Management of type 1 diabetes

Continuous glucose monitoring sensor placement and its role in the artificial pancreas

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People with diabetes and healthcare professionals alike struggle to come to terms with the vast amount of data provided by continuous glucose monitoring (CGM) sensors. Many of us find it difficult to make sense of capillary blood glucose measurements made four times a day, let alone the stream of information provided second-by-second with CGM. The devices are becoming more accurate and easier to use, and wireless technology can even allow remote monitoring by others which, for the parents of children with diabetes, could be comforting. Nevertheless, in the real world, a high proportion of even the most enthusiastic users stop using CGM after 6 months to 1 year, owing to information overload.

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The holy grail, of course, is closed-loop pump and sensor technology – the true "artificial pancreas." Both for this and for those people who currently use CGM to provide tight glycaemic control, any lag between changes in blood glucose levels measured in capillary blood and subcutaneous tissue fluid could result in hypoglycaemia or hyperglycaemia.

In the study by Burnett et al (summarised alongside), comparisons were made between glucose sensors placed in the intravenous, intra-arterial, subcutaneous and intraperitoneal space in pigs. These showed that intraperitoneal kinetics were more than twice as fast as subcutaneous kinetics (mean time constant, 5.6 min vs 12.4 min).

These discoveries set the scene for comparative studies of sensors placed in the intraperitoneal space compared to standard CGM sensor placement. Whether these performance characteristics will be translated into significant benefits for people with diabetes remains to be seen. ■

Diabetes Care

Suspending insulin delivery in a home closed-loop system

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

1 These authors have previously created an automated algorithm that can predict nocturnal hypoglycaemia and suspend insulin delivery via a closed-loop system. In this trial, they evaluated the system in a group of 45 people with T1D over a 42-night period.

2 The system was randomised either to operate or not on a given night, providing an elegant way to mask the treatment both to participants and clinicians. When operating, the algorithm suspended insulin delivery if blood glucose levels were predicted to fall below 80 mg/dL (4.4 mmol/L) in the next 30 minutes.

3 Over a total of 942 nights when the algorithm was engaged, the pump was suspended on 719 nights (76%). As a result, hypoglycaemia (blood glucose ≤60 mg/dL [≤3.3 mmol/L]) occurred in 21% of nights in this group, compared with 33% in control nights ($P<0.001$).

4 The cumulative duration of hypoglycaemia was significantly lower in the intervention group. Despite this, the time spent in hyperglycaemia did not differ between the two groups.

Maahs DM, Calhoun P, Buckingham BA et al (2014) A randomized trial of a home system to reduce nocturnal hypoglycemia in type 1 diabetes. *Diabetes Care* **37**: 1885–91

Diabetes

Placement of CGM sensors in the peritoneal space reduces sensor delay

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

1 Typically, continuous glucose monitoring (CGM) sensors are placed in the subcutaneous space. While this is safe and results in few complications, measurements of blood glucose lag several minutes behind the actual levels.

2 Conversely, CGM sensors placed intravenously provide real-time measurements of blood glucose levels but have an unacceptable safety profile. Placing CGM sensors in the intraperitoneal space, however, may provide a good compromise in terms of measurement delay and safety.

3 As reductions in delays of the feedback loop have been shown to improve artificial pancreas performance, these authors compared the glucose kinetics of intraperitoneally and subcutaneously placed sensors.

4 Multiple sensors were placed in the intraperitoneal, subcutaneous, intravenous and intra-arterial spaces in eight pigs, which then underwent an intravenous glucose tolerance test.

5 Intraperitoneal glucose kinetics were found to be, on average, 2.3-times as fast as the subcutaneous kinetics (mean time constant, 5.6 min vs 12.4 min)

6 Given that insulin has also been shown to have faster kinetics when injected peritoneally rather than subcutaneously, the authors conclude that artificial pancreas technologies could be improved by placing both the sensor and the insulin pump line in the intraperitoneal space.

Burnett DR, Huyett LM, Zisser HC et al (2014) Glucose sensing in the peritoneal space offers faster kinetics than sensing in the subcutaneous space. *Diabetes* **63**: 2498–505

Diabet Med

Effects of advanced carbohydrate counting in T1D

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

1 In this systematic review, the authors assessed the effects of advanced carbohydrate counting on glycaemic control, psychosocial measures, weight loss and adverse events in people with T1D.

2 In total, 27 studies, with populations ranging from nine to 9583 people, met the inclusion criteria. However, the studies were too heterogeneous for a meta-analysis to be carried out.

3 All but one very small study demonstrated reductions in HbA_{1c} (ranging from 0.4% to 1.1% [4.4– 12.0 mmol/mol]) with advanced carbohydrate counting.

4 Counting was also generally associated with significant but clinically negligible improvements in psychosocial measures, including general and diabetes-related quality of life and treatment satisfaction. There was an inconsistent relationship between with weight gain/loss.

5 Most studies in which hypoglycaemia was examined showed no significant effect; however, the regimen reduced the incidence of severe hypoglycaemia.

6 It should be borne in mind that the participants in these studies were a selected group of motivated individuals who were able and willing to use advanced carbohydrate counting, and that these results may not apply to all people with T1D.

7 The authors conclude that, while current evidence is not sufficiently robust, this method appears to be preferable to other insulin-dosing procedures.

Schmidt S, Schelde B, Nørgaard K (2014) Effects of advanced carbohydrate counting in patients with type 1 diabetes: a systematic review. *Diabet Med* **31**: 886–96

Diabetologia

A 10-second sprint raises glycaemia in exercise even after earlier hypoglycaemia

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

1 A 10-second sprint at >80% of the maximal rate of oxygen consumption has previously been shown to protect against hypoglycaemia resulting from subsequent moderate-intensity exercise in people with T1D.

2 However, given that antecedent hypoglycaemia reduces the counterregulatory response to moderate exercise, by dampening increases in catecholamine, glucagon and cortisol, it is uncertain whether the effects of sprinting persist in people who have had hypoglycaemia earlier in the day.

3 Therefore, these authors evaluated the effects of morning hypoglycaemia on both the counterregulatory and blood glucose responses to a 10-second sprint in eight young adults with T1D.

4 On two separate days, each participant performed an afternoon sprint following either hypoglycaemia or euglycaemia in the morning, and the levels of blood glucose and glucoregulatory hormones were compared between the two conditions.

5 Neither blood glucose nor hormone levels were significantly different between the two conditions.

6 These findings indicate that morning hypoglycaemia should not alter the protective effects of sprinting against exercise-induced hypoglycaemia; however, the authors caution that this interpretation still needs to be tested in future studies.

Davey RJ, Paramalingam N, Retterath AJ et al (2014) Antecedent hypoglycaemia does not diminish the glycaemia-increasing effect and glucoregulatory responses of a 10 s sprint in people with type 1 diabetes. *Diabetologia* **57**: 1111–8

Diabetes Care

Neurocognitive deficits detectable at T1D diagnosis in children

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

1 Persistent and severe fluctuations in blood glucose levels are likely to occur in the time leading up to a diagnosis of diabetes, potentially with neurotoxic effects.

2 Therefore, the authors sought to assess whether neurocognitive impairments were observable at T1D diagnosis, and whether these had an effect on subsequent glycaemic control 1 year later.

3 A total of 147 children/adolescents (age, 5–18 years) underwent neurocognitive assessment at T1D diagnosis and were compared with normative population expectations.

4 Children with T1D performed significantly below normative expectations, particularly in terms of psychomotor speed (>1 standard deviation [SD] from the norm), phonemic fluency (0.8 SD) and visuomotor integration (0.7 SD).

5 Measures of executive functioning, attention and reading ability were largely normal, suggesting that malaise or fatigue were unlikely to be a factor and that the visuomotor system was specifically affected.

6 At 1 year after diagnosis, impaired psychomotor speed was significantly associated with poor glycaemic control (HbA_{1c} ≥80 mmol/mol [≥9.5%]) after adjustment for ethnicity, gender and reading ability.

7 Neurocognitive impairment may, therefore, predict subsequent glycaemic control and could be targeted to improve T1D management.

Schwartz DD, Axelrad ME, Anderson BJ (2014) Neurocognitive functioning in children and adolescents at the time of type 1 diabetes diagnosis: associations with glycemic control 1 year after diagnosis. *Diabetes Care* **37**: 2475–82

"These findings indicate that morning hypoglycaemia should not alter the protective effects of sprinting against exercise-induced hypoglycaemia; however, the authors caution that this interpretation still needs to be tested in future studies."