Technology

Calculating bolus doses in insulin pump therapy: Not just for carbohydrates, but now for fat and protein too?

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While the advantage of insulin pump therapy over multiple daily injections is largely attributed to its ability to deliver variable basal rates of insulin infusion, there is increasing evidence that fully optimised insulin pump therapy is achieved by more complex bolus dosing.

Several studies have attempted to determine what is the most effective method of bolus insulin delivery, in particular whether dual-wave or extended boluses result in more stable blood glucose levels postprandially. Most of these studies have used pizza for their test meals, as the mix of carbohydrate, protein and fat results in a slower rise in blood glucose levels, and this may be more effectively dealt with by the extended bolus (Chase et al, 2002; Jones et al, 2005). There has also been some interest, particularly from a few European centres, on using a calculation for insulin bolus dosing that includes not only the carbohydrate content of the meal, but also the protein and fat content (Kordonouri et al, 2010; Pankowska and Błazik, 2010).

The study from Pankowska et al (2011; summarised alongside) describes their attempt to construct an algorithm to address this issue and determine whether this approach is more effective in controlling blood glucose levels following a pizza meal.

The control group were given a standard bolus dose based on the carbohydrate content of the food, averaging 5.9 units; the intervention group were given the same standard bolus, and then a bolus extended over 6 hours based on the fat and protein content of the meal, the total dose averaging 9.6 units. The blood glucose levels remained virtually unchanged for 4 hours in the intervention group, then fell by about 1 mmol/L over the next 2 hours, with four hypoglycaemic events in 12 individuals compared with none in the control group. In contrast, blood glucose levels rose throughout the 6 hours in the control group, and were about 3 mmol/L above baseline at 6 hours.

Should this change current practice in terms of bolus dosing for pump users? The study itself can be criticised in that the control group used a standard bolus, whereas a dual-wave bolus might be more effective in controlling the postprandial blood glucose rise following a pizza. Giving the same bolus dose, but as a dual-wave, would probably have still resulted in rising blood glucose levels, but they would likely have been closer to baseline at the end of 6 hours. Furthermore, in the intervention group, blood glucose levels were dropping by the end of this time and there were episodes of hypoglycaemia. Therefore, the total insulin dose was probably overestimated by this algorithm.

Given that most people find carbohydrate counting alone sufficiently challenging, the addition of fat and protein counting would probably not be welcomed by most pump users. The effect of fat and protein on postprandial hyperglycaemia is clearly important, and if more evidence becomes available pump manufacturers may decide to include fat and protein content in bolus calculators. Currently a simpler way to implement the findings of this study may be to increase the insulin : carbohydrate ratio for a pizza or similar meal, and deliver this as a dual-wave bolus, with 50% as standard and 50% as an extended bolus.

Chase HP, Saib SZ, MacKenzie T et al (2002) Post-prandial glucose excursions following four methods of bolus insulin administration in subjects with type 1 diabetes. *Diabet Med* **19**: 317–21

Jones SM, Quarry JL, Caldwell-McMillan M et al (2005) Optimal insulin pump dosing and postprandial glycemia following a pizza meal using the continuous glucose monitoring system. *Diabetes Technol Ther* **7**: 233–40

Kordonouri O, Hartmann R, Remus K et al (2010) Supplementary fat plus protein (CFP) counting for insulin bolus calculation in children with pump therapy is superior to conventional carbohydrate (CARB) counting. *70th Scientific Sessions of the American Diabetes Association*, June 25–29, Orlando, Florida: 303-OR

Pankowska E, Błazik M (2010) Bolus calculator with nutrition database software, a new concept of prandial insulin programming for pump users. *J Diabetes Sci Technol* **4**: 571–6

DIABETES TECHNOLOGY AND THERAPEUTICS

Glycaemia better controlled with dual-wave insulin bolus

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

1 Insulin pumps integrated with a glucose monitoring system deliver prandial insulin based on the carbohydrate (CHO) content of the meal; however, fat–protein nutrients may also cause postprandial hyperglycaemia.

2 A modernised algorithm for calculating insulin pump delivery would therefore include an insulin bolus based on the CHO content of the meal as well as a modified, extended bolus with consideration of the fat–protein component of the meal.

3 The authors examined the effect of a fat–protein meal on hyperglycaemia and the effectiveness of a modernised algorithm for calculating insulin dose for both CHO and fat–protein components of a meal to control postprandial hyperglycaemia.

4 Twenty-four people with T1D on insulin pump therapy were randomised to receive either dual-wave insulin boluses based on the CHO and fat–protein content of a meal or insulin boluses based on the usual CHO content of a meal (control group); analyses included blood glucose, C-peptide and glucagon levels before and up to 6 hours after the meal.

5 There were no significant differences in glucagon and C-peptide secretion between the groups, and before and after the meal.

6 The authors concluded that a mixed meal effectively increases postprandial blood glucose levels after 4–6 hours, and that dual-wave insulin bolus is effective in controlling postprandial glycemia.

Pankowska E, Błazik M, Groele L (2011) Does the fat-protein meal increase postprandial glucose level in type 1 diabetes patients on insulin pump. *Diabetes Technol Ther* **14**: 16–22

DIABETES TECHNOLOGY AND THERAPEUTICS

QOL improved in people using an insulin bolus-patch

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

1 Although insulin therapy can improve glycaemic control, barriers that impede its effectiveness include difficulty of insulin administration and multiple dosing, as well as impact on quality of life (QOL).

2 The objective of this study was to compare the efficacy, device satisfaction and QOL in people with diabetes using a novel insulin bolus-patch (Finesse™, Calibra Medical Inc.) versus pen/syringe devices that deliver bolus insulin.

3 In total, 26 people with T1D and 12 people with T2D were randomised to bolus-patch (n=19) or injection device (n=19; 10 pen/9 syringe) therapy to deliver pre-meal insulin for 6 weeks before crossing over treatment.

4 Clinic visits were at baseline, 6-week crossover and 12 weeks; outcome measures included equivalence in mean daily seven-point blood glucose (MDBG), adverse events, device safety, device satisfaction and QOL.

5 Mean MDBG in the bolus-patch group was equivalent to that in the injection device group (8.61±0.28 vs 9.02±0.26 mmol/L; P=0.098).

6 Pre-meal bolus-patch insulin delivery resulted in a lower standard deviation and lower coefficient of variation of the seven-point MDBG measurements, indicating less glycaemic variability.

7 It was concluded that bolus-patch insulin delivery showed good tolerability, significant device satisfaction and improved QOL; 76% of participants in the study would choose to switch to this method of delivery (P=0.001).

Bohannon N, Bergenstal R, Cuddihy R et al (2011) Comparison of a novel insulin bolus-patch with pen/syringe injection to deliver mealtime insulin for efficacy, preference and quality of life in adults with diabetes. *Diabetes Technol Ther* **13**: 1031–7

DIABETES TECHNOLOGY AND THERAPEUTICS

CGM and problem-solving skills improve management of T2D

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

1 Continuous glucose monitoring (CGM) technology can enhance behaviour change in people with diabetes with suboptimal glycaemic control.

2 This study aimed to compare the effectiveness of CGM with problem-solving skills (n=12) and CGM with standard diabetes care (n=15) in improving physical activity behaviour in 27 women with T2D randomly assigned to one of the two regimens.

3 Efficacy data included intensity and duration of physical activity, problem-solving skills and HbA_{1c} level; parameters were measured at baseline and at 12 weeks for both regimens.

4 Although treatment satisfaction was high, it was higher in the CGM plus problem-solving group (P=0.07).

5 Women in the CGM plus problem-solving group showed significantly improved problem-solving skills as well as increased physical activity behaviour.

Allen N, Whittemore R, Melkus G (2011) A continuous glucose monitoring and problem-solving intervention to change physical activity behaviour in women with type 2 diabetes. *Diabetes Technol Ther* **13**: 1091–9

DIABETES TECHNOLOGY AND THERAPEUTICS

Learning algorithm for artificial pancreas improves control

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

1 A novel learning system was integrated into the MD-Logic Artificial Pancreas (MDLAP) system (Schneider Children's Medical Centre of Israel, Petah Tikva, Israel) to establish individual patient profiles (open-loop data) and then make adjustments to the MDLAP system for insulin delivery (closed-loop operation) to optimise glycaemic control.

2 The performance of the learning algorithm-integrated MDLAP system was tested in seven experiments using the Virginia/Padova simulator.

3 It was concluded that the learning algorithm-integrated MDLAP system effectively characterised patient profiles from open-loop data and adjusted insulin delivery to provide improved glycaemic control during closed-loop operations.

Miller S, Nimri R, Atlas E et al (2011) Automatic learning algorithm for the MD-Logic Artificial Pancreas System. *Diabetes Technol Ther* **13**: 983–90

DIABETES TECHNOLOGY AND THERAPEUTICS

Insulin pump therapy at diagnosis improves HbA_{1c}

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

1 As between 10–30% of residual beta-cell function exists at the time of T1D diagnosis, it is imperative to preserve residual insulin secretory capacity with treatment.

2 The authors compared the efficacy of initiating insulin pump therapy at diagnosis of T1D with standard multiple daily injection (MDI) therapy.

3 A total of 24 participants aged 8–18 years with newly diagnosed T1D were randomised to insulin pump therapy or MDI treatment; data were collected 1, 3, 6, 9 and 12 months after T1D diagnosis and treatment initiation.

4 Initiation of insulin pump therapy at diagnosis improved glycaemic control and patient satisfaction, and may preserve residual beta-cell function in T1D.

Thrailkill KM, Moreau CS, Swearingen C et al (2011) Insulin pump therapy started at the time of diagnosis. *Diabetes Technol Ther* **13**: 1023–30

"Initiation of insulin pump therapy at diagnosis improved glycaemic control and patient satisfaction, and may preserve residual beta-cell function in T1D."