Technology

Identifying the reasons behind poor glycaemic control in insulin pump users

Peter Hammond, Consultant in General Medicine, Harrogate

Insulin pump therapy has proven to be popular with users, with over 90% of those who are started on pump therapy preferring it to multiple daily injections (MDI) and continuing it long-term (Nixon and Pickup, 2011; summarised alongside). Yet even in experienced centres there are as many as 30% of insulin pump users whose control remains suboptimal.

In this survey, 28 of the 104 non-pregnant insulin pump users with type 1 diabetes and over 6 months' pump usage in their clinic had an HbA_{1c} level >8.5% (>69 mmol/mol), the threshold for starting insulin pump therapy for suboptimal control defined by NICE.

It is suggested that fear of hypoglycaemia might be a significant factor in failure to optimise control (Nixon and Pickup, 2011). This fear could lead to the individual wanting to maintain blood glucose at a higher level in order to avoid hypoglycaemia. On the other hand, one of the supposed advantages of insulin pump therapy is the ability to maintain tighter glycaemic control with a lower frequency of hypoglycaemia than when using MDI, so if the insulin pump user fully understands the potential of pump therapy then it would be hoped that fear of hypoglycaemia would not dissuade them from optimising glycaemic control.

Nixon and Pickup surveyed their 104 insulin pump users with a questionnaire about fear of hypoglycaemia, and 75 responded, with similar numbers of non-responders in the good and poor control groups. Substantial fear of hypoglycaemia was present in 27% of those surveyed, and was correlated with frequency of hypoglycaemia and cumulative episodes of severe hypoglycaemia. There was, however, no association between fear of hypoglycaemia and glycaemic control as assessed by HbA_{1c} level. The average fear of hypoglycaemia score was 51.0% in the group with HbA_{1c} levels <7.0% (<53 mmol/mol) and 40.6% in the group with HbA_{1c} ≥8.5% (≥69 mmol/mol), although this difference was not significant. Poor glycaemic control on insulin pump therapy was correlated with poor control on MDI.

This survey would appear to exclude fear of hypoglycaemia as a reason for poor glycaemic control on pump therapy, although it remains a significant issue for some pump users and its effect on their quality of life cannot be underestimated. To understand why some insulin pump users are still incapable of optimising their glycaemic control we need to look at other personal attributes. There is a dearth of research into the psychological profile of successful insulin pump users and this would be an area worthy of investigation since it might allow even more successful targeting of pump therapy.

Paradoxically, those who benefit most from insulin pump therapy in terms of HbA_{1c} reduction are those with the highest HbA_{1c} on MDI, and yet these are also the pump users most likely to have suboptimal control using the therapy. Thus, poor glycaemic control on MDI cannot be used as a criterion for non-selection for insulin pump therapy, so we need to identify behaviours once on pump therapy that are likely to indicate lack of success in optimising control. Poor adherence to diabetes self-management is the catch-all for such behaviours. Inadequate self-monitoring of blood glucose before starting pump therapy may be a key to those who do less well on pump therapy, while recent evidence suggests that the use of different bolus functions is associated with better control (Hammond, 2011; Cukierman-Yaffe et al, 2011; summarised overleaf). Fortunately, these adverse behaviours may be more amenable to intervention than fear of hypoglycaemia.

Hammond P (2011) An insight into the factors that improve glycaemic control in young people using insulin pumps. *Diabetes Digest* **10**: 36–7

Fear of hypos not correlated with HbA_{1c} level in insulin pump users

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

1 The extent of fear of hypoglycaemia among insulin pump users was surveyed to determine its impact on glycaemic control.

2 Fear of hypoglycaemia was assessed in non-pregnant people with T1D who were treated with an insulin pump. Out of the 104 people identified, 74 responded.

3 Of the respondents, 27% had poor glycaemic control (defined as an HbA_{1c} level of ≥8.5% [≥69 mmol/mol]). The mean HbA_{1c} in this group was 9.1±1.0% (76±10.9 mmol/mol).

4 Substantial fear of hypoglycaemia (with a score of >50%) was identified in 27% of respondents. However, fear of hypoglycaemia did not correlate with HbA_{1c} levels.

5 Accumulated episodes of severe hypoglycaemia since starting insulin pump therapy ($r=0.48$; $P<0.001$) and rate of hypoglycaemia (episodes per patient-year of treatment) ($r=0.48$; $P<0.001$) were the only significant correlates with fear of hypoglycaemia.

6 The only significant correlates of HbA_{1c} achieved during insulin pump therapy were HbA_{1c} while treated with multiple daily injections (MDI) ($r=0.66$; $P<0.001$) and the change in HbA_{1c} when switching from MDI to insulin pump therapy.

7 The authors concluded that fear of hypoglycaemia is present among insulin pump users but is not correlated with HbA_{1c} level.

Nixon R, Pickup JC (2011) Fear of hypoglycemia in type 1 diabetes managed by continuous subcutaneous insulin infusion: is it associated with poor glycemic control? *Diabetes Technol Ther* **13**: 93–8

DIABETES TECHNOLOGY & THERAPEUTICS

Efficacy and durability of insulin pump therapy in T2D

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

1 The long-term efficacy of insulin pump therapy in people with T2D was assessed in this retrospective observational study.

2 Out of 102 participants, 93% had previously been treated with insulin for a mean duration of 5.6 years before commencing insulin pump therapy.

3 HbA$_{1c}$ levels improved from baseline (9.3±1.8% [78±19.7 mmol/mol]) to evaluation at 1 year (7.8±1.4% [62±15.3 mmol/mol]; $P<0.001$).

4 The amount of improvement in HbA$_{1c}$ level largely depended on the individual's pretreatment HbA$_{1c}$ level, their degree of autonomy and previous antidiabetes treatment.

5 Mean weight gain was 3.9±8.6 kg after 1 year ($P<0.001$) and subsequently remained stable. Insulin requirement did not change significantly.

6 The authors concluded that insulin pump therapy is well tollerated, effective and durable in people with T2D.

Reznik Y, Morera J, Rod A et al (2010) Efficacy of continuous subcutaneous insulin infusion in type 2 diabetes mellitus: a survey on a cohort of 102 patients with prolonged follow-up. *Diabetes Technol Ther* **12**: 931–6

DIABETES TECHNOLOGY & THERAPEUTICS

Optimal length and frequency of short-term CGM

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

1 This analysis looked at the optimum length of time for short-term continuous glucose monitoring (CGM).

2 Correlations (r^2) were calculated for various glucose indices for a 3-month interval versus other sampling periods ranging from 3 to 15 days.

3 For 3 days of sampling the r^2 value was 0.32–0.47 compared with 15 days of sampling when it was 0.66–0.75.

4 The more days of glucose data that were sampled, the higher the correlation with 3-month data.

5 The authors concluded that to optimally assess overall glycaemic control, these data suggest that a 12–15-day period of CGM every 3 months is required.

Xing D, Kollman C, Beck RW et al (2011) Optimal sampling intervals to assess long-term glycemic control using continuous glucose monitoring. *Diabetes Technol Ther* **13**: 351–8

DIABETES RESEARCH AND CLINICAL PRACTICE

Using bolus calculator improves glycaemic control

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

1 The authors of this analysis aimed to establish which features of insulin pump use (such as different modes of bolus delivery and bolus calculators) are associated with improved glycaemic control.

2 Data from 88 people with T1D who were treated with an insulin pump were included in the analysis.

3 People who used the bolus calculator 50% of the time had an HbA$_{1c}$ level 0.6% (17.5 mmol/mol) lower than those who did not.

4 It was concluded that bolus calculator use was associated with improved glycaemic control.

Cukierman-Yaffe T, Konvalina N, Cohen O (2011) Key elements for successful intensive insulin pump therapy in individuals with type 1 diabetes. *Diabetes Res Clin Pract* **92**: 69–73

DIABETES TECHNOLOGY & THERAPEUTICS

Simple bolus dose is best for controlling BG levels after pizza

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

1 The most effective type and timing of an insulin pump-delivered pre-prandial bolus following a "margherita" pizza meal was assessed in children with T1D treated with an insulin pump.

2 A total of 38 children ate a mozarella cheese and tomato sauce pizza. Several different types of bolus doses were administered before eating and glucose levels were measured for 6 hours after eating.

3 Blood glucose levels were closest to the therapeutic target of 7.8 mmol/L with the simple bolus administered 15-minutes before the meal (area under the curve [AUC] 0–6 hours, 0.38±0.83 mmol/L/min).

4 Compared with the bolus dose above, the simple bolus administered immediately before the meal was not significantly different (AUC 0–6 hours, 0.24±1.44 mmol/L/min), nor was the dual-wave bolus extended over a 6-hour period and administered 15 minutes before the meal (AUC 0–6 hours, 0.11±1.18 mmol/L/min).

5 The simple bolus administered 15 minutes before the meal did control blood glucose levels to target significantly more than the dual-wave bolus 30/70 extended over 6 hours and administered immediately before the meal (AUC 0–6 hours, 0.74±0.87 mmol/L/min; $P=0.01$).

6 The authors concluded that these data support the use of a simple bolus dose administered 15 minutes before a meal to control blood glucose levels following consumption of a margherita pizza.

De Palma A, Giani E, Iafusco D et al (2011) Lowering postprandial glycemia in children with type 1 diabetes after Italian pizza "margherita" (TyBoDi2 Study). *Diabetes Technol Ther* **13**: 483–7

> "People who used the bolus calculator 50% of the time had an HbA$_{1c}$ level 0.6% (17.5 mmol/mol) lower than those who did not."