Technology

How is continuous glucose monitoring data being used?

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There are few guidelines available as to the optimal way of adjusting insulin delivery or carbohydrate intake in response to continuous glucose monitoring (CGM) data. The Diabetes Research In Children Network (DirecNet) and Juvenile Diabetes Research Foundation (JDRF) trials both used protocols that specified how CGM users should adjust their therapy according to the glucose trends (DirecNet Study Group, 2008; JDRF CGM Study Group, 2008), while the ALGOS study from Melbourne, Australia, was a clinical trial specifically designed to assess whether their algorithm for real-time and retrospective therapy adjustment had a significant impact on glycaemic control compared to CGM use without the algorithm (Jenkins et al, 2010). They showed that the algorithm was beneficial when used at initiation of CGM, although the benefit was not sustained when CGM users deployed sensing without applying the algorithm in the crossover part of the study. Following the publication of this study, we have used the algorithm when CGM users have struggled with adjusting therapy in response to their CGM data, and some users have found such an algorithm is of benefit, which is counter to the findings of the study.

In the majority of cases, our CGM users make their own decisions about how to adjust therapy, so the survey by Pettus et al (summarised alongside) is informative in showing how consistent – or not – these decisions are across this group.

There were 222 respondents to the survey, all of the responders were using the Dexcom sensor and 75% were using CGM in combination with an insulin pump. In total, 43% wore the sensor for the recommended 7 days or less, meaning 57% tried to prolong their sensor life beyond 7 days and 32% reported that they wore the sensor for more than 11 days. Almost all used a customised low glucose alert set between 60 and 100 mg/dL (3.3 and 5.5 mmol/L) rather than the default 55 mg/dL (3.05 mmol/L). This suggests those regularly using CGM are not put off by a potential increase in the frequency of hypoglycaemia alarms. This may then explain why 78% reported a reduction in hypoglycaemia frequency since using CGM. Of the responders, 98% had a high-glucose alarm set, and 66% had this set at less than 200 mg/dL (11.1 mmol/L). This again suggests an acceptance of frequent alerts in this user group.

Where there was less consistency among the responders was in the therapy adjustments made in various scenarios. For example, in response to seeing one or two upward arrows, the average usual correctional dose was increased by 111% and 140% respectively, but this varied from 0–600%. In response to seeing one or two downward arrows, the insulin adjustment would be on average 40% and 42% of the usual correctional dose respectively. The range of insulin adjustment here was 0–100%, so some would not adjust their dose at all, while others would omit insulin completely!

Only 28% of respondents regularly downloaded and reviewed their CGM data suggesting that the benefit most users perceived was in the ability to respond in real time to changes in glucose levels. Unsurprisingly, 81% reported real-time trend data or the low and high glucose alerts as the most important features of the CGM technology.

What can we conclude from the mass of information in this survey? CGM users see this principally as a real-time glucose-sensing technology rather than a device to allow retrospective analysis of glucose data. However, the response to the real-time data is highly variable and emphasises the need to develop more structured guidance on how to optimise individual responses. ■

DirecNet Study Group (2008) Use of the DirecNet Applied Treatment Algorithm (DATA) for diabetes management with a real-time continuous glucose monitor (the Free Style Navigator). *Pediatr Diabetes* **9**: 142–7

JDRF Continuous Glucose Monitoring Study Group (2008) Continuous glucose monitoring and intensive treatment of type 1 diabetes. *N Engl J Med* **359**: 1464–76

Jenkins AJ, Krishnamurthy B, Best JD et al (2010) Evaluation of an algorithm to guide patients with type 1 diabetes treated with continuous subcutaneous insulin infusion on how to respond to real-time continuous glucose levels. *Diabetes Care* **33**: 1242–8

Endocr Pract

Survey on CGM data use

Readability	✓✓✓
Applicability to practice	✓✓✓✓✓
WOW! Factor	✓✓✓✓

1 The authors surveyed 222 people with T1D who used continuous glucose monitoring (CGM) daily to understand its effect on insulin adjustments.

2 In one scenario, respondents were asked how much insulin they would take if it had been 4 hours since taking any insulin or eating and their CGM device showed a glucose value of 220 mg/dL (confirmed by self-monitored blood glucose) with a flat rate of change (ROC) arrow. The target glucose was 120 mg/dL (6.7 mmol/L) if they were not planning to eat or exercise. In this scenario, the average correction dose adjustment based on ROC arrows on the CGM system varied dramatically.

3 In particular, when the CGM device showed two ROC arrows up (a glucose increase of >3 mg/dL/min [>0.2 mmol/L/min]) the responders' answers ranged from raising the correction bolus by 0–600% (average 140%). The recommended insulin increase in this instance is 20%.

4 Two ROC arrows down (glucose decrease of >3 mg/dL/min [>0.2 mmol/L/min]) caused respondents to reduce their dose by 42%, and nearly a quarter omitted an insulin dose completely. The recommended insulin dosage adjustment in this instance is to lower by 20%.

5 Nearly 50% of those surveyed had never downloaded CGM data, and users found the real-time data the most important information available from CGM. ROC correctional formulas may need to be developed to provide accurate guidelines and recommendations to go alongside carbohydrate ratio and "correction factors".

Pettus J, Price D, Edelman S (2015) How patients with type 1 diabetes translate continuous glucose monitoring data into diabetes management decisions. *Endocr Pract* **25**: 1–25

Endocrine

Factors associated with glycaemic control with insulin pump use

Readability	✓✓✓
Applicability to practice	✓✓✓✓
WOW! Factor	✓✓✓

1 Continuous subcutaneous insulin infusion therapy (or insulin pump therapy) has been effective in improving glycaemic control for people with T1D; however, not everyone experiences an improvement.

2 The authors sought to identify the factors associated with glycaemic control among people treated with insulin pump therapy using HbA_{1c} as a measure.

3 In a retrospective analysis of 192 people in Poland (133 women and 59 men), medical records, read-outs from pumps and glucose monitoring data was analysed. Participants were included if they had remained under medical care at the department for at least 6 months.

4 The mean age of the participants was 28.9 (±11.2) years, the mean duration of T1D was 14.6 (±7.6) years, mean BMI was 23.5 (±3.1) kg/m^2, and the mean HbA_{1c} of the group was 57 mmol/mol (7.4%).

5 In the univariate logistic regression for reaching the therapeutic target of a HbA_{1c} level <53 mmol/mol (<7%), factors associated with achieving this target were the mean number of daily blood glucose measurements, number of hypoglycaemic episodes per 100 blood glucose measurements, age at examination, and continuous glucose monitoring system use.

6 The study found that the independent predictors included technological and patient-related factors.

Matejko B, Skupien J, Mrozinska S et al (2015) Factors associated with glycemic control in adult type 1 diabetes patients treated with insulin pump therapy. *Endocrine* **48**: 164–9

Diabetes Res Clin Pract

CGM during dialysis

Readability	✓✓✓✓
Applicability to practice	✓✓✓✓
WOW! Factor	✓✓✓✓

1 As part of the DIALYDIAB trial, the impact of iterative sequences of continuous glucose monitoring (CGM) on glucose control in people with diabetes receiving dialysis was investigated.

2 In a before–after monocentric 12-week pilot study, during the first 6 weeks, people were monitored with self-monitoring of blood glucose (SMBG) three times a day. During the second 6-week period, a 5-day blinded CGM was performed at 2-week intervals.

3 Fifteen adults were entered in the study, and dialysis duration before the study was 6.5±6.9 years. Treatments were diet alone or diet plus insulin (80%).

4 Mean CGM glucose level was 8.3±2.5 mmol/L at baseline, 8.2±1.6 mmol/L at the end of the SMBG period and 7.7±1.6 mmol/L at the end of the CGM period (P<0.05 vs baseline).

5 Iterative use of CGM for people receiving dialysis may improve glycaemic control.

Joubert M, Fourmy C, Henri P et al (2015) Effectiveness of continuous glucose monitoring in dialysis patients with diabetes: the DIALYDIAB pilot study. *Diabetes Res Clin Pract* **107**: 348–54

Diabet Med

Best CGM strategy for maintaining glucose control

Readability	✓✓✓✓
Applicability to practice	✓✓✓✓
WOW! Factor	✓✓✓✓

1 In a 100-day randomised controlled trial, the best strategy for glucose monitoring was investigated: continuous glucose monitoring (CGM) with alarm, CGM without alarm or self-monitoring of blood glucose (SMBG).

2 The 145 participants were split in three similar-sized groups with similar baseline characteristics. There was a mix of T1D and T2D, and a mix of multiple daily injection users and pump users.

3 The CGM with alarm group spent less time in hypoglycaemia than the SMBG group (P=0.03), and both CGM groups spent less time outside the glucose target range than the SMBG group.

4 There was no difference in HbA_{1c} between the groups after the study period, but the proportion of participants with a reduction of ≥6 mmol/mol (≥0.5%) was higher in the CGM groups with and without alarms.

New JP, Ajjan R, Pfeiffer AF, Freckmann G (2015) Continuous glucose monitoring in people with diabetes: the randomized controlled Glucose Level Awareness in Diabetes Study (GLADIS). *Diabet Med* **32**: 609–17

Endocrinol Diabetes Metab Case Rep

Suspending basal insulin case reports

Readability	✓✓✓
Applicability to practice	✓✓✓✓
WOW! Factor	✓✓✓

1 In this case report, two female adults with T1D who began treatment with continuous subcutaneous insulin infusion were required to increase their previous breakfast insulin-to-carbohydrate ratio in order to achieve postprandial glycaemic goals. However, they simultaneously presented recurrent episodes of late hypoglycaemia several hours after breakfast bolus.

2 To avoid this in future, the clinical team advised setting a basal insulin rate to zero units per hour during the 6 hours after breakfast. This was suggested instead of increasing the timing of the bolus after breakfast.

3 Both individuals were required to take a mid-morning snack of 10–20 g of carbohydrates.

4 Three years on from introducing this adjustment, neither individual had experienced any complications.

Boronat M, Sánchez-Hernández RM, Rodríguez-Cordero J et al (2015) Suspension of basal insulin to avoid hypoglycemia in type 1 diabetes treated with insulin pump. *Endocrinol Diabetes Metab Case Rep* **2015**: 140081

"The patient response to real-time continuous glucose monitoring data is highly variable and emphasises the need to develop more structured guidance on how to optimise these responses."