Understanding Physical Activity and T1D:

From Playgrounds to Playing Fields

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Presenter Disclosure Info

- I have no financial relationships pertinent to this presentation to disclose.
Objectives

• Understand how we maintain our “blood sugar”.
• What things to keep in mind when you have diabetes and you exercise.
• How to have fun and be safe.
What do we see?

What do we choose to see?
Athletes with Type 1 Diabetes

- Gary Hall Jr
- Wasim Akram
- Sir Steve Redgrave
- Jason Johnson
- Chris Dudley
- Mimmi Hjorth
- Charlie Kimball
- Bill Carlson
The Varsity Squad

Insulin

Glucagon
Adrenaline
Tanks of Sugar

When we eat carbs...

- Insulin goes up
- Glucagon goes down

Muscle − Liver − Fat

Glucose in the Blood

+ Insulin

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Glucose in the Blood

+ Insulin
When we fast...

- Insulin decreases
- Glucagon increases
When we exercise...

- Insulin decreases
- Glucagon and catecholamines increase
- Catecholamines make it harder for glucose to enter muscle during the activity
- After the exercise, muscles and the liver are more sensitive to insulin

![Diagram showing glucose in the blood, muscle, liver, glucagon, and adrenaline]
Our defense against hypoglycemia

Pancreas Response
↓ Insulin  ↑ Glucagon

~ 72-108 mg/dL

Autonomic Response
Shaky  Palpitations
Anxious  Sweating
Hungry  Numbness

~ 65-70 mg/dL

Brain Alert
Warmth  Weakness  Fatigue  Confusion

~ 50-55 mg/dL
Our defense against hypoglycemia - Summary

- Decrease Insulin
- Increase Glucagon
- Increase counter-regulatory hormones
The issues with diabetes type 1

- Can’t suppress insulin once it’s given
- Glucagon release may be impaired
- Adrenaline response can be attenuated
- And yet adrenaline can also increase BG’s

So you are susceptible to lows and highs!
Effects of exercise on Type 1 teens

n = 50 children and teens

Exercise: 4x15 min treadmill periods with 3 x 5 minute rest periods at VO$_{2\text{max}}$ of 60%

<table>
<thead>
<tr>
<th>Baseline BG level (mg/dl)</th>
<th>Hypoglycemia risk (% of subjects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;120</td>
<td>86%</td>
</tr>
<tr>
<td>120-180</td>
<td>13%</td>
</tr>
<tr>
<td>&gt;180</td>
<td>6%</td>
</tr>
</tbody>
</table>
Hypoglycemia overnight

• 2x as many kids aged 11-17 years old had a low BG overnight after an exercise day compared to when they had no exercise.
Effect of anaerobic exercise…

- With 10 s of maximal exercise there is a transient increase in BG for up to 2 hours after exercise

$n = 7$ T1DM males (age $21 \pm 4$)  
Exercise: cycling at 40% VO2 max x 20’ followed by rest or 10 second max sprint
So why exercise?

- Reduces risk of
  - Heart attacks
  - Stroke
  - High cholesterol
  - High blood pressure
  - Increase life expectancy
- Increases team comaraderie
- Improves mental health and self-confidence
“People with diabetes should be advised to perform at least 150 min/week of moderate-intensity aerobic physical activity (50–70% of maximum heart rate), spread over at least 3 days per week with no more than 2 consecutive days without exercise. (A)”
BG Targets

Non-diabetic

Diabetic

Diabetic during exercise
Factors affecting response to exercise

- Duration and Intensity
- Type of activity
- Metabolic control
- BG level
- Type and timing of insulin injections
- Type and timing of food
- Absorption of insulin
Anaerobic vs Aerobic

- Period of maximal $O_2$ use
- Anaerobic is only a short time, sometimes seconds
- BG rises lasting typically 30-60 min

- Aerobic tends to lower BG both during (usually within 20-60 min after onset) and after the exercise
Metabolic control

• When control is bad, circulating insulin may not be enough, and counter-regulatory hormones may be exaggerated
  – Ketosis
• High BG associated with reduced beta-endorphins during exercise
Timing of Insulin

Heinemann et al. Diabetic Medicine, 13:625-629, 1996
Type and timing of food

- 3-4 h prior to competition meals with fat, carbs, and protein
- Faster acting glucose just prior to exercise or within an hour to help build glycogen stores faster
Absorption of insulin

- Choice of site
  - Avoid extremity which will be used
- Ambient temperature
  - Increases metabolic demands and greater potential for BG drop
Other considerations

- More muscles used
  - Greater drop
- Adrenaline, being amp’d up
  - Game days will be different from practice days
- Mornings have higher counter-regulatory hormones
  - May have less likelihood of lows
- Sports unfamiliar with may have more likelihood of low
- Remember to hydrate
Estimated number of min covered by 15 grams of extra carb and no change in basal activity

<table>
<thead>
<tr>
<th>Activity</th>
<th>Body mass (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Cycling</td>
<td></td>
</tr>
<tr>
<td>10 km/h</td>
<td>65</td>
</tr>
<tr>
<td>15 km/h</td>
<td>45</td>
</tr>
<tr>
<td>Walking</td>
<td></td>
</tr>
<tr>
<td>4 km/h</td>
<td>60</td>
</tr>
<tr>
<td>6 km/h</td>
<td>40</td>
</tr>
<tr>
<td>Swimming</td>
<td></td>
</tr>
<tr>
<td>30 m/min breast stroke</td>
<td>55</td>
</tr>
<tr>
<td>Tennis</td>
<td>45</td>
</tr>
<tr>
<td>Cross-country ski</td>
<td>40</td>
</tr>
<tr>
<td>Basketball (game)</td>
<td>30</td>
</tr>
<tr>
<td>Snow shoeing</td>
<td>30</td>
</tr>
<tr>
<td>Soccer</td>
<td>30</td>
</tr>
<tr>
<td>Figure skating</td>
<td>25</td>
</tr>
<tr>
<td>Ice Hockey (ice time)</td>
<td>20</td>
</tr>
<tr>
<td>Running</td>
<td></td>
</tr>
<tr>
<td>8 km/h</td>
<td>25</td>
</tr>
<tr>
<td>12 km/h</td>
<td>20</td>
</tr>
</tbody>
</table>
In General: Carbing Up

- 15 grams for every 20-30 minutes of play
- Gatorade is about 6% glucose
- G2 is about 2% glucose
- Generally drinks > 8% is too much
  - Juice is about 11% glucose
  - Slows gastric absorption
- Powerade is about 8% glucose
Reducing pre-exercise insulin for meals

<table>
<thead>
<tr>
<th>Exercise intensity (% V̇O₂max)</th>
<th>30 min of exercise</th>
<th>60 min of exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>25*</td>
<td>50</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td>75</td>
</tr>
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<td>75</td>
<td>75</td>
<td>—</td>
</tr>
</tbody>
</table>

*Extrapolated.

Insulin Pumps

- Do not disconnect for > 2 hours
- May need to reduce basal 90 min prior to exercise.
- After reconnecting, may need to correct with only 50% of usual dose.
- Can use temp basals, before, during, and after exercise.
Recovery

• Quickly provide carbs post-exercise to rebuild glycogen stores within the first few hours
  – Take advantage of the heightened insulin sensitivity
  – Adding protein helps with glycogen formation
• For short duration high intensity anaerobic activities (weight lifting, sprints, diving, and baseball), you can have delayed drops and may only need carbs after activity
  – Remember, opposite for aerobic or mixed (soccer, cycling, jogging, and swimming)
    • Use carbs before, during, and after
Practical points

- Always have a form of glucose readily available
- On activities, buddy system
- Have at least one person who knows how to use glucagon
- Don’t keep insulin in direct sunlight or warm temperatures
Red Flags

- **Hypoglycemia**
  - Glazed look
  - Incoherent
  - Unresponsive
  - Pale

- **Hyperglycemia**
  - Fruity-smelling breath
  - Nausea and vomiting
  - Shortness of breath
  - Dry mouth
  - Weakness
  - Confusion
  - Coma
  - Abdominal pain
What to do for hypoglycemia

- Check the BG
- If < 80 mg/dL, treat with 15 grams of fast acting carbs (ie juice, glucose tabs, gels)
- Re-check in 10 minutes, if still < 80 mg/dL repeat 15 grams of fast acting carbs
- If > 80 mg/dL give 15 grams of slow acting carbs (ie snack bar, powerbar, trail mix) and go and play
- If unresponsive, unable to swallow, or SEIZURE, 1 mg of glucagon given IM, if < 6 years old, give 0.5 mg (remember to mix powder with liquid)
  - Patient’s BG should increase within 10 min, and patient may throw up from the glucagon, don’t worry about this.
- Consider giving extra carbs at bedtime and check BG’s overnight
What to do for hyperglycemia

• Check the BG
• If > 250 mg/dL check for ketones, but keep in mind, you can still have ketones with normal or low BG’s
• If there are moderate to large ketones, sub out, hydrate, give insulin
• If no ketones, use insulin scale but give 50% of what they normally use, may need even less for some activities
• If they are unconscious or vomiting with elevated BG, call 911, or take to the ER.
Good things to have in your bag of tricks!

- Glucagon
- Fast acting glucose
- Meter and strips
- Serum ketone meter
- Insulin and needles
- Water
- Snack bar (mixed protein/fat/carbs)
- Doctor’s phone numbers
- Parent’s phone numbers
- Don’t need to have it, but good if the athlete has a paper with their doses.
Let’s sum up…

- Reduce pre- and post-exercise insulin boluses and basal rates
- Carb up before play or exercise, make sure glycogen stores are full
- For daylong activities (camp, long distance walking, skiing, water sports) consider 30-50% reduction in long acting insulin or basal the night previous and following night
- Check BG’s before exercise and every 30 min or so during exercise if possible
Let’s sum up…

- Consider bursts of anaerobic (high intensity) activity before aerobic exercise.
- To prevent overnight hypoglycemia
  - Bedtime snack (low glycemic index) if BG < 120 mg/dL
  - Lower overnight basal (by 20-30%)
  - Reduce pre-dinner bolus (with PM exercise)
  - Exercise in AM instead of PM
  - Consider a continuous glucose monitor
- Consider a serum ketone meter
THANK YOU
Childrens Hospital Oakland and Research Institute
Division of Endocrinology

- **Diabetes Nurses**
  - Kathy Love (R.D)
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  - Victor Woolworth
  - Rosibel Silva

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