Utility of Continuous Glucose Monitoring in Type 1 and Type 2 Diabetes

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KEYWORDS

• Technology • Type 1 diabetes mellitus • Type 2 diabetes mellitus
• Continuous glucose monitoring

KEY POINTS

- Continuous glucose monitoring (CGM) improves glycemic control in adults with type 1 diabetes and reduces the risk of hypoglycemia.
- Short-term, intermittent use of CGM has been shown to be effective in adults with type 2 diabetes (not on prandial insulin) who have a hemoglobin A1c of 7% or greater.
- The use of technological devices in clinical practice is time intensive and requires a substantial investment in education of both practitioners and patients.
- Cost-effectiveness studies are needed to further document health care cost reduction associated with CGM.
- Sensor-augmented insulin pump therapy and closed-loop "artificial pancreas" systems are currently in development and show great promise to automate insulin delivery with minimal patient intervention.

INTRODUCTION

Results from the Diabetes Control and Complication Trial have underlined the importance of glucose control in prevention of microvascular and macrovascular disease, and over the last 4 decades the use of self-monitoring blood glucose (SMBG) has become the standard of care.[1]

However, striving toward near-normal glycemia is difficult to achieve without substantial patient and health care provider effort, and leads to an increase in episodes of hypoglycemia. Moreover, although SMBG is a widely used and important component of therapy for type 1 diabetes mellitus (T1DM), it is challenging in day-to-day practice: patients' monitoring may be infrequent or intermittent, and overnight glucose

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levels are seldom measured. Given these limitations, episodes of hypoglycemia and hyperglycemia may be missed and not factored into treatment decisions.[2,3]

Real-time (RT) continuous glucose monitoring (CGM)—the newest diabetes technological device—has been commercially available since the mid 2000s. The potential clinical benefit of this technology as a tool to assist with optimization of glucose control for both T1DM and types 2 diabetes mellitus (T2DM) adult populations is reviewed in this article.

CONTINUOUS GLUCOSE MONITORING TECHNOLOGY

Current models of CGM measure the glucose concentration in the interstitial fluid every 1 to 5 minutes for up to 7 days via a short subcutaneous probe (glucose sensor). There is a lag of several minutes between plasma and interstitial fluid concentrations, which also depends on the glucose rate of change at any given time; this can lead to inconsistencies between SMBG and CGM values in excess of 20 mg/dL. SMBG values are still required to calibrate CGM devices—the best time to calibrate is during glucose steady state—and SMBG is required to confirm glucose levels before an insulin bolus is administered and to confirm hypoglycemia before treatment. At this time, CGM devices cannot substitute SMBG, but they are valuable in providing detailed information on blood glucose trends in between SMBG, especially after meals and overnight. Moreover, whereas SMBG is a static value, CGM shows current glucose levels along with trend arrows, providing a dynamic tracing, which is likely much more helpful in decision making throughout the day. It also provides threshold alerts for low and high blood glucose values. Currently, we do not have guidelines on how to choose and adjust alert settings, and it is up to the clinician along with the patient to decide what works best to tighten glucose control, reduce hypoglycemic risk, and avoid alert fatigue. This technology is evolving steadily in terms of accuracy and ease of use. Factory-calibrated devices are in development that could reduce common calibration errors.

Recent enhancements have also made it possible to project data to other devices such as smartphones, smart wrist-watches, and computers with the possibility of sharing data safely with clinicians, spouses, and others remotely. In 2015, the US Food and Drug Administration approved 3 such systems: the Dexcom Share (Dexcom, Inc., San Diego, CA),[4] Dexcom G5 with Bluetooth (Dexcom, Inc.),[5] and MiniMed Connect (Medtronic, North Haven, CT).[6] An open-source system (not US Food and Drug Administration approved) called Nightscout is also available.

USE OF CONTINUOUS GLUCOSE MONITORING IN TYPE 1 DIABETES MELLITUS

Impact of Continuous Glucose Monitoring on Glycemic Control

Several major studies have evaluated the use of CGM in adults with T1DM (**Table 1**): the Juvenile Diabetes Research Foundation (JDRF) CGM randomized controlled trial,[7] the GuardControl Study,[8] and O'Connell and colleagues,[9] and they all demonstrated that adults with T1DM with a hemoglobin A1c of at least 7.0% had a greater reduction in hemoglobin A1c with the use of RT-CGM than with intermittent SMBG (0.5%, 0.6% and 0.43%, respectively). Furthermore, unlike findings with SMBG, the improvement in hemoglobin A1c with CGM is not accompanied by an increase in biochemical hypoglycemia.[8,10] Interestingly, in the JDRF 6-month trial, the improvement in hemoglobin A1c in the subjects using CGM was sustained over the 6-month observational period that followed completion of the trial.[11] This ongoing benefit occurred despite reduction in office visit frequency during this observational period to levels (2.7 ± 1.2 visits over 6 months), similar to routine care.