Not All Exercise is Created Equal:
Exercise and Glycemic Control in Type 1 Diabetes

Candace Garner, MS
Montana State University Dietetic Internship
Outline

- Types of exercise
- Insulin and nutrition adjustments
- Post exercise hypoglycemia
- Role of the RD
Objectives

+ Describe the difference in glucose utilization in aerobic versus anaerobic exercise
+ Evaluate appropriate insulin and glucose adjustments based on blood glucose values and planned exercise
+ Select and justify at least two strategies to prevent post-exercise or nocturnal hypoglycemia
# Exercise with Type 1 Diabetes

<table>
<thead>
<tr>
<th>Barriers</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fear of hypoglycemia</td>
<td>Improved HbA1c</td>
</tr>
<tr>
<td>Lack of knowledge</td>
<td>Improved body composition</td>
</tr>
<tr>
<td>Poor motivation</td>
<td>Cardiorespiratory fitness</td>
</tr>
<tr>
<td>Body image</td>
<td>Reduced risk of CVD</td>
</tr>
<tr>
<td>Time constraints</td>
<td>Improved blood markers</td>
</tr>
</tbody>
</table>
Influences of glycemic response

1. Location of insulin delivery
2. Amount of insulin in circulation
3. Blood glucose (BG) concentration before exercise
4. Composition of last meal or snack
5. Intensity and duration of activity

Image courtesy of: https://www.drugs.com/cg/images/en3010152.jpg
Types of Exercise

**Aerobic**
- Repeated and continuous movement of large muscle groups
- Oxygen requiring

**Anaerobic**
- Short duration, high intensity exercise
- Oxygen not required for energy production
Figure 1: Glucose Utilization

Preparation for Exercise

+ Time of day
+ Maximize glycogen stores in liver and muscle (~4 hr. prior)
+ Initial BG goal
  + Aerobic: 126-180 mg/dL
  + Anaerobic or mixed: 90-126 mg/dL
Nutritional Adjustments

- Carbohydrate and fat fuel performance
- Low glycemic index (GI) food prior to exercise
- High GI food during exercise
  - 30-60 g/hour or higher
- Mixed GI following exercise

<table>
<thead>
<tr>
<th>Carbohydrates</th>
<th>Fat</th>
<th>Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>45-65%</td>
<td>20-35%</td>
<td>10-35%</td>
</tr>
</tbody>
</table>
Insulin Adjustments

**Bolus**
- Timing prior to exercise, intensity, carb content
- Reduce meal dose 25-75%

**Basal**
- Hyperglycemia risk
- Greater than usual activity
- Continuous subcutaneous infusion vs. multiple injections
  - Suspension, 2 hr. limit
  - 20-80% rate reduction 60-90 min prior to exercise
Late Onset Hypoglycemia

Carbohydrates post exercise, mix high and low GI foods

Bolus reduced (50%) post-exercise meal, low GI food before bed

Basal reduce (20-50%) and carbohydrate before bed
Role of the RD

- Educate the client: risks and benefits
- Individualize: each person will be different
- Formulate plan with the clients individual needs:
  - Exercise frequency, intensity, time, and type
  - Meal and snack timing and composition
  - Insulin routine
  - Blood glucose values
Is there anything further you would like to know?
References:


Franç, S, Daoudi, A, Pochat, A et al. Insulin-based strategies to prevent hypoglycemia during and after exercise in adult patients with type 1 diabetes on pump therapy: the DIABRASPORT randomized study. Diabetes Obes Metab. 2015; 17: 1150–1157


Tanenberg, RJ, Newton, CA, and Drake, AJ. Confirmation of hypoglycemia in the “dead-in-bed” syndrome, as captured by a retrospective continuous glucose monitoring system. Endocr Pract. 2010; 16: 244–248

Teich, T and Riddell, MC. The enhancement of muscle insulin sensitivity after exercise: a Rac1-independent handoff to some other player?. Endocrinology. 2016; 157: 2999–3001

### Table 2: Adjustments for prolonged or brief exercise

<table>
<thead>
<tr>
<th></th>
<th>Prolonged endurance exercise (predominantly aerobic)</th>
<th>Brief intense exercise (aerobic and anaerobic)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bolus insulin dose reduction</strong></td>
<td>Advised when exercise occurs within ~120 min of bolus dose; the magnitude of reduction varies according to timing, type, duration, and intensity of exercise</td>
<td>Bolus reduction not advised; might require additional conservative bolus dose correction if hyperglycaemia develops</td>
</tr>
<tr>
<td><strong>Before exercise, basal insulin</strong></td>
<td>Useful especially if exercise is done less than every 3 days or if the frequency of exercise is high throughout the day; might also be useful if patients are on twice daily intermediate insulin</td>
<td>Basal insulin dose reduction not advised</td>
</tr>
<tr>
<td><strong>Basal nocturnal insulin</strong></td>
<td>Particularly important if the exercise was done in the afternoon or early evening</td>
<td>Useful for helping to prevent hypoglycaemia after a high intensity interval training exercise session</td>
</tr>
<tr>
<td><strong>Temporary basal rate change</strong></td>
<td>Basal rate can be reduced by up to 100% (ie, pump suspension) during exercise, however, keeping some basal insulin delivery is preferred; to take into account rapid acting insulin pharmacokinetics, a basal rate reduction should ideally occur well before exercise is started (up to 90 min); normal basal rates can be resumed either at the end of exercise, or later in recovery depending on glucose trends</td>
<td>Increased basal rate might be needed to help prevent or treat hyperglycaemia either during or immediately after exercise</td>
</tr>
<tr>
<td><strong>Carbohydrate intake before</strong></td>
<td>See table 1 for details</td>
<td>Not usually needed</td>
</tr>
<tr>
<td><strong>Carbohydrate intake during</strong></td>
<td>Typically up to 60 g/h if no insulin dose adjustments have been made (see table 1 for additional information)</td>
<td>Not usually needed</td>
</tr>
<tr>
<td><strong>Carbohydrate intake after</strong></td>
<td>Useful to reduce the risk of hypoglycaemia and improve recovery; might need a specified bolus insulin dose depending on the length and intensity of exercise (eg, a reduced insulin to carbohydrate ratio)</td>
<td>Useful to reduce the risk of hypoglycaemia and enhance recovery but should be delayed if hyperglycaemia is initially observed; might need a specified bolus insulin strategy (eg, a reduced insulin to carbohydrate ratio)</td>
</tr>
<tr>
<td><strong>Sprint before or after</strong></td>
<td>Might help reduce the risk of hypoglycaemia</td>
<td>Might increase the risk of hyperglycaemia; consider a prolonged aerobic cool down</td>
</tr>
</tbody>
</table>
Table 3: Suggested bolus reduction prior to exercise

<table>
<thead>
<tr>
<th>Exercise intensity</th>
<th>30 min</th>
<th>60 min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild aerobic exercise ((~25% \text{VO}_2\text{max}))</td>
<td>-25%</td>
<td>-50%</td>
</tr>
<tr>
<td>Moderate aerobic exercise ((~50% \text{VO}_2\text{max}))</td>
<td>-50%</td>
<td>-75%</td>
</tr>
<tr>
<td>Heavy aerobic exercise ((70-75% \text{VO}_2\text{max}))</td>
<td>-75%</td>
<td>NA</td>
</tr>
<tr>
<td>Intense aerobic or anaerobic exercise ((&gt;80% \text{VO}_2\text{max}))</td>
<td>No reduction recommended</td>
<td>NA</td>
</tr>
</tbody>
</table>