Continuous Glucose Monitoring for Non-insulin Dependent Diabetics in Naturopathic Clinical Practice

Dr. David Duizer, BSc, ND, RMC

Abstract:

With a strong focus on lifestyle medicine and desire for evidence-informed, individualized treatment protocols naturopathic doctors have much to offer the type 2 diabetes patient. The newest addition to the naturopathic doctor's tool kit is continuous and flash glucose monitoring devices. Data obtained from this technology supports healthy glucose control in type 2 diabetes patients. When clinicians are able to be connected to this data nutrition, exercise, supplement, herbal and medication prescriptions can be individualized to the patients insulin sensitivity and glucose disposal. The article reviews one naturopathic doctor's approach to type 2 diabetes management using continuous glucose monitoring.

Naturopathic doctors are poised to blunt the growth of type 2 diabetes in Canada in part because of their focus on lifestyle medicine and continued growth as a profession.[9] The ability to scientifically evaluate glucose responses to food and the extent of insulin resistance using laboratory assessments has enabled the emergence of patient-centered, holistic, and precise approaches to diabetes. The newest additions to the naturopathic doctor's tool kit are continuous and flash glucose monitoring devices (for the purpose of this article we will refer to both types as simply CGM). This technology connects practitioners to their patients' diet and exercise choices through distributed applications that store real-time glucose data on cloud computing platforms. When treatment goals are well-established and evidence-based protocols are used, CGM data has the potential to personalize nutritional, exercise and supplement treatment strategies to improve patient outcomes.[10] This method of practice is well-aligned with the mentality of the naturopathic doctor.

What are CGM devices?

CGM devices are small sensors that can be placed on the body to accurately monitor interstitial fluid glucose levels immediately below the skin; they are clinically validated to measure blood glucose levels.[1] These devices are able to communicate glucose levels with handheld devices including both patient and practitioner smartphones. Common market CGMs can be used for two weeks before replacement is necessary. Data can be analyzed at any time to facilitate lifestyle change and to track intervention impacts.

Two commonly used terms to describe these devices are continuous glucose monitors and flash glucose monitors. Continuous glucose monitors do not need to be scanned to transmit data while flash glucose monitors store data which is submitted when a capture device is brought close to, or 'flashed', over the sensor.[2] CGM devices are highly accurate, although they lag behind plasma glucose levels by approximately 15 minutes.[2] They can be properly calibrated through fingerstick glucose testing if needed.

CGM devices are applied to the posterior non-dominant upper arm by the naturopathic doctor and require target zones to be individualized to patient goals. Although they require a short period of instruction, they are generally easy to use and have an intuitive interface that even the least tech-savvy patient usually finds simple to understand.[23] Initial lessons for patients include how often to scan (for flash glucose monitors), and how to understand alerts (for pure CGM users). Application settings within the system include, but are not limited to: predicted HbA1C, average glucose, alerts for both hypoglycemia and hyperglycemia and percentage time-in-target reporting.

An important benefit of CGM is a greatly reduced reliance on finger-stick measurements to maintain glycemic control. CGM provides real-time glucose levels including first morning, pre- and postprandial readings. With the use of an app or external device a graphical representation of the day's glucose readings can show the ebb and flow of glucose levels. Most devices provide an opportunity for patient journaling tagged to readings or timings. For example, if a meal needs to be reported and tracked or if exercise influenced levels, a journal entry tagged to the corresponding data set could be valuable for patient understanding and practitioner review. Finger-sticks are only required for device calibration and for confirming levels occasionally with other devices.

An important negative to consider when discussing CGM usage is cost, which ranges from $90 to $120 per sensor. CGM sensors

last 10-14 days depending on the brand. Scanners can be purchased separately for those without a compatible smartphone. As a relatively new technology and with significant investment involved in their production and market release, these devices can be cost-prohibitive for some. In addition, each sensor is only viable for 3-14 days. For type 1 diabetic patients using multiple insulin injections and still experiencing suboptimal glycemic control, CGM has been shown to be cost-effective when compared to finger-stick testing as it has been projected to reduce the risk of type 1 diabetes complications and increase quality-adjusted life-years.[7] For those with type 2 diabetes not on prandial insulin, CGM used short-term and intermittently has been shown to be a cost-effective self-care tool for disease management.[11]

How can CGM devices be used clinically?

The most common uses of CGM devices are in the management of type 1 diabetes and insulin-dependent type 2 diabetes however the management of non-insulin-dependent type 2 diabetes, a condition commonly addressed in naturopathic medicine, is an emerging application.[3] For insulin-dependent populations CGM provides improved glycemic control and a better understanding of how food, exercise and lifestyle influence insulin requirements. As a technological advancement, the ability of CGM devices to detect hypoglycemia in patients unaware of this phenomenon is highly valued.[3] A meta-analysis and systematic review published in 2018 showed CGM use leads to statistically significant (although modest at 0.2%) reductions in HbA1C in patients with type 2 diabetes.[4] Clinical trial data shows CGM use in this population increases time-in-range and reduces glycemic variability, metrics that represent overall glycemic control.[12] A growing body of evidence suggests that such precision medical devices could aid practitioners in tracking and optimizing the effectiveness of nutrition and exercise programs.[4] Continuous glucose monitoring can identify patients at a higher risk of developing complications that develop as a result of poor glycemic control, such as diabetic retinopathy. In fact, patients with less "time-in-range", defined as 3.9-10 mmol/L, and higher measures of glycemic variability have an increased prevalence of diabetic retinopathy.[5] Identifying patients with poor control will empower the patient and practitioner to work together to reduce the risks of diabetes complications.

For those diabetic patients who experience difficulty reducing glycemic variability and lack an understanding for how to utilize finger-stick testing to evaluate effectiveness of diet, exercise and lifestyle CGM helps to reduce both high and low blood glucose.[13] CGM can also be a valuable tool for patient recognition of hyperglycemia in prediabetes.[14] This use aligns well with the naturopathic principles of "prevention" and "doctor as teacher". CGM provides an opportunity to teach patients about what actions contribute to hyperglycemia, how to measure morning and post-prandial glucose levels as well as how to adapt diet and exercise to improve these markers. Achieving improved "time-in-target" and lower glycemic variability reduces the risk of the progression of diabetes and can support a program focused on the prevention of diabetes in insulin resistant patients. These two populations are commonly being managed by naturopathic doctors who are experienced in combining lifestyle interventions with common medications for glycemic control.[15] Learning about and facilitating the introduction of CGM to these patients may lead to improved care and further personalized programs to be adopted.[16]

How can CGM devices be used clinically by naturopathic doctors?

Discussing glycemic index, glycemic load, low carbohydrate diet, carbohydrate usage as a fuel source, delaying gastric emptying and improving insulin sensitivity with the metabolically unhealthy patient is a common practice of the naturopathic doctor. Real time evidence of glycemic change as illustrated in the graphical representation of glucose levels provided by CGM applications is one of the simplest, most intuitive ways to teach patients about this topic and how glycemic control relates to end-organ function. Thus, through the use of CGM devices naturopathic doctors have an opportunity to utilize a holistic approach to metabolic wellness that could include a review of the impacts of stress, hormone imbalance, inflammation and appetite control on blood sugar levels. Discussions with patients could be as simplistic as reviewing the influence of fibre on gastric emptying or as complex as a guided analysis of how postprandial high intensity interval training reduces the "area-under-the-curve" or facilitates carbohydrate usage during exercise and therefore improves glycemic control. With CGM devices naturopathic doctors have an opportunity for precision patient care, individualized treatment as well as the privilege of being community leaders in the field of metabolic wellness.

In the region the author is writing from, a prescription is required for a CGM sensor. If the patient is smartphone-savvy an extra device is not necessary as the smartphone can handle the data.

Naturopathic interventions that can evaluated and individualized using real time glucose data include:

1) **Exercise choice and the difference between post-exercise glucose levels**
   - Naturopathic doctors use progressive overload resistance training, high intensity interval training, medium continuous intensity training, sprint training and others to support the fitness levels of patients. Each can impact glycemic control.[17]

2) **Macronutrient planning and the influence of a low carb diet, managing glycemic load and glycemic index as well as the role of protein and fat on glucose levels**
   - Clinical trials have shown that naturopathic medical practice, which includes nutritional counselling, is an effective way of promoting lifestyle changes that prevent the development of disorders linked with insulin resistance, such as the metabolic syndrome.[18]

3) **Immediate impacts of supplements on glucose levels and tracking supplements used for improving insulin sensitivity**
   - Following the recommendation of a supplement a common tracking tool for naturopathic doctors is a HbA1c test after 12 weeks. CGM devices predict HbA1c, provide real time feedback on supplement effectiveness and may save time and resources when glycemic control is the ultimate goal.[19]

4) **Relationship and interactions between medications used in diabetes and naturopathic protocols**
   - Practicing safe and effective therapeutics is very important to naturopathic doctors. CGM provides a level of security highly valued to patients and healthcare teams when considering the prevention of hypoglycemic events.

Commonly-used assessments by naturopathic doctors in diabetes management include fasting plasma glucose, random plasma glucose, fasting insulin level, oral glucose tolerance test and HbA1c, among others. These methods of assessment are each clinically useful and relevant however they lack an ability to provide real-time, easy-to-obtain feedback to guide healthy nutrition choices. They are less functional in their utility then what a practitioner looking to support a healthy lifestyle may desire. An optimal nutrition plan for a type 2 diabetes patient takes into account how medication usage, macronutrient combining, fibre intake, supplement routine and exercise habits have on glycemic control. With CGM the naturopathic doctor is able to accurately assess how external and internal influences alter blood glucose levels. This level of connection to patient data could potentially influence positive nutrition choices in the insulin resistant patient.

An example of a process for clinical use of CGM in naturopathic practice

The following is an example for how CGM devices can be used in a naturopathic practice focused on chronic disease prevention and management. The author's experience provides the basis for this protocol. It is intuitive, provides adequate follow up, promotes patient involvement and encouragement and generally produces positive results for the author. Protocols including CGM implementation, counselling and intervention adjustment similar to this have been shown to be effective for reducing HbA1c, increasing "time-in-range", lowering total caloric intake and reducing glycemic variability.[16]

Initial consultation:

The initial visit with the diabetic and/or insulin resistant patient is an enlightening experience as it tends to reveal patterns conducive to worsening glycemic control. Diet, exercise, stress, sleep, past medical history and comorbidities are reviewed among other important items of an initial intake. Prior to the initiation of CGM laboratory assessments are commonly completed. They may include fasting plasma glucose and HbA1c. During this visit the clinical utility of CGM is discussed and a prescription for the device is provided to the patient.

Follow up consultation:

A follow-up visit is an appropriate time to apply the sensor, ensure comfort and review usage instructions. Usage instructions should be focused on using the CGM data to facilitate nutritional intake autoregulation for the purpose of improving glycemic control. Generally, reviewing scanning and assessing timings are helpful. These could include first morning measurements, pre and post meal scans including 1 and 2 hours postprandial. Finally, pre- and post-exercise as well as pre-sleep measurements can round out the schedule. If abnormalities, or "time-out-of-target" is significant a good note to mention is to journal meals and activities for the 2-4 hours prior. Supplement, medication and exercise recommendations round out the protocol and a note is then made about their influence on glycemic control, ie. what to expect and when. When instructed patients learn to effectively journal foods and activities that both positively and negatively influence glucose levels. This has the potential to reduce insulin resistance through the development of healthier habits.

Day 7 data review consultation:

Some practitioners may request a follow-up at the 7 day mark (of a 14 day sensor length). The author recommends patients eat their typical diet from days 1-7 of a 14 day sensor. This method allows for the application of lessons learned from days 8-14. In order to appropriately apply lessons learned, a follow up consultation at day 7 is valuable. From days 8-14 optimal glycemic control is a common goal.

During the day 7 follow-up consultation the following discussion points may be relevant:

- how late-night eating can influence sleeping glucose levels[20]
- how exercise influences glycemic levels[17]
- the impact of stress on glucose[21]
- the dangers of liquid sugar[22]

When using CGM patients are able to visualize these lessons. It is this process of visualization that promotes improved adherence. Learning about glycemic control in this way inspires healthy lifestyle changes.

Day 14 data review and long term planning consultation:

Following day 14 practitioners commonly remove the sensor for patients and request a follow up consultation to review the full data set and prepare a plan for the next 12 weeks. Following the 12 week period fasting plasma glucose and HbA1c are retested to assess improvements in glycemic control.

Follow-up assessments for the asymptomatic type 2 diabetes patient can be heavily focused on subjective reporting and HbA1c results. This type of consultation can be very uninspiring. When

using CGM devices naturopathic doctors are able to have detailed nutrition and exercise conversations with their patients. They are able to adjust supplement dosing accurately. They're able to add and subtract single dietary items that may influence sugar absorption and facilitate safe fasting protocols. Since these devices enable practitioners to get alerts at home on their own personal devices about their patients' glucose levels there is an extra layer of service that can be applied. Naturopathic doctors can be alerted when patients experience hypoglycemia and hyperglycemia. Through custom setting management on CGM devices naturopathic doctors can change target windows and challenge patients to improve their glycemic control when their comfort level with the system improves.

This technology has the potential to transform the practice of the naturopathic doctor working in chronic disease prevention and management by enhancing their ability to provide patient-centered care. CGM devices can be used across patient populations including in the elderly, those with acute coronary syndrome, in insulin-resistant patients struggling to lose weight in addition to their common applications of insulin dependent and non-insulin dependent diabetes mellitus. With proper goal setting, adequate data review and clear programming, results obtained from CGM devices can support program optimization for those struggling to control glucose levels. Naturopathic doctors have the expertise and desire to engage in patient education required to maximize the potential benefits of CGM devices.

About the Author

Dr. David Duizer, BSc, ND, RMC is the co-owner of Noble Naturopathic in Vancouver, BC. His clinical focus is chronic disease management and integrative cancer care. He completed his Bachelor of Science at the Royal Military College of Canada and is a graduate of the Boucher Institute of Naturopathic Medicine. Dr. Duizer is the Co-Vice-Chair of the Board of Directors of the Canadian College of Naturopathic Medicine.

Competing interests: none declared

References

1. Fechner E, Op 't Eyndt C, Mulder T, Mensink RP. Diet-induced Differences in Estimated Plasma Glucose Concentrations in Healthy, Non-diabetic Adults are Detected by Continuous Glucose Monitoring—a randomized crossover trial, *Nutrition Research*, Volume 80, 2020, Pages 36-43, ISSN 0271-5317. doi: 10.1016/j.nutres.2020.06.001.
2. Staal OM, Hansen HMU, Christiansen SC, Fougner AL, Carlsen SM, Stavdahl Ø. Differences Between Flash Glucose Monitor and Fingerprick Measurements. *Biosensors* (Basel). 2018;8(4):93. Published 2018 Oct 17. doi:10.3390/bios8040093
3. Continuous Glucose Monitoring. NIH: National Institute of Diabetes and Digestive and Kidney Diseases. Last reviewed 2017. Accessed 25 May 2021: https://www.niddk.nih.gov/health-information/diabetes/overview/managing-diabetes/continuous-glucose-monitoring
4. Park C, Le QA. The Effectiveness of Continuous Glucose Monitoring in Patients with Type 2 Diabetes: A Systematic Review of Literature and Meta-analysis. *Diabetes Technol Ther*. 2018;20(9):613-621. doi:10.1089/dia.2018.0177
5. Lu J, Ma X, Zhou J, et al. Association of Time in Range, as Assessed by Continuous Glucose Monitoring, With Diabetic Retinopathy in Type 2 Diabetes. *Diabetes Care*. 2018;41(11):2370-2376. doi:10.2337/dc18-1131
6. Radermecker RP, Sultan A, Piot C, Remy AS, Avignon A, Renard E. Continuous Glucose Monitoring as a Tool to Identify Hyperglycaemia in Non-diabetic Patients with Acute Coronary Syndromes. *Diabet Med*. 2009;26(2):167-170. doi:10.1111/j.1464-5491.2008.02643.x
7. Wen Wan, M. Reza Skandari, Alexa Minc, Aviva G. Nathan, Aaron Winn, Parmida Zarei, Michael O'Grady, Elbert S. Huang. Cost-effectiveness of Continuous Glucose Monitoring for Adults With Type 1 Diabetes Compared With Self-Monitoring of Blood Glucose: the DIAMOND Randomized Trial. *Diabetes Care*, 2018; dc171821 DOI: 10.2337/dc17-1821
8. Palta P, Huang ES, Kalyani RR, Golden SH, Yeh HC. Hemoglobin A1c and Mortality in Older Adults With and Without Diabetes: Results From the National Health and Nutrition Examination Surveys (1988-2011). *Diabetes Care*. 2017;40(4):453-460. doi:10.2337/dci16-0042
9. Fleming SA, Gutknecht NC. Naturopathy and the Primary Care Practice. *Prim Care*. 2010;37(1):119-136. doi:10.1016/j.pop.2009.09.002
10. Freeman J, Lyons L. The Use of Continuous Glucose Monitoring to Evaluate the Glycemic Response to Food. *Diabetes Spectrum*. 2008, 21 (2) 134-137; DOI: 10.2337/diaspect.21.2.134
11. Fonda SJ, Graham C, Munakata J, Powers JM, Price D, Vigersky RA. The Cost-Effectiveness of Real-Time Continuous Glucose Monitoring (RT-CGM) in Type 2 Diabetes. *J Diabetes Sci Technol*. 2016;10(4):898-904. Published 2016 Jun 28. doi:10.1177/1932296816628547
12. Yoo JH, Kim JH. Time in Range from Continuous Glucose Monitoring: A Novel Metric for Glycemic Control. *Diabetes Metab J*. 2020;44(6):828-839. doi:10.4093/dmj.2020.0257
13. Bui A, Kim J. Continuous Glucose Monitoring for Underserved and Minority Patients with Type 2 Diabetes in an Interprofessional Internal Medicine Clinic. *Innov Pharm*. 2020;11(4):10.24926/iip.v11i4.3501. Published 2020 Dec 3. doi:10.24926/iip.v11i4.3501
14. Ehrhardt N, Al Zaghal E. Behavior Modification in Prediabetes and Diabetes: Potential Use of Real-Time Continuous Glucose Monitoring. *J Diabetes Sci Technol*. 2019;13(2):271-275. doi:10.1177/1932296818790994
15. Steel, A., Foley, H., Bradley, R. et al. Overview of International Naturopathic Practice and Patient Characteristics: Results from a Cross-sectional Study in 14 Countries. *BMC Complement Med Ther* 20, 59 (2020). https://doi.org/10.1186/s12906-020-2851-7
16. Rivera-Ávila DA, Esquivel-Lu AI, Salazar-Lozano CR, Jones K, Doubova SV. The Effects of Professional Continuous Glucose Monitoring as an Adjuvant Educational Tool for Improving Glycemic Control in Patients with Type 2 Diabetes. *BMC Endocr Disord*. 2021;21(1):79. Published 2021 Apr 23. doi:10.1186/s12902-021-00742-5
17. van Dijk JW, van Loon LJ. Exercise Strategies to Optimize Glycemic Control in Type 2 Diabetes: A Continuing Glucose Monitoring Perspective. *Diabetes Spectr*. 2015;28(1):24-31. doi:10.2337/diaspect.28.1.24
18. Seely D, Szczurko O, Cooley K, et al. Naturopathic Medicine for the Prevention of Cardiovascular Disease: a Randomized Clinical Trial. *CMAJ*. Jun 2013, 185 (9) E409-E416; DOI: 10.1503/cmaj.120567
19. Yin J, Xing H, Ye J. Efficacy of Berberine in Patients with Type 2 Diabetes Mellitus. *Metabolism*. 2008;57(5):712-717. doi:10.1016/j.metabol.2008.01.013
20. Imai S, Kajiyama S, Hashimoto Y, et al. Divided Consumption of Late-night-dinner Improves Glycemic Excursions in Patients with Type 2 Diabetes: A Randomized Cross-over Clinical Trial. *Diabetes Res Clin Pract*. 2017;129:206-212. doi:10.1016/j.diabres.2017.05.010
21. Surwit RS, van Tilburg MA, Zucker N, et al. Stress Management Improves Long-term Glycemic Control in Type 2 Diabetes. *Diabetes Care*. 2002;25(1):30-34. doi:10.2337/diacare.25.1.30
22. Sundborn G, Thornley S, Merriman TR, et al. Are Liquid Sugars Different from Solid Sugar in Their Ability to Cause Metabolic Syndrome?. *Obesity* (Silver Spring). 2019;27(6):879-887. doi:10.1002/oby.22472
23. Mattishent K, Lane K, Salter C, et al. Continuous Glucose Monitoring in Older People with Diabetes and Memory Problems: A Mixed-methods Feasibility Study in the UK. *BMJ Open*. 2019;9(11):e032037. Published 2019 Nov 18. doi:10.1136/bmjopen-2019-032037