Management of the Athlete with Diabetes Mellitus

Kristin Harmon, M.D.
Endocrinologist
Tallahassee Primary Care Associates
June 8, 2012
Outline

• Definition of Diabetes
• Diagnosis
• Treatment
• Hypoglycemia and hyperglycemia
• Return to play
Definition

• Diabetes Mellitus is a chronic metabolic disorder characterized by hyperglycemia, caused by either absolute insulin deficiency or resistance to the action of insulin at the cellular level, which results in the inability to regulate blood glucose levels with the normal range.
Classification of Diabetes

• Type 1 Diabetes Mellitus
• Type 2 Diabetes Mellitus
• Other specific types of Diabetes
  – Genetic defects in β-cell function, insulin action
  – Diseases of the exocrine pancreas
  – Drug- or chemical-induced
• Gestational Diabetes Mellitus
Type 1 Diabetes Mellitus

- Autoimmune Disorder caused by a combination of genetic and environmental factors.
- Autoimmune response is often triggered by an environmental event, such as a virus, and it targets the insulin secreting beta cells of the pancreas.
- When beta cell mass is reduced by ~80%, the pancreas is no longer able to secrete sufficient insulin to compensate for hepatic glucose output.
Type 2 Diabetes Mellitus

- Results from a progressive insulin secretory defect on the background of insulin resistance
Major Pathophysiologic Defects in Type 2 Diabetes

Islet-cell dysfunction

Glucagon (alpha cell)

Insulin (beta cell)

Hepatic glucose output

Pancreas

Insulin resistance

Glucose uptake in muscle and fat

Liver

Muscle

Adipose tissue

Hyperglycemia

Del Prato S, Marchetti P. Horm Metab Res. 2004;36:775–781.
Criteria for the Diagnosis of Diabetes

- A1C ≥6.5%
- OR
- Fasting plasma glucose (FPG) ≥126 mg/dl (7.0 mmol/l)
- OR
- Two-hour plasma glucose ≥200 mg/dl (11.1 mmol/l) during an OGTT
- OR
- A random plasma glucose ≥200 mg/dl (11.1 mmol/l)
Prediabetes: IFG, IGT, Increased A1C

Categories of increased risk for diabetes (Prediabetes)*

FPG 100-125 mg/dl (5.6-6.9 mmol/l): IFG

or

2-h plasma glucose in the 75-g OGTT
140-199 mg/dl (7.8-11.0 mmol/l): IGT

or

A1C 5.7-6.4%

*For all three tests, risk is continuous, extending below the lower limit of a range and becoming disproportionately greater at higher ends of the range.
## Aggressive Control of Diabetes: Goals of Treatment

<table>
<thead>
<tr>
<th>AMERICAN DIABETES ASSOCIATION</th>
<th>NORMAL</th>
<th>GOAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1C (%)</td>
<td>&lt; 6</td>
<td>&lt; 7</td>
</tr>
<tr>
<td>Preprandial plasma glucose (mg/dL)</td>
<td>&lt;110</td>
<td>90-130</td>
</tr>
<tr>
<td>Peak postprandial plasma glucose (mg/dL)</td>
<td>&lt;140</td>
<td>&lt;180</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AMERICAN ASSOCIATION OF CLINICAL ENDOCRINOLOGISTS (AACE)</th>
<th>NORMAL</th>
<th>GOAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1C (%)</td>
<td>&lt; 6</td>
<td>≤ 6.5</td>
</tr>
<tr>
<td>Preprandial plasma glucose (mg/dL)</td>
<td>&lt;110</td>
<td>&lt;110</td>
</tr>
<tr>
<td>2-hour postprandial glucose (mg/dL)</td>
<td>&lt;140</td>
<td>&lt;140</td>
</tr>
</tbody>
</table>

A1C is “gold standard” measure of diabetes control over previous 2-3 months

### Correlation of A1C with Estimated Average Glucose (eAG)

<table>
<thead>
<tr>
<th>A1C (%)</th>
<th>Mean plasma glucose (mg/dl)</th>
<th>Mean plasma glucose (mmol/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>126</td>
<td>7.0</td>
</tr>
<tr>
<td>7</td>
<td>154</td>
<td>8.6</td>
</tr>
<tr>
<td>8</td>
<td>183</td>
<td>10.2</td>
</tr>
<tr>
<td>9</td>
<td>212</td>
<td>11.8</td>
</tr>
<tr>
<td>10</td>
<td>240</td>
<td>13.4</td>
</tr>
<tr>
<td>11</td>
<td>269</td>
<td>14.9</td>
</tr>
<tr>
<td>12</td>
<td>298</td>
<td>16.5</td>
</tr>
</tbody>
</table>

These estimates are based on ADAG data of ~2,700 glucose measurements over 3 months per A1C measurement in 507 adults with type 1, type 2, and no diabetes. The correlation between A1C and average glucose was 0.92. A calculator for converting A1C results into estimated average glucose (eAG), in either mg/dl or mmol/l, is available at [http://professional.diabetes.org/GlucoseCalculator.aspx](http://professional.diabetes.org/GlucoseCalculator.aspx).
Complications

- Microvascular: retinopathy, nephropathy, neuropathy
  - Sensory neuropathy
  - Autonomic neuropathy, including sexual dysfunction and gastroparesis
- Macrovascular: CHD, cerebrovascular disease, PAD
- Other: psychosocial problems, dental disease
Preparticipation Examination

• History
  – Sports history, level of diabetes self-care skills, knowledge of their diabetes, complications, medications

• Physical examination

• Assessment from Endocrinologist regarding current level of glycemic control, complications, and management plan

• Consultation with other specialists if there are complications

• Labs
  – A1C, CMP, Lipid Panel, TSH, Urine MA/Cr
Diabetes Treatment Tools for Athletes
Basal-Bolus Insulin Therapy: Detemir or Glargine at HS and Mealtime Aspart, Lispro, or Glulisine

Insulin Effect

B L D HS

Insulin aspart, lispro, glulisine

detemir or glargine

Insulin Pumps
Continuous Glucose Monitor
Prevention of Hypoglycemia and Hyperglycemia

• Exercise training and competition can result in major disturbances to blood glucose management
• Extreme glycemic fluctuations (severe hypoglycemia or hyperglycemia with ketoacidosis) can lead to sudden death in athletes with Type 1 DM
• Prevention of these potentially life-threatening events begins with the creation of the diabetes care plan by a physician.
Diabetes Care Plan

• Identify blood glucose targets for practices and games
• Strategies to prevent exercise-associated hypoglycemia, hyperglycemia, and ketosis
• Medications
• Signs, symptoms, and treatment protocols for hypoglycemia, hyperglycemia, and ketosis
• Emergency contact information
Preventing Hypoglycemia

- Frequent blood glucose monitoring
- Carbohydrate supplementation
- Insulin adjustments
Glucose Monitoring

- Athlete should check blood glucose levels 2 or 3 times before exercise
- Every 30 minutes during exercise
- Every hour up to 4 hours after exercise
Carbohydrate Supplementation

- Carbohydrates should be eaten before, during, and after exercise.
- Quantity depends on the blood glucose level and exercise intensity.
- In general, when the blood glucose is <100 mg/dL before exercise, carbohydrates should be consumed.
- Additional carbohydrate supplementation may be needed for practices or games lasting >60 minutes especially if the pre-exercise insulin dosage was not reduced or if they are exercising at the peak of insulin activity.
- Athletes should eat a snack or meal shortly after exercise.
Insulin Adjustments

• To prevent hypoglycemia
  – Depends on blood glucose level
  – Exercise intensity
  – Method of insulin delivery
    • Insulin pump therapy
      – Reduce basal rate by 20-50% 1-2 hours before exercise
      – Reduce bolus dose 30-50% at the meal preceding exercise
      – Suspend or disconnect the insulin pump at the start of exercise (no longer than 60 minutes without supplemental insulin)
    • Multiple daily injections
      – Reduce bolus dose 30-50% at the meal preceding exercise
      – Reduce basal insulin if prolonged exercise
Relative Energy system involvement for competitive sports

<table>
<thead>
<tr>
<th>Anaerobic ATP - PC</th>
<th>Anaerobic Glycolysis</th>
<th>Aerobic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Weightlifting, Power lifting</td>
<td>• Basketball, Soccer, Tennis, Lacrosse</td>
<td>• Road cycling</td>
</tr>
<tr>
<td>• Track (sprinting and field events), Diving (platform &amp; springboard)</td>
<td>• Speed skating (500–1000 m)</td>
<td>• In-line skating</td>
</tr>
<tr>
<td>• Golf, American football, Swimming (sprints), Gymnastics, Fencing</td>
<td>• Skiing (slalom &amp; downhill), Field hockey</td>
<td>• Cross country skiing</td>
</tr>
<tr>
<td>• Wrestling, Baseball, Softball, Volleyball, Ice hockey, Track cycling</td>
<td>• Rowing</td>
<td>• Race walking</td>
</tr>
<tr>
<td></td>
<td>• Running (middle distance), Speed skating (&gt; 1500 m)</td>
<td>• Marathon running</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Iron Man triathlon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Ultra-marathon running</td>
</tr>
</tbody>
</table>
Recognition of Hypoglycemia

• Signs and symptoms of hypoglycemia can occur when blood glucose levels fall below 70 mg/dL
Early Signs of Hypoglycemia

- Tachycardia
- Sweating
- Palpitations
- Hunger
- Nervousness
- Headache
- Trembling
- Dizziness

Autonomic symptoms are related to the release of epinephrine and acetylcholine.
Hypoglycemia

As glucose levels continue to fall, symptoms of brain neuronal glucose deprivation occur.

Neurogenic Symptoms

- Blurred vision
- Fatigue
- Difficulty thinking
- Loss of motor control
- Aggressive behavior
- Seizures
- Convulsions
- LOC
Hypoglycemia
Hypoglycemia

• If hypoglycemia is prolonged, severe brain damage and even death can occur
• Athletic trainers should be aware of the signs and symptoms and be prepared for treatment
Treatment of Mild Hypoglycemia

• Give 10-15 grams of fast acting carbohydrate - glucose tablets or 2 Tbsp honey and measure blood glucose level immediately
• Wait 15 minutes and recheck glucose level
• If blood glucose remains low, administer another 10-15 grams of fasting acting carbohydrate
• Recheck blood glucose level in 15 minutes
• If blood glucose level does not return to normal after the second dose of carbohydrate, call EMS
• Once blood glucose level normalizes, provide a snack
Treatment of Severe Hypoglycemia

• Call EMS
• Give glucagon injection
• Once athlete is conscious and able to swallow, provide food
Hyperglycemia

- Can occur during exercise
  - Related to exercise intensity
    - High intensity exercise increases catecholamines, FFAs, and ketone bodies, all of which impair muscle glucose utilization, and increase blood glucose levels
    - Transient if athlete has adequate insulin
    - Psychological stress of competition
- Ketosis can occur when there is insufficient insulin
- Exercise is contraindicated when ketones are present in the urine
Hyperglycemia

• Signs and Symptoms
  – Nausea
  – Dehydration
  – Reduced cognitive performance
  – Slowing of visual reaction time
  – Sluggishness
  – Fatigue
Ketoadidosis

- Kussmaul breathing
- Fruity odor to the breath
- Sleepiness
- Inattentiveness
- Loss of appetite
- Increased thirst
- Frequent urination
- Loss of consciousness
### ADA Guidelines for Athletes Exercising during Hyperglycemia

<table>
<thead>
<tr>
<th>Blood Glucose Level</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting Blood Glucose $\geq 250$ mg/dL</td>
<td>Test urine for ketones</td>
</tr>
<tr>
<td></td>
<td>If ketones present, exercise is contraindicated</td>
</tr>
<tr>
<td>Blood Glucose $\geq 300$ mg/dL and no ketones</td>
<td>Exercise with caution and continue to monitor blood glucose levels</td>
</tr>
</tbody>
</table>

Athlete and physician need to make appropriate insulin adjustments
Return to Play

• Literature does not address specific return to play guidelines after hypoglycemic or hyperglycemic events

• Return to play varies with the individual and becomes easier to determine as the athletic trainer works with the athlete on a regular basis and learns how his or her blood sugar reacts to exercise, insulin, and glucose if hypoglycemic
Return to Play

• Athlete should demonstrate a stable blood glucose level that is within the normal range before returning to play.

• Athletic trainers working with new athletes should seek guidance from the athlete, athlete’s physician, and athlete’s parents to gain insight on how the athlete has been able to best control the blood glucose level during exercise.
Conclusions

• Start exercise in a safe glucose range
  – Aim for >100 and <250 mg/dL
  – Most Athletes should try to keep Blood Glucose ~150 mg/dl for competition
  – Take extra insulin if high and supplement with carb if low
• Plan ahead and reduce insulin level if appropriate
  – Depending on type and duration of exercise
  – Bolus reduction if exercise 1-4 hour post meal
  – Basal reduction if exercise is prolonged
• Monitor Blood Sugar Frequently
  – Before, during, and after exercise
  – Support glucose level with extra carb if appropriate
Conclusions

• It is important to work closely with the athlete’s Endocrinologist to develop a diabetes care plan
• Recognize the signs and symptoms of hypoglycemia and hyperglycemia and initiate treatment early in the process
• Hyperglycemia and hypoglycemia can be life-threatening and can definitely AFFECT PERFORMANCE
Thank You