Technology

The Paradigm® Veo™ System: Benefits and safety

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The benefits and safety of the low-glucose suspend (LGS) of insulin delivery via continuous subcutaneous insulin infusion (CSII), a feature of the Medtronic Paradigm® Veo™ system, are gradually becoming clearer.

In the study by Ly et al (2012; summarised alongside) the authors observed the effect of 2 hours of LGS on subsequent glucose parameters. There were 24 people in the study, all of whom had T1D and hypoglycaemia unawareness. Prior to commencing sensor-augmented pump therapy they experienced on average 45.8 episodes of severe hypoglycaemia per 100 patient years.

The median percentage of sensor use was 72%. There were 406 episodes of LGS which lasted the full 2 hours dictated by the system – 80% (*n*=324) of these occurred overnight, and in 48% (*n*=156) of these nocturnal episodes there was no response from the user. A total of 81% (*n*=126) of these episodes with no patient response took place before 03.00 hours. In these cases, the researchers evaluated the glucose profiles for the subsequent 4 hours, allowing evaluation of 2 hours of LGS followed by 2 hours in which the insulin infusion was restarted without any user intervention. One quarter of users had at least one such suspend per week during the 6-month study period.

The LGS feature was initiated when glucose levels fell below 3.3 mmol/L. The fall in sensor glucose was arrested as soon as the insulin infusion was suspended. Sensor glucose then rose steadily to a mean of 5.5 mmol/L at the time insulin infusion resumed, and then to 8.6 mmol/L in the 2 hours following. The mean capillary blood glucose level at the first morning check was 10.3 mmol/L. In 14 cases there was a second overnight suspend lasting 2 hours, as sensor glucose levels had not risen sufficiently after 30 minutes of insulin infusion being resumed. In these cases the mean sensor glucose at the end of the second suspend period was 6.2 mmol/L, but the mean capillary glucose level in the morning was 13.3 mmol/L.

Encouragingly, there was a significant reduction in hypoglycaemia unawareness scores when the sensor-augmented pump therapy was used, and there were no episodes of severe hypoglycaemia during the time of study, nor were there any episodes of diabetic ketoacidosis.

> *"It is reassuring that the low-glucose suspend feature appears safe and produces clear benefits for the user, particularly in the context of hypoglycaemia unawareness."*

It is reassuring that the LGS feature of CSII appears safe and produces clear benefits for the user, particularly in the context of hypoglycaemia unawareness. The results from this study also emphasise the potential discrepancy between sensor readings and capillary blood glucose measurements at times of rapid glucose change, with the sensor underestimating the blood glucose levels following episodes of LGS. However, in no case was there any acute metabolic derangement as a consequence of LGS usage.

The next advancement in the technology promised by Medtronic is a "predictive LGS", which will allow suspension of insulin infusion when hypoglycaemia is predicted to occur based on the trend in sensor glucose levels (Roy et al, 2012).

Studies such as this which demonstrate the benefit and safety of the LGS feature are crucial in providing assurance before such further technological advances are introduced into clinical practice.

Roy A, Keenan B, Spital GB et al (2011) Short-term glucose prediction algorithm reduces hypoglycaemia among virtual patients. Presented at: *the 48th Annual Meeting of the European Association for the Study of Diabetes* (presentation number 193). Berlin, Germany, 1–5 October

DIABETES CARE

Capillary blood glucose responses with the Paradigm® Veo™ system

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

1 The authors compared the Medtronic Paradigm® Veo™ system (with continuous glucose monitoring and low-glucose suspend [LGS] function) with standard insulin pump therapy over 6 months in 24 people with T1D and impaired hypoglycaemia awareness.

2 The LGS threshold was a blood glucose level of 3.3 mmol/mol. The authors recorded the time and duration of LGS function-activated insulin suspension, and evaluated overnight suspend events occurring prior to 03.00 hours with and without patient intervention. Following 2-hour suspend events, blood glucose profiles were analysed.

3 Over 2493 patient-days, 3128 LGS events occurred (median duration 11.2 min) with 13% (*n*=406) lasting for 2 hours. No LGS-related hypoglycaemia or diabetic ketoacidosis was reported.

4 A total of 81% (*n*=126) of overnight suspend events without patient intervention occurred before 03.00 hours. Glucose rose steadily in the 2 hours following insulin suspension, and the mean sensor glucose level at the end of these events was near-normal at 5.49 mmol/mol. Multiple overnight suspend events occurred in 14 people.

5 Over 6 months, hypoglycaemia awareness score improved and there was no change in HbA_{1c}. The authors concluded that people with T1D are at a low risk of adverse outcomes using LGS technology.

Ly TT, Nicholas JA, Retterath A et al (2012) Analysis of glucose responses to automated insulin suspension with sensor-augmented pump therapy. *Diabetes Care* **35**: 1462–5

"The hybrid nanogels could detect glucose in a sensitive and selective manner, whilst systematically regulating insulin release."

WORLD JOURNAL OF DIABETES

CIPII remains a safe treatment option: A 10-year study

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

1 The authors monitored the complications and operation-free period (OFP) associated with continuous intraperitoneal insulin infusion (CIPII) use over a decade (2000–2011) in 56 people with T1D. They performed subanaylses between those treated between 2000 and 2007, and from 2007 onwards.

2 People were followed up for a median of 283 patient years, during which time 70 complications occurred – the most frequent were catheter occlusion (37%), pump dysfunction (17.1%), pain at the pump site (15.7%) and infections (10%). Nine episodes of ketoacidosis occurred during follow-up.

3 Complications accounted for 50 re-operations (one per 5.6 patient-years of follow-up), most frequently pump and catheter explantation (34%) and catheter replacement (26%).

4 The median OFP between initial implantation and re-operation was 4.5 years (95% confidence interval, 3.9–5.0 years) per 283 patient-years.

5 People who started CIPII therapy after 2007 had a significantly greater number of pump dysfunctions and significantly fewer re-operations to remove pumps and catheters than those who started therapy between 2000 and 2007. The OFP remained stable across the two time frames. No CIPII mortality was reported.

6 The authors concluded that CIPII is still a safe treatment option for people with indications including "brittle diabetes".

van Dijk PR, Logtenberg SJ, Groenier KH et al (2012) Complications of continuous intraperitoneal insulin infusion with an implantable pump. *World J Diabetes* **3**: 142–8

DIABETES TECHNOL THER

CGMS arrows predict glycaemia in T1D

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

1 The authors investigated whether the arrow position on a continuous glucose monitoring system (CGMS; an indication of the direction of interstitial blood glucose change) can predict the course of capillary blood glucose (CBG) change 15 minutes later.

2 The researchers studied 23 people with T1D receiving CGMS education and taking intensive insulin therapy. A total of 242 observations were made. CBG was measured at 0 and 15 minutes.

3 Compared with ascending arrows (n=40) and stable arrows (n=147), descending arrows (n=55) had subsequently lower CBG levels 15 minutes later (decrease in CBG, -0.83±1.55 mmol/L and 0.04±0.09 mmol/L; P<0.001 and P<0.01, respectively). A similar pattern was observed when interstitial CBG was <5.55 mmol/L. A total of 4.5% of arrows were grossly erroneous.

4 The authors concluded that the CGMS could have a role in the prevention of hypoglycaemia in people with T1D taking intensive insulin therapy.

Gonzalez C, Maury E, Barcos I et al (2012) Can continuous glucose monitoring systems predict glycemia? *Diabetes Technol Ther* 30 Aug [Epub ahead of print]

JOURNAL OF DIABETES, SCIENCE AND TECHNOLOGY

A hybrid nanogel for closed-loop control of glucose

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

1 The authors aimed to develop insulin-releasing, inorganic hybrid nanogels suitable for closed-loop glucose control.

2 Zinc oxide@poly(NIPAM-AAm-FPBA) hybrid nanogels were developed and studied for their glucose-repsonsive properties at varying glucose levels in phosphate-buffered saline and serum blood samples (obtained after overnight fasting) from 11 adults with diabetes. An *in vitro* insulin-release study was also carried out.

3 Over a glucose concentration range of 1–30 mmol/L the hybrid nanogels could detect glucose in a sensitive and selective manner, whilst systematically regulating insulin release.

4 The authors concluded that the study results may contribute to the development of a miniature closed-loop system for diabetes management.

Wu W, Chen S, Hu Y et al (2012) A fluorescent responsive hybrid nanogel for closed-loop control of glucose. *J Diabetes Sci Technol* **6**: 892–901

PEDIATRIC DIABETES

Carbohydrate counting in children with T1D

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

1 The authors investigated the effect of carbohydrate counting (CC) with a bolus calculator on post-prandial blood glucose levels in children with T1D using insulin pumps.

2 Young people were randomised to either manual CC or CC with a bolus calculator in the pump and CC education, or to a control group with dietary education, and followed up for 1 year.

3 HbA_{1c} did not differ between the groups. CC use lowered plasma glucose fluctuations and increased post-meal glucose values to within target (4–8 mmol/mol; this was not significant). All young people who had used CC wanted to continue use after the study.

4 The authors concluded that CC use can help to reduce overall and post-meal plasma glucose fluctuations.

Enander R, Gundevall C, Strömgren A et al (2012) Carbohydrate counting with a bolus calculator improves post-prandial blood glucose levels in children and adolescents with type 1 diabetes using insulin pumps. *Pediatr Diabetes* 8 Jul [Epub ahead of print]