Technology

Insulin pump therapy: assessing bolus calculators

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Insulin pumps are equipped with increasingly sophisticated technology in an attempt to fine-tune insulin delivery to better reproduce physiological pancreatic insulin secretion. Variable basal insulin infusion rates have been a feature of pump therapy for well over a decade, and the only recent changes to basal delivery have been the ability to infuse increasingly small amounts of insulin and change the infusion rate by smaller increments.

By contrast, there have been significant recent advances in bolus insulin delivery, with all pumps having the ability to deliver both conventional and extended boluses, or combinations of these. Furthermore, the reliance on the individual to calculate their bolus insulin requirement can be replaced by automated bolus calculation, taking into account insulin already "on board" as a result of previous insulin boluses.

However, there is a degree of controversy as to whether these automated calculators do predict the bolus dose needed more accurately than manual calculation. The study by Zisser et al (summarised alongside) reviews the bolus calculator function of four insulin pumps, and compares them to the results of an *in silico* simulation of blood glucose levels following a meal and a snack 2 hours later against multiple insulin decay curves. Two of the pumps are currently in use in the UK – the MiniMed Paradigm® 515/715 (Medtronic MiniMed, Northridge, California), and the Animas® IR 1250 (Animas Corp, West Chester, Pennsylvania) – one has recently been withdrawn (Deltec Cozmo®) and the other is a patch pump currently available in the US (Insulet Omnipod®, Insulet Corp, Bedford, Massachusetts).

The *in silico* exercise shows that the device user still has to make an intelligent judgement as to what duration of insulin action to enter into the bolus calculator. The default duration of action for each pump varies from 3–6 hours, and the assumed profile of insulin action can be curvilinear or linear. In the *in silico* model, the 6-hour curve results in glucose levels returning to baseline levels. Predicting a shorter duration of insulin action would lead the bolus calculator to advise a larger bolus with the snack and, hence, risk hypoglycaemia, while extending the predicted duration of action to 8 hours results in a much smaller dose being advised and, consequently, persistent hyperglycaemia.

Zisser et al concluded that bolus calculators may be of value, and that there is nothing to suggest one pump's algorithm is superior to any other. However, the user needs to be aware of the possible errors, which may result from incorrectly predicting the duration of insulin action, using an erroneous insulin:carbohydrate ratio, inaccurate carbohydrate counting, or transcribing the blood glucose level incorrectly if there is no automatic communication between blood glucose meter and pump. In addition to such errors, the calculator cannot take into account the impact of exercise or of other factors that alter insulin absorption, such as temperature. It is, therefore, imperative that pump users retain the ability to calculate bolus doses manually in order to overcome potential shortcomings of bolus calculators.

DIABETES TECHNOLOGY & THERAPEUTICS

Evaluating the efficacy of insulin pump bolus calculators

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

1 Although continuous subcutaneous insulin infusion (CSII) therapy is useful for people with diabetes, calculating the correct dosage and estimating the effect of other contributing factors can often be difficult.

2 New CSII technologies have attempted to make the process easier for the user, by automating bolus insulin calculation, thus significantly decreasing the amount of manual calculations needed.

3 This study aimed to examine the efficacy of four different insulin pump technologies; the authors aimed to discuss the merits of each technology, and the comparative efficacy of insulin calculation compared with results obtained from an *in silico* simulation.

4 Insulin recommendations were compared for four devices after a meal and a snack, and potential errors for each method were recorded.

5 The authors concluded that although it is important for people with type 1 diabetes to have a thorough understanding of insulin calculations, there is no significant evidence indicating that one automatic method is superior to another.

6 Potential errors that were associated with CSII therapy use included inaccurate predictions for the duration of insulin action, dietary factors, and impact of external factors affecting insulin absorption.

Zisser H, Robinson L, Bevier W et al (2009) Bolus calculator: a review of four "smart" insulin pumps. *Diabetes Technol Ther* **10**:441–4

DIABETES TECHNOLOGY & THERAPEUTICS

"Real-time" monitoring possible using continuous glucose monitors

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

1 Continuous glucose monitoring (CGM) devices have made measurement of ambulatory blood glucose levels easier, and the latest models aim to provide users with "real-time" information about their blood glucose.

2 This study aimed to compare two new CGM devices and evaluate their efficacy in real-time measurement of blood glucose levels.

3 A total of 16 people with diabetes, 11 with type 1 diabetes and five with type 2 diabetes, participated in this study, and were assigned to use either a Guardian© RT (GRT) or DexCom™ (DEX) CGM device.

4 Analysis showed that there was a 21 ± 5 minute and a 7 ± 7 minute lag-time for the GRT and DEX CGM devices, respectively (P<0.005). Compared with laboratory data, reliability was measured as 99% for GRT and 82% for DEX.

5 Eight participants were assigned to test both GRT and DEX devices; of these, six completed the study. Results showed that the lag-time between the two devices when compared on the same individual ranged from 0–32 minutes.

6 The authors concluded that CGM measurements identify changes in blood glucose in exceptional detail. However, they expressed concerns that interstitial fluid glucose levels and levels of blood glucose measured in the laboratory are not always the same and should not necessarily correlate.

Mazze RS, Strock E, Borgman S et al (2009) Evaluating the accuracy, reliability, and clinical applicability of continuous glucose monitoring (CGM): Is CGM ready for real time? *Diabetes Technol Ther* **11**: 11–18

DIABETES CARE

Age of insulin injection site does not affect efficacy

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

1 This study included young people with type 1 diabetes, and investigated the effect of two bolus insulins (aspart and lispro) at injection sites of differing ages; the effect of these parameters on pharmacodynamic efficacy were compared.

2 The main outcome measure of this study was the glucose infusion rate; overall, no statistically significant differences were observed between the two different types of insulin bolus injection, or at the different ages of injection sites.

3 The authors conclude that, although the peak and duration of each bolus is affected according to the age of insulin injection site, the pharmacological action of the insulin remains unaffected.

Swan KL, Dziura JD, Steil GM et al (2009) Effect of age of infusion site and type of rapid-acting analog on pharmacodynamic parameters of insulin boluses in youth with type 1 diabetes receiving insulin pump therapy. *Diabetes Care* **32**: 240–4

PEDIATRIC DIABETES

Young CSII therapy users at higher risk of diabetic ketoacidosis

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

1 This study aimed to identify the potential triggers of diabetic ketoacidosis (DKA) associated with the use of insulin pumps in children and adolescents with type 1 diabetes.

2 In this retrospective study, 142 cases of DKA were identified in 115 children with a diabetes duration of 6.6 ± 3.5 years.

3 Rate of DKA was 1.4 per 100 patient years in the first year studied, and 1.7 per 100 patient years in the second year studied. In those using CSII therapy, the rates were 3.2 per 100 patient years and 3.6 per 100 patient years, respectively.

4 The authors concluded that not only is the rate of DKA in children and adolescents with type 1 diabetes using CSII nearly double the rate of those using multiple daily injection therapy, but approximately 77% of cases occur within the first year of CSII use.

Hanas R, Lindgren F, Lindblad B et al (2009) A 2-yr national population study of pediatric ketoacidosis in Sweden: predisposing conditions and insulin pump use. *Pediatr Diabetes* **10**: 33–7

DIABETES TECHNOLOGY & THERAPEUTICS

Insulin aspart better than lispro for CSII in type 1 diabetes

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

1 Some people with type 1 diabetes receive continuous subcutaneous insulin infusion (CSII) therapy to normalise blood glucose levels.

2 This randomised study compared the use of insulin aspart with insulin lispro for glycaemic stability in 17 people with type 1 diabetes over a 3-day period.

3 Individuals using CSII therapy with insulin aspart had more stable postprandial blood glucose than those using insulin lispro (P<0.0019). Overall, daily blood glucose variability was similar between groups.

Bartolo PD, Pellicano F, Scaramuzza A et al (2008) Better postprandial glucose stability during continuous subcutaneous infusion with insulin aspart compared with insulin lispro in patients with type 1 diabetes. *Diabetes Technol Ther* **10**: 495–8

"Individuals using continuous subcutaneous insulin infusion therapy with insulin aspart had more stable postprandial blood glucose than those using insulin lispro (P<0.0019)."