The design and evaluation of a self-management algorithm for people with type 1 diabetes performing moderate intensity exercise

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Abstract
Limited evidence is available to advise people with type 1 diabetes about self-management strategies for maintaining acceptable glycaemic control when exercising.

A systematic review was conducted to design a self-management algorithm for moderate intensity exercise. The effectiveness was investigated regarding the attainment of acceptable glucose concentrations during and after 40 minutes of exercise at 70% VO₂ max in the real-life environment.

Nine individuals with type 1 diabetes (five male, four female) completed the study over a two-week period. All used a basal bolus analogue insulin regimen and exercised regularly. Participants undertook 40 minutes of moderate intensity exercise on days 1 and 8 in real-life environments, and followed the self-management algorithm. Data were collected for glucose concentrations at 10 time-points, i.e. before, during and after exercise.

Analysis showed that during the whole time-period, 56% of participant episodes were in the acceptable glucose range of 4–9 mmol/L, and 39% were above 9 mmol/L. In relation to hypoglycaemic episodes, one episode occurred during exercise, and eight episodes occurred during 8–12 hours after exercise.

Despite post-exercise insulin reduction, nocturnal hypoglycaemia occurred and algorithm adjustments are required regarding carbohydrate consumption at bedtime for future prevention. An addition to the current self-management algorithm would be to perform blood glucose monitoring 8–12 hours after post-exercise insulin and meal. Copyright © 2015 John Wiley & Sons.

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Key words
type 1 diabetes; moderate intensity exercise; self-management algorithm; self-management strategies

Introduction
A multitude of factors need to be considered by a person with type 1 diabetes (T1DM) when performing physical activity. These issues are based around the actual exercise session and diabetes self-management strategies to maintain acceptable glycaemic control. Most patient education regarding this is not evidence based and a person with T1DM through trial and error over time may derive self-management strategies themselves. Patients are often uncertain and, when using ad hoc self-management strategies, can experience acute complications that cause negative experiences with regard to exercise. These were described in a focus group analysis regarding patient perspectives relating to diabetes and exercise management.

The main implications are the potential risk of acute complications as a result of mismanagement. Being one of the most feared complications of diabetes, hypoglycaemia is the main deterrent for exercise participation. Hence, hyperglycaemia can be a purposeful result of patient self-management to avoid hypoglycaemia. In turn, efforts to avoid hypoglycaemia can result in symptoms which affect the enjoyment and performance of exercise.

From clinical experience, when discussing exercise patterns with patients, physical activity after work and before consuming the evening meal is a popular time for many, with the exercise duration being approximately 30–40 minutes. Presently, the most common method of insulin therapy for a person with T1DM is a basal bolus regimen. A self-management algorithm for 70% VO₂ max (moderate intensity) exercise, taken 3 hours after a fast-acting analogue
injection at lunchtime and before the evening meal, would help many people.

This current study attempted to pool all related evidence and experiential opinions regarding self-management strategies, before and after moderate intensity exercise, to provide a one-stop self-management algorithm.

**Methods**

**Design of the self-management algorithm**

A systematic literature review was performed to identify specific evidence-based insulin dose-adjustment and dietary strategies, and the subsequent effects on glycaemic control for both during and after moderate intensity exercise, for people with T1DM (not athletes).

The results showed there were no published self-management algorithms for direct use in patient care, and all research was performed in the laboratory environment, studying one self-management strategy.7–10 These individual strategies were incorporated into the self-management algorithm design that also includes experiential opinions in the absence of evidence (Table 1).

**Evaluation of algorithm and its effectiveness on HbA1c levels**

**Study design.** The inclusion criteria for participants were: people with T1DM of over two years’ duration; aged 18–60 years old; HbA1c under 86mmol/mol (10.0%); using a basal bolus insulin regimen; hypoglycaemia awareness; exercise twice a week or more.

The exclusion criteria were: pre-proliferative/proliferative retinopathy, neuropathy/foot ulceration; blood pressure >150/90mmHg; and cardiovascular disease/history of angina; orthopaedic problems.

The algorithm evaluation ran over a two-week period for each participant. Prior to week one, the exercise intensity was pre-determined by a sub-maximal incremental walking test to define an individual’s 70% VO2 max (or moderate intensity exercise). Then, during weeks one and two, two exercise sessions were performed in a real-life environment (days 1 and 8) in a location and route chosen by the participant. Each exercise session consisted of 40 minutes running at 70% VO2 max. Participants were instructed to follow the self-management algorithm for insulin and carbohydrate adjustment.

To perform exercise at 70% VO2 max, participants were given an individual training heart rate (THR) with a minimum and maximum range, determined by the sub-maximal incremental walking test. They used a Polar wristwatch during

<table>
<thead>
<tr>
<th>Before exercise</th>
<th>Amount of CHO (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lunchtime insulin</td>
<td>• If exercising within 2 hours of eating a meal, reduce the bolus/meal dose by 75%9,10</td>
</tr>
<tr>
<td>Blood glucose</td>
<td>• Aim for blood glucose of 8mmol/L immediately before exercise</td>
</tr>
<tr>
<td></td>
<td>• If blood glucose over 12mmol/L, check for ketones and take a correction dose</td>
</tr>
<tr>
<td></td>
<td>• If blood glucose over 17mmol/L do not exercise1,16,19,21</td>
</tr>
<tr>
<td>Food</td>
<td>• If blood glucose under 8mmol/L have the following carbohydrate (CHO)7,22</td>
</tr>
<tr>
<td>Blood glucose prior to exercise (mmol/L)</td>
<td>30</td>
</tr>
<tr>
<td>Under 4</td>
<td>20</td>
</tr>
<tr>
<td>4–6</td>
<td>10</td>
</tr>
<tr>
<td>6–8</td>
<td>0</td>
</tr>
<tr>
<td>8 or over</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>After exercise</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolus/meal insulin</td>
<td>• Eat within 2 hours of exercise and reduce the bolus/meal dose by 30%9,14,18,23</td>
</tr>
<tr>
<td></td>
<td>• After 2 hours return to usual dose</td>
</tr>
<tr>
<td>Long-acting insulin</td>
<td>• Take usual Lantus or Levemir dose8</td>
</tr>
<tr>
<td>Blood glucose</td>
<td>• If blood glucose at 8mmol/L or under before bedtime have 10–20g of CHO</td>
</tr>
</tbody>
</table>

Table 1. Algorithm for insulin and carbohydrate adjustment for exercising at 70% VO2 max

<table>
<thead>
<tr>
<th>Time</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>During exercise</td>
<td>The time-point data for baseline, 20 minutes mid-way and 40 minutes at the end of the exercise session will correspond to lunch insulin dose adjusting, the starting exercise blood glucose and carbohydrate (CHO) consumed prior to exercise</td>
</tr>
<tr>
<td>Before evening meal</td>
<td>These data will provide information regarding the need for CHO consumption at the finish of exercise, which was not incorporated into the algorithm</td>
</tr>
<tr>
<td>2–6 hours post-exercise</td>
<td>The time-point data for 2, 4 and 6 hours after the evening meal will analyse the effect of reducing the evening meal fast-acting analogue dose</td>
</tr>
<tr>
<td>8–12 hours post-exercise</td>
<td>The time-point data for 8, 10 and 12 hours after evening meal will relate to basal insulin dose adjustments or CHO consumption at bedtime</td>
</tr>
</tbody>
</table>

Table 2. Data analysis time-points and strategies
were hypoglycaemia (range 4–46 years). All performed carbohydrate (CHO) counting and insulin dose adjustments using an analogue basal bolus regimen. All participants engaged in exercise for more than two sessions a week. All had hypoglycaemia awareness, with no long-term complications or orthopaedic problems.

To evaluate the overall general glycaemia trend after using the algorithm, data regarding mean ± standard deviations were pooled at specific time-points (see Table 3). The mean glucose concentrations appear to be satisfactory and explainable, i.e. high baseline and high post-prandial levels. The mean glucose concentrations also appear to be satisfactory and explainable, i.e. high baseline and high post-prandial levels. However, when considering the large standard deviations the glucose variability was apparent, with the greatest standard deviation shown at the 4-hour time-point (SD ±4.8).

When analysing each time-point across the two combined exercise sessions the frequency of individual participant episodes for each of the glucose ranges were stated as numbers. There were 18 individual participant episodes (nine participants: two sessions) for each of the 10 time-points. The results within each group of time-points are shown in Table 4 and are discussed below.

During exercise, only one episode of hypoglycaemia occurred. Acceptable concentrations were achieved by 63% of study participant episodes, while the other 35% were hyperglycaemic.

Before the evening meal, there were no hypoglycaemia episodes between the end of the exercise session and within 2 hours before

<table>
<thead>
<tr>
<th>Time-point</th>
<th>Under 4mmol/L</th>
<th>4–9mmol/L</th>
<th>Over 9mmol/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline – 40 minutes</td>
<td>1.9% (1)</td>
<td>63% (34)</td>
<td>35.2% (19)</td>
</tr>
<tr>
<td>Before evening meal</td>
<td>0 (0)</td>
<td>50% (9)</td>
<td>50% (9)</td>
</tr>
<tr>
<td>2–6 hours after</td>
<td>1.9% (1)</td>
<td>46.3% (25)</td>
<td>51.9% (28)</td>
</tr>
<tr>
<td>8–12 hours after</td>
<td>14.8% (8*)</td>
<td>61.1% (33)</td>
<td>25.9% (14)</td>
</tr>
</tbody>
</table>

*One participant had one hypoglycaemic episode in between the time-points and this was included in the episode numbers.

The data collection methods for glucose levels were:
- Before exercise until before the evening meal; participants performed self blood glucose monitoring (SBGM) using a TrueResult meter (Nipro Diagnostics UK). This meter was chosen due to its ease of use and small size for carrying in the exercise sessions. SBGM was chosen for this time-period as it was important to establish any immediate changes in blood glucose that might require cessation of exercise.
- After the evening meal until 12 hours after, interstitial glucose levels – using the Minimed iPro (Medtronic) continuous glucose meter – were employed. This method was used as this time-period was during the night and performing SBGM would disturb participants’ sleep. Continuous glucose monitoring data were only available by download after the study period.

### Data analysis
The blood and interstitial glucose frequencies within glucose ranges at 10 time-points were examined. The glucose ranges were hypoglycaemia (≤4.0mmol/L), acceptable (4–9mmol/L) and hyperglycaemia (≥9.0mmol/L). The 10 time-points were: before exercise; at 20 minutes during exercise and at 40 minutes (end of exercise session); before the evening meal; then 2, 4, 6, 8, 10 and 12 hours after the evening meal. The time-points were grouped: (1) during exercise; (2) before the evening meal (within

### Table 3. The mean glucose concentrations (and standard deviations) at each time-point

<table>
<thead>
<tr>
<th>Time-point</th>
<th>Baseline</th>
<th>20 mins during exercise</th>
<th>40 mins at end of exercise</th>
<th>Before evening meal</th>
<th>2 hours after</th>
<th>4 hours after</th>
<th>6 hours after</th>
<th>8 hours after</th>
<th>10 hours after</th>
<th>12 hours after</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-life blood glucose (mmol/L)</td>
<td>10.9 (3.4)</td>
<td>8.8 (3.7)</td>
<td>7.6 (3.4)</td>
<td>9.9 (4.1)</td>
<td>10.3 (3.3)</td>
<td>10.5 (4.8)</td>
<td>9.2 (3.3)</td>
<td>7.7 (3.2)</td>
<td>7.4 (3.2)</td>
<td>7.9 (3.7)</td>
</tr>
</tbody>
</table>

### Table 4. Summary of episode percentages and numbers (brackets) in the algorithm sections for each glucose range

<table>
<thead>
<tr>
<th>Time-point</th>
<th>Under 4mmol/L</th>
<th>4–9mmol/L</th>
<th>Over 9mmol/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>2 hours post-exercise</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>2–6 hours after</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
</tr>
</tbody>
</table>

### Results
Nine participants who matched the inclusion/exclusion criteria (five males, four females) were included and completed the study. The demographic data are presented as means ± standard deviation: age 39.3±10.5 years (range 24–56 years), BMI 24.8±1.7kg/m², weight 75.6±6.2kg, HbA1c 7.9±0.7%, duration of T1DM 16.8±14.2 years (range 4–46 years). All performed carbohydrate (CHO) counting and insulin dose adjustments using an analogue basal bolus regimen. All participants engaged in exercise for more than two sessions a week. All had hypoglycaemia awareness, with no long-term complications or orthopaedic problems.

To evaluate the overall general glycaemia trend after using the algorithm, data regarding mean ± standard deviations were pooled at specific time-points (see Table 3). The mean glucose concentrations appear to be satisfactory and explainable, i.e. high baseline and high post-prandial levels. The mean glucose concentrations also appear to be satisfactory and explainable, i.e. high baseline and high post-prandial levels. However, when considering the large standard deviations the glucose variability was apparent, with the greatest standard deviation shown at the 4-hour time-point (SD ±4.8).

When analysing each time-point across the two combined exercise sessions the frequency of individual participant episodes for each of the glucose ranges were stated as numbers. There were 18 individual participant episodes (nine participants: two sessions) for each of the 10 time-points. The results within each group of time-points are shown in Table 4 and are discussed below.

During exercise, only one episode of hypoglycaemia occurred. Acceptable concentrations were achieved by 63% of study participant episodes, while the other 35% were hyperglycaemic.

Before the evening meal, there were no hypoglycaemia episodes between the end of the exercise session and within 2 hours before
the evening meal. During this time period participants had either acceptable or hyperglycaemic levels (both 50%).

In the 2–6 hours after exercise group, there was one hypoglycaemia episode at 4 hours after the bolus insulin dose. Again, there were similar episode frequencies for both acceptable concentrations (46%) and hyperglycaemia (52%).

In the 8–12 hours after exercise group, the glucose trends changed with 15% of participant episodes exhibiting nocturnal hypoglycaemia. Differences were also apparent with a reduction of hyperglycaemia episodes (26%), and improved acceptable concentrations (61%).

**Discussion**

Following evaluation of the data, the algorithm was adjusted; the changes are discussed below.

**Algorithm adjustment:**

**Before exercise**

When evaluating the algorithm relating to before performing exercise, the blood glucose response and, in particular, any hypoglycaemic episodes during exercise are important factors to consider. There was no lunchtime insulin reduction prior to the exercise session, and the before exercise self-management strategies regarding food in the algorithm worked well as only one hypoglycaemic episode out of a possible 54 episodes occurred, with 63% of glucose episodes in the acceptable range.

With regard to the algorithm the following considerations and changes were implemented (see Table 5).

**Lunchtime insulin.** No insulin reduction, unless exercising within 2 hours of eating a meal, then reduce the bolus/meal dose by 75%.

**Blood glucose.** The participants with starting glucose concentrations around 8.0mmol/L (n = 6) had glucose concentrations ranging between 4.5–8.0mmol/L at 40 minutes, and the CHO amount taken before exercise appeared to prevent hypoglycaemia. However, one participant with the lowest blood glucose of 6.9mmol/L consumed the recommended amount of glucose but still developed hypoglycaemia (3.8mmol/L). Although this was based on only one participant, the avoidance of hypoglycaemia is of paramount importance and the algorithm was therefore amended to increase the glucose/CHO amount if the starting blood glucose value was ≤8.0mmol/L.

The target starting glucose concentration was 8.0mmol/L; however, if patient preference is a higher starting glucose concentration, this is safe. The impact of pre-exercise insulin reductions on ketogenesis after running was previously investigated; this found that large reductions (25%, 50 or 75% insulin reduction) in the pre-exercise fast-acting analogue insulin doses did not affect beta-hydroxybutyrate (ketone) formation, to the extent that ketoacidosis occurred. However, consideration must be given to the recent glycaemic pattern and to ensure fast-acting analogue insulin is in circulation, otherwise ketosis could be a risk.

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**Table 5. Amended self-management algorithm for insulin and carbohydrate adjustment for exercising at 70% VO2 max (changes are highlighted in purple)**

<table>
<thead>
<tr>
<th>Blood glucose prior to exercise (mmol/L)</th>
<th>Amount of CHO (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 4</td>
<td>40</td>
</tr>
<tr>
<td>4–6</td>
<td>30</td>
</tr>
<tr>
<td>6–8</td>
<td>20</td>
</tr>
<tr>
<td>8 or over</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>After exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolus/meal insulin</td>
</tr>
<tr>
<td>• Eat within 2 hours of exercise and reduce the bolus/meal dose by 30%</td>
</tr>
<tr>
<td>• After 2 hours return to usual dose</td>
</tr>
<tr>
<td>Long-acting insulin</td>
</tr>
<tr>
<td>• Take usual Lantus or Levemir dose</td>
</tr>
<tr>
<td>Blood glucose</td>
</tr>
<tr>
<td>• Before bedtime have 30–40g of slowly absorbed CHO, i.e. cereal, banana</td>
</tr>
<tr>
<td>• Aim for a blood glucose of 10mmol/L</td>
</tr>
<tr>
<td>• It is important to test blood glucose occasionally 8–12 hours after evening meal to check for night-time hypoglycaemia</td>
</tr>
</tbody>
</table>
Food. Subsequent to the algorithm design, a study by West et al. compared the consumption of two different types of CHO (isomaltulose [low GI] and dextrose [high GI]), taken 2 hours prior to moderate to high intensity exercise.\textsuperscript{12} The study concluded that the consumption of low GI CHO prior to exercise maintained more acceptable blood glucose concentrations before, during and after exercise, compared with the consumption of high GI CHO. In the algorithm, high GI snacks were given to participants with a starting exercise blood glucose level below 8.0mmol/L that could account for the mean baseline glucose level of 10.9mmol/L (SD ±3.4). These results are useful to incorporate into the amended algorithm, as they suggest a low GI lunch could prevent high starting glucose values and ensure a steady CHO absorption rate, which may be more effective for glucose control.

Algorithm adjustment: after exercise

Next to consider are the glucose concentrations and self-management strategies for 12 hours after exercise.

Consumption of CHO at the end of exercise. The glucose pattern showed an increase in mean blood glucose concentrations and hyperglycaemic episodes from the end of the exercise session to the evening meal. The last fast-acting analogue insulin dose was administered at lunchtime so the hypoglycaemia action would end by the evening meal, which could account for the increasing blood glucose concentrations.\textsuperscript{10,13} Also gluconeogenesis and glycolysis would be increased due to increased exercise and energy demands. Hypoglycaemia was not a potential risk, and during the exercise sessions hypoglycaemic episodes were minimal (n=1). No adjustment was made to the algorithm to include food at this time-point.

Evening meal insulin. During 2–6 hours after exercise, the glucose episodes in the 4–9mmol/L range (46%) and over 9.0mmol/L (52%) appear to suggest acceptable or slightly higher glucose concentrations, albeit minimal hypoglycaemia. However, the glucose variability was considerable as shown by high standard deviations in Table 3. These data can be explained, as post-prandial hyperglycaemia is a common phenomenon in T1DM. Further evening meal insulin reduction would cause increased hyperglycaemia as, even with the 30% reduction, 52% of results were above 9mmol/L in the current study. From these data, no amendments were made to the algorithm.

During 8–12 hours after the evening meal, the standard deviations were the lowest demonstrating less variability. This observation probably occurred because participants were asleep and not performing daily living activities nor consuming CHO. In view of the frequency of 4–9mmol/L glucose episodes, a slight increase was shown but, more importantly, changes in hypoglycaemia and hyperglycaemia episodes were found. This showed an increase in hypoglycaemia episode frequency with eight episodes occurring out of a possible 54 participant episodes (15%). This observation has not been demonstrated in any previously related research as far as we are aware.\textsuperscript{8–10} although several authors have commented on the risk.\textsuperscript{2,14–16} Long-acting insulin. Long-acting insulin or basal dose reduction is a commonly used strategy to prevent overnight hypoglycaemia despite the lack of evidence to support the recommendation. Hypoglycaemia episodes increased during the night; however, they did not continue during the following day. Considering this observation, it does not appear necessary to reduce the Lantus dose which may cause possible risk of hyperglycaemia the following day.

Bedtime blood glucose. In the algorithm, the consumption of 10–20g CHO before bed was advised if the blood glucose was below 8mmol/L at bedtime. When reviewing the participants’ continuous glucose monitoring data, the period between 8–12 hours post-exercise corresponded with the early hours of the morning. If increased CHO in the region of 20–40g were given at bedtime this may cause hyperglycaemia within the post-exercise 4–6 hour time-period, which would be around midnight. Although used at a different time-period, the delay in absorption of low GI CHO and the subsequent stable effect on glycaemic control have been previously demonstrated.\textsuperscript{12} Hence, if low GI foods – i.e. certain fruits, porridge and cereals containing bran\textsuperscript{17} – were consumed at bedtime, this would be absorbed slowly and cause a delayed rise in blood glucose, which may occur during the 8–12 hour time-point.

However, some people with T1DM may not accept this CHO strategy, if the main reason for performing exercise is for weight loss or weight maintenance. In this instance, the basal insulin dose may need to be reduced to prevent nocturnal hypoglycaemia.

In relation to bedtime, a target blood glucose concentration was not stipulated in the self-management algorithm. After reviewing the findings, a blood glucose of 10.0mmol/L at bedtime was incorporated into the algorithm with regard to preventing hypoglycaemia.

New recommendation for the algorithm. As delayed hypoglycaemia was shown in this study to be a genuine problem, it is vital to educate patients about the risk, and how it might be prevented. To monitor this risk, performing occasional SMBG monitoring in the time-period of 8–12 hours after the evening meal will be recommended.

Hypoglycaemia prevention was a primary aim of the study, but another was also to achieve acceptable glucose values between 4–9mmol/L. The results showed that, during the whole time-period, 56% of participant episodes were in the acceptable range and 39% were above 9mmol/L. This may be viewed negatively by health care professionals (HCPs), with the implication that the algorithm was ineffective. However, one might consider that 9mmol/L was too tight a target, and some HCPs may aim for a target of <11.0mmol/L, especially with regard to post-prandial hyperglycaemia in the 2–4 hour time-point range. In addition, when
considering patient preference of running blood glucose concentra-
tions higher with exercise, this figure may be acceptable. Difficulties
do arise, however, when making such statements on small sample
sizes, together with the challenges of analysing data using descriptive
methods rather than statistical tests.

Another discussion point from the study was the variability of glu-
cose concentrations within subjects despite controlling the environment,
exercise intensity and insulin dose adjustment. Authors have acknow-
ledged that this type of research does generate difficulties with analysis
when using standard statistical
techniques and some variability
would be expected because of multi-
ple factors that can affect glycaemic
control. Individual variability is
another issue, which has also been
discussed by expert authors in review
articles when recommending exercise
management strategies, and they
advocate that insulin and CHO adjus-
tments must be tailored to the
individual.[14,15,19,20]

**Relevance to clinical practice**

After analysing the data and applying the findings into the real-life situation
and patient self-management, the following issues could be discussed
with patients to consider and evaluate in their own personal self-
management plans. It must be stressed to patients that these strategies
would have to be monitored and maybe modified depending on the
effects on the individual.

- There is a risk of delayed nocturnal
  hypoglycaemia after performing
  moderate intensity exercise in the evening.

**Conclusion**

As this is the first time a complete self-management algorithm has been investigated, it would not be deemed as unusual that the algorithm requires amendments. Although based on a small sample size, there was consistency in the data regarding glucose concentra-
tions and patterns that emphasised specific glycaemic problems at cer-
tain time-points. In each algorithm section, the participant episodes
within the acceptable range varied between 46% and 63%, and, by
making the suggested amendments to the algorithm, this may improve glucose control while reducing hypoglycaemic episodes.

**Acknowledgments**

We thank Dr Martin Maxwell for his on-going support, and Spencer
Fildes from Nipro Diagnostics UK for providing the TrueResult blood
glucose meters.

**Declaration of interests**

There are no conflicts of interest declared.

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