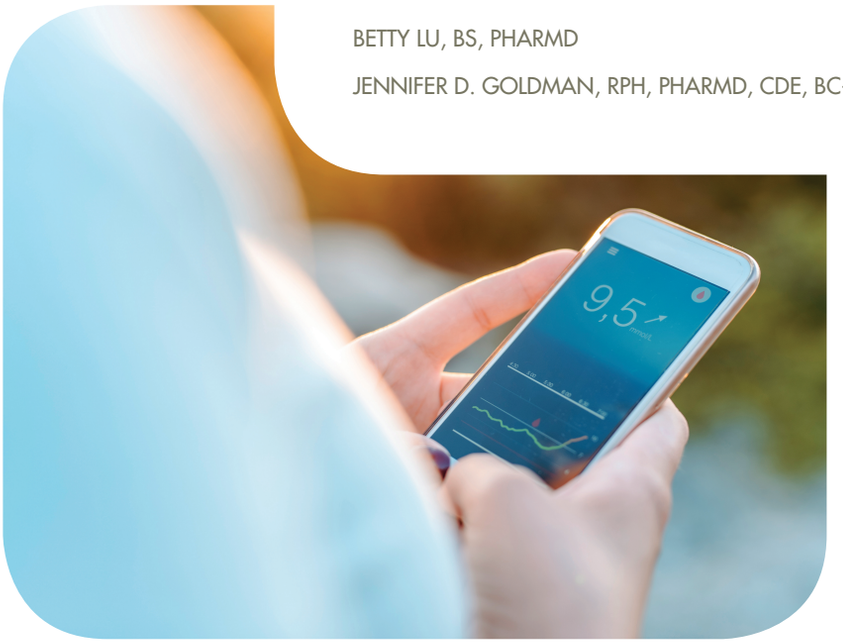

It is well known that healthy blood sugars lead to the prevention of many long-term complications. Patients taking insulin will work with their health care providers to make dose adjustments based on their blood glucose values to properly manage their disease and meet glycemic targets. The A1C shows the time-averaged glucose values and is regarded as the gold standard of monitoring for diabetes management. Although the A1C has an integral role in diagnosing and monitoring treatment, it does not provide information on glycemic variability.

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What Is Glycemic Variability?

Glycemic variability (GV) is a fluctuation in blood glucose throughout the day, which is the result of periods of low blood glucose and increases in blood glucose that can be seen after a meal. There is a degree of GV in healthy individuals; however, this is more profound in patients with diabetes or impaired blood glucose regulation. Researchers established that associations between GV and diabetes complications were found with microvascular complications and coronary arterial disease in patients with type 2 diabetes, but it was less clear in patients with type 1 diabetes.

We present an example of a patient with type 1 diabetes with a point of care A1C of 6.2%, which was stable and comparable to previous values in the past year. He reports several instances of symptomatic hypoglycemia with appropriate

treatment. He checked his blood sugar 4 to 6 times per day but was unable to identify a pattern or definitive cause. A Libre Pro was placed on him, which he wore for 13 days. Based on the average of blood sugars during the 13 days, the A1C calculates to 6.3%. What you can identify in a graph of the daily patterns (Figure 1) is large swings in blood sugar, some lower than 50 and some higher than 300. This is an example of GV that is not identifiable by assessing the A1C. GV was only identified with the aid of a continuous glucose monitor (CGM). The CGM provided data allowing a change in his insulin regimen as well as evidence to show the patient the value of obtaining a personal CGM for self-monitoring and dosing.

As demonstrated by this case, the use of a CGM is a solution to identifying GV. CGM measures a patient's interstitial glucose levels in real time to give the patient and health care provider a much clearer identification of the patient's glucose trends. Schwartz and Scheiner review the role of CGMs and identify that it allows for better and more accurate insulin adjustments and recognition of glycemic issues.

The majority of the CGMs available in the United States will discreetly check patients' glucose levels every couple of minutes, transmitting data that can be viewed through a display window on the device. The Freestyle Libre CGM has a different model in that it will capture glucose level readings only when the sensor is scanned with the transmitter. Most CGMs, with the exception of the Freestyle Libre, will alert patients when the glucose levels are too low or too high. Patients using these types of CGMs can more readily adjust their therapy based on the immediate high or low alerts. This extensive, around-the-clock data will aid health care providers in making adjustments in drug therapies more unique to each patient and allow those patients, with proper education and self-treatment plans, to also do the same with their insulin doses.

Components of a Continuous Glucose Monitor

Outlined in TheDiabetesCouncil.com, diagnostic and personal CGMs are the 2 different types of CGMs currently available. A diagnostic CGM functions as a tool solely for health care professionals to obtain the data they need. A personal CGM is used by the patient as part of their diabetes self-management and functions as either a standalone device or a combination insulin pump–CGM device that incorporates an insulin pump into the design.

Both types of CGM function in the same way and consist of the same components. A CGM is comprised of a sensor, transmitter, and receiver. The sensor is inserted subcutaneously by a needle to obtain the glucose values within the interstitial fluid. The transmitter fits onto the sensor and wirelessly sends the glucose readings to the receiver, which has a display to show all records of the glucose readings.

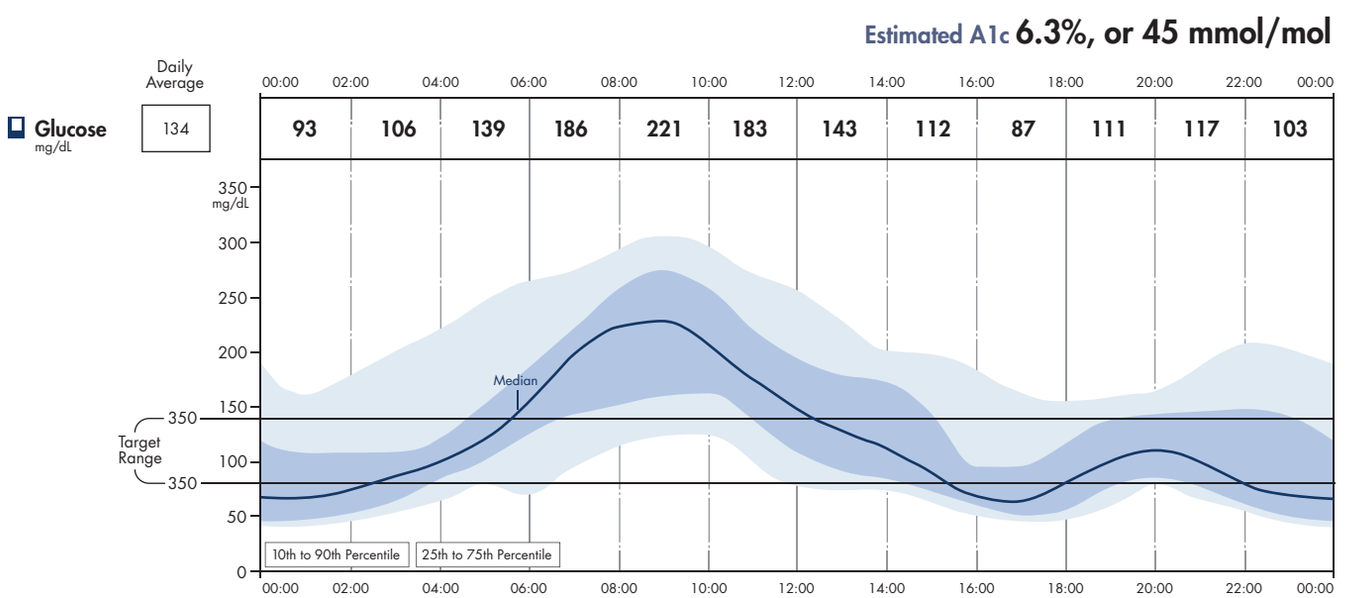


Figure 1. Graph of glucose readings for patient with type 1 diabetes.

Patients with type 1 diabetes are encouraged to use CGMs, and CGMs can be considered for any patient using basal-bolus insulin regardless of whether they have type 1 or type 2 diabetes.

Who Can Benefit From Using Continuous Glucose Monitors?

Standard glucose testing with glucometers may function just as well as CGMs in most patients with predictable or managed diabetes. However, CGMs are encouraged for certain populations. CGMs could provide much benefit for patients with unexplained high or low readings and patients who are frequently unable to reach their glycemic targets or are at high risk of hypoglycemia. CGM would also be useful for those who check blood glucose values more than 10 times a day or have difficulty with finger-stick checks throughout the day. Additionally, patients with type 1 diabetes are encouraged to use CGMs, and CGMs can be considered for any patient using basal-bolus insulin regardless of whether they have type 1 or type 2 diabetes.

Table 1. Characteristics of Available Continuous Glucose Monitors.

	Type	How Long Can Sensors Be Worn?	Are There Alarms?	Is Finger-Stick Testing Required for Calibration?
Medtronic MiniMed	Personal	Enlite sensors: 6 days	Yes	Yes
Medtronic iPro2 Professional	Diagnostic	Enlite sensors: 6 days	No	Yes
FreeStyle Libre	Personal	10 days	No	No
FreeStyle Libre Pro	Diagnostic	14 days	No	No
Dexcom G4 Platinum	Personal	7 days	Yes	Yes
Dexcom G5 Mobile	Personal	7 days	Yes	No
Dexcom G6	Personal	10 days	Yes	No

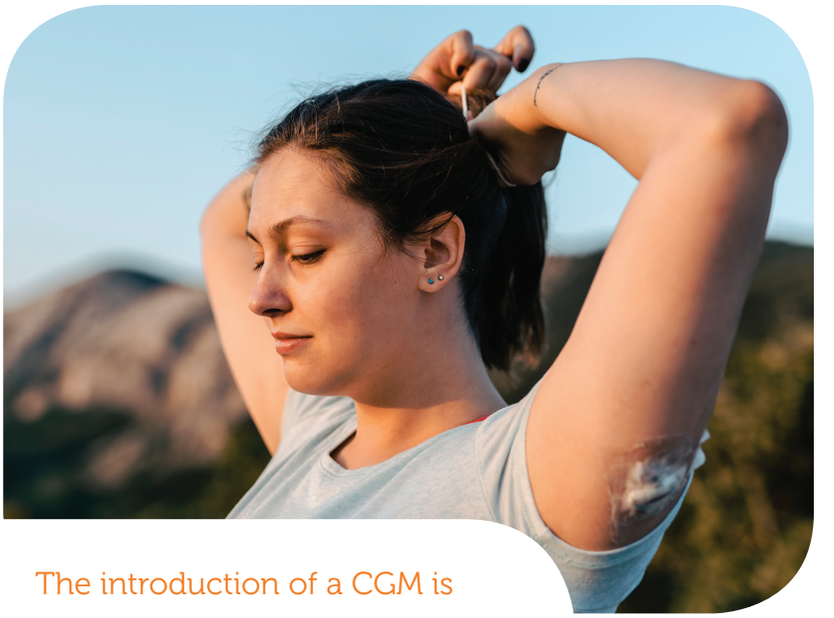
Download this resource to use in your practice at diabeteseducator.org/AIPresources.

Types of Continuous Glucose Monitors on the Market

The first CGM approved by the US Food and Drug Administration (FDA) was the Medtronic MiniMed in 1999. Since then, many have received FDA approval and are on the market, including the FreeStyle Libre and Libre Pro, Medtronic iPro2 Professional, Dexcom G4 Platinum, Dexcom G5 Mobile, and Dexcom G6.

CGMs that are combined with an insulin pump include Animas Vibe using Dexcom 4 Platinum; Medtronic MiniMed 530G, 630G, and 670G using Medtronic Enlite sensors or the 670G also using Guardian sensors; and the Tandem T:slim G4 using Dexcom 4 Platinum sensors. There are differentiating characteristics between the various CGMs available today (Table 1).

It's important for the patient to understand the specific features of their device and the requirements needed to ensure there will be an accurate reading. Additionally, it is important for providers to understand this, allowing them to recommend the most appropriate device for their patient. For some CGMs, finger-stick glucose testing will be required throughout the day to calibrate the device and ensure accuracy of the readings. Only the Dexcom G5 Mobile, Dexcom G6, and Freestyle Libre CGM are approved by the FDA without calibration. The Freestyle Libre CGM is approved as a "flash glucose monitoring system" and, unlike the others, replaces routine finger-stick calibrations and is used to dose insulin based on real-time glucose readings and trends. It offers an alternative for patients in the features for this type of glucose monitoring and has a less expensive sensor.



The introduction of a CGM is one of the approaches healthcare providers can take to better understand patients' GV to develop a more personalized diabetes management plan.

Conclusion

The landscape for treating and managing diabetes is continually changing. The introduction of a CGM is one of the approaches health care providers can take to better understand patients' GV to develop a more personalized diabetes management plan.

The cost of CGMs is largely dependent on the type of CGM, whether the patient has insurance, and the type of insurance. Patients with type 1 diabetes are more likely to be covered for a CGM than patients with type 2 diabetes. Patients with type 2 diabetes who meet the same criteria for coverage, however, may also be qualified for coverage through their insurance.

The different CGM options that are available today give patients and providers the opportunity to work together to choose the best device to fit the patient's lifestyle and needs. ■

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