Technology

DIABETES CARE

Improved HbA_{1c} with use of a real-time CGM algorithm

Readability	✓✓✓✓
Applicability to practice	✓✓✓✓
WOW! factor	✓✓✓✓

1 This study was designed to evaluate an algorithm that guides people with T1D using continuous subcutaneous insulin infusion (CSII) on how to respond to real-time continuous glucose monitoring (RT-CGM) feedback.

2 A total of 60 people using CSII (aged 13–70 years; HbA_{1c} ≤9.5% [≤80 mmol/mol]) participated in this 16-week randomised controlled trial.

3 Participants were randomised into two groups: group A was treated with CSII and RT-CGM plus the algorithm and group B with CSII and RT-CGM without the algorithm.

4 Primary outcome was time in target glucose range (4–10 mmol/L), measured by masked CGM over 6 days.

5 A second phase of the study involved 16 weeks of follow-up where group B received treatment with the algorithm.

6 In phase 1 there was no difference between the groups in time spent in the target glucose range, however more people in group A achieved an HbA_{1c} level of ≤7% [≤53 mmol/mol] than in group B (P=0.015).

7 In phase 2, HbA_{1c} returned to baseline level in group A, but did not change in group B.

8 The authors concluded that use of the algorithm did not change the time spent in target glucose range, but did significantly reduce HbA_{1c} levels.

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: a randomized controlled trial. *Diabetes Care* **33**: 1242–8

The importance of algorithms for interpreting and acting on continuous glucose monitoring data

Peter Hammond, Consultant in General Medicine, Harrogate

There is an increasing evidence base suggesting that use of sensor-augmented insulin pump therapy – combining real-time continuous glucose monitoring (RT-CGM) with continuous subcutaneous insulin infusion (CSII), commercially available as the Paradigm® (Medtronic, Watford) system – can result in a significant lowering of HbA_{1c}, particularly when the sensors are used almost continually (Juvenile Diabetes Research Foundation CGM Study Group et al, 2009). However, evidence suggests that there is a need to provide RT-CGM users, in combination with whatever mode of intensified insulin therapy they are using, with standardised advice to allow them to interpret RT-CGM data and to implement effective changes to their insulin therapy, both immediately, in response to significant trends in glucose levels, and following review of the data from an extended period of time.

In the article summarised alongside, Jenkins et al (2010) from the University of Melbourne describe their experience using the ALGOS algorithm, which they created to educate and guide people with type 1 diabetes starting to use RT-CGM in combination with CSII. This algorithm was presented to users in the form of a handbook; a wallet card advising them of changes to make immediately in response to glucose trends (reactive algorithm); and a wallchart explaining how to interpret data downloads, from the sensor via the Medtronic Carelink software, to make adjustments to settings for basal and bolus insulin delivery (proactive algorithm).

The users of the system were randomised to either have access to the algorithm, or not, for the first phase. In the second phase, the group who had access to the algorithm went back to CSII alone (without RT-CGM) while those who had not used the algorithm initially were given access to it and, in addition, had a handheld version that could be used to enter data and get a recommendation as to what reactive change to make.

There was no difference between the two groups in the primary outcome: time spent in the glycaemic target range (based on data from retrospective CGM performed for 6 days at baseline and the end of each study phase). The group who used the algorithm from the start did achieve a significant reduction in HbA_{1c} in the first phase of the study. However, once they had no access to RT-CGM in the second phase, HbA_{1c} rose back above the baseline level. Interestingly, the use of RT-CGM by adolescents in the study – who, as a group, have had bad press in other CGM studies – was as frequent as the adults, but they had no change in HbA_{1c} before or after use of the algorithm. The group who had access to the algorithm in the second phase of the study had no significant change in HbA_{1c} in either phase.

What can we conclude from all this? It would appear that use of the algorithm in those who were naïve to RT-CGM allowed them to make changes that improved control, and that the more adjustments they made, the better the improvement. However, if no specific assistance is provided from the outset, self-interpretation of data and subsequent self-management using RT-CGM does not, in itself, improve glycaemic control. In addition, when an algorithm is introduced at a later date it is ineffective, possibly because the user prefers to continue with now established behaviours. Furthermore, once RT-CGM is withdrawn from those who have benefited from its use, their control reverts to baseline at best.

This evidence supports the use of algorithms from initiation of RT-CGM, and hopefully refinements in the algorithms will improve glycaemic outcomes further. When glycaemic control improves with RT-CGM it should not be withdrawn, but what we now need to know is whether it needs to be used as frequently (about 4.5 days a week on average, in this study), or whether less frequent use in those trained to use it effectively may make for a more cost-effective intervention.

Juvenile Diabetes Research Foundation Continuous Glucose Monitoring Study Group et al (2009) *Diabetes Care* **32**: 1947–53

"This artificial pancreas was found to provide comparable postprandial glycaemic control to usual care, with a tendency to a higher percentage of time spent in euglycaemia."

THE DIABETES EDUCATOR

CSII improved HbA_{1c} in people with T2D

Readability	✓✓✓✓
Applicability to practice	✓✓✓✓
WOW! factor	✓✓✓

1 This pilot study aimed to evaluate whether treatment with CSII would be as effective as multiple daily injections in people with poorly controlled T2D.

2 CSII was initiated in 15 people (age, 40–64 years) with T2D (HbA_{1c} ≥8% [≥64 mmol/mol]).

3 At 1 year, there was a significant decrease in mean HbA_{1c} (P=0.04).

4 There was a significant reduction in the use of basal insulin after 1 year (P=0.02), but no significant difference in bolus insulin dose was noted.

5 The authors concluded that CSII could be considered as an alternative treatment for people with poorly controlled T2D.

Wolff-McDonagh P, Kaufmann J, Foreman S et al (2010) Using insulin pump therapy in poorly controlled type 2 diabetes. *Diabetes Educ* **36**: 657–65

DIABETES TECHNOLOGY & THERAPEUTICS

CSII improves hypo awareness

Readability	✓✓✓
Applicability to practice	✓✓✓✓
WOW! factor	✓✓✓

1 The effect of CSII on hypoglycaemia awareness was evaluated in people with T1D and repeated hypoglycaemic episodes.

2 Continuous glucose monitoring was used 72 hours before CSII and a hypoglycaemia-inducing test evaluated hypoglycaemic symptoms.

3 At baseline, 19 of the 20 participants experienced hypoglycaemia unawareness, which significantly diminished to three out of 20 following CSII therapy.

4 Non-severe episodes of hypoglycaemia decreased from 5.40±2.09 episodes per person-year at baseline to 2.75±1.74 (P<0.001).

5 Non-severe episodes of hypoglycaemia fell from 1.25±0.44 at baseline to 0.05±0.22 (P<0.001).

6 CSII was found to improve hypoglycaemia awareness in people with T1D.

Giménez M, Lara M, Conget I (2010) Sustained efficacy of continuous subcutaneous insulin infusion in type 1 diabetes subjects with recurrent non-severe and severe hypoglycemia and hypoglycemia unawareness: a pilot study. *Diabetes Technol Ther* **12**: 517–21

DIABETES CARE

Continuous glucose monitoring is cost-effective long term

Readability	✓✓✓
Applicability to practice	✓✓✓✓
WOW! factor	✓✓✓

1 The cost-effectiveness of continuous glucose monitoring (CGM) in people with T1D was compared with standard blood glucose monitoring.

2 Cost-effectivness analyses were conducted in trial populations that had experienced a significant glycaemic benefit from CGM use.

3 In the cohort with an HbA_{1c} level ≥7.0% (≥53 mmol/mol), CGM was projected to reduce the lifetime probability of microvascular complications, and the average gain in quality-adjusted life-years (QALYs) was 0.60. The incremental cost-effectiveness ratio (ICER) was US$98 679 per QALY.

4 In the HbA_{1c} <7.0% (<53 mmol/mol) cohort the average gain in QALYs was 1.11 and the ICER was US$78 943 per QALY.

5 The authors concluded that long-term projections indicated that CGM is cost-effective at the US$100 000 per QALY threshold.

Huang ES, O'Grady M, Basu A (2010) The cost-effectiveness of continuous glucose monitoring in type 1 diabetes. *Diabetes Care* **33**: 1269–74

JOURNAL OF DIABETES SCIENCE & TECHNOLOGY

Closed-loop system performs well postprandially

Readability	✓✓✓✓
Applicability to practice	✓✓✓
WOW! factor	✓✓✓✓

1 In this pilot study the efficacy of a closed-loop system to control postprandial glucose excursions in people with T1D was evaluated.

2 Six participants treated with CSII ate a standardised meal on three days: day 1 was a control; day 2 was a run-in for the algorithm; and analysis took place on day 3.

3 The artificial pancreas was a continuous glucose monitor, an algorithm running on a computer and two pumps – one to deliver insulin and one glucagon.

4 One person was excluded from analysis due to technical problems with CGM. Three of the remaining five participants were male, mean age was 50.8 years and mean HbA_{1c} level was 8.7% (72 mmol/mol).

5 Venous blood glucose levels were taken up to 300 minutes after the meal was consumed. The mean postprandial venous blood glucose concentration on day 1 was 11.39 mmol/L compared with 7.12 mmol/L on day 3 (P=0.14).

6 On day 1, the percentage of time spent in euglycaemia after the meal was 31% versus 60% on day 3 (P=0.08). The amount of time spent with glucose levels below 3.9 mmol/L was 19% on day 1 compared with 11% on day 3 (P=1.00), and time above 10 mmol/L was 60% on day 1 versus 29% on day 3 (P=0.22).

7 This artificial pancreas was found to provide comparable postprandial glycaemic control to usual care, with a tendency to a higher percentage of time spent in euglycaemia.

van Bon AC, Hermanides J, Koops R et al (2010) Postprandial glycemic excursions with the use of a closed-loop platform in subjects with type 1 diabetes: a pilot study. *J Diabetes Sci Technol* **4**: 923–8