Driving Under the Influence of Insulin

The Diabetic Driver

Types of Diabetes

- **Type 1**
  - Younger
  - Lean
  - Require Insulin Injections
  - Fluctuating Blood Sugars Throughout the Day

- **Type 2**
  - Older
  - Overweight
  - Oral Medicines Effective
  - More Stable Sugars

Expected Blood Sugar Levels

<table>
<thead>
<tr>
<th>Normal</th>
<th>After Eating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting</td>
<td>70 – 100</td>
</tr>
<tr>
<td></td>
<td>&lt; 140</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting</td>
</tr>
<tr>
<td>After Eating</td>
</tr>
</tbody>
</table>

Target BG on Treatment

<table>
<thead>
<tr>
<th>Type 1</th>
<th>80 – 180</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 2</td>
<td>70 – 150</td>
</tr>
</tbody>
</table>
What’s so bad about high blood sugar?

It’s a toxic state!

Chronic Complications of Diabetes

- Microvascular
  - Retinopathy
  - Nephropathy
  - Neuropathy
- Macrovascular
  - Heart Attack
  - Stroke
  - Lower Limb Gangrene

Oral Anti-Diabetic Drugs

Hypoglycemic Agents
- Glyburide (Micronase ®)
- Glipizide (Glucotrol ®)
- Glimeperide (Amaryl ®)
- Repaglinide (Prandin ®)
- Nateglinide (Starlix ®)

Anti-Hyperglycemic Agents
- Acarbose (Precose ®)
- Rosiglitazone (Avandia ®)
- Pioglitazone (Actos ®)
- Metformin (Glucophage ®)
Insulin Treatment

- **Different Types**
  - Quick, Slow
- **Newer Insulins**
  - More Consistent, Predictable Effect
- **Advanced Tactics**
  - Require Greater Skills

Sugar!

“Where Does It Come From?”

Origins of Glucose

- **Intestinal Absorption of Food**
- **Endogenous Glucose Production**
  - Glycogenolysis
  - Gluconeogenesis
    - Lactate
    - Amino Acids
    - Glycerol

Utilization of Glucose

Systemic Glucose Balance

**Hormonal Regulation**

- To Lower Blood Sugar
  - Insulin
- To Raise Blood Sugar
  - Epinephrine
  - Glucagon
  - Cortisol
  - Growth Hormone
Dilemma

- One the One Hand - On the Other Hand
  - Controlling High Blood Sugar to Prevent Chronic Complications
  - Increases Risk of Acutely Disabling Hypoglycemia

Protective Effect of Epinephrine

- Increases Hepatic Glucose Production
- Decreases Muscle Glucose Uptake
- Provokes Behavioral Response

Symptoms of Hypoglycemia

- Early
  - Sweaty
  - Hungry
  - Tremulous
  - Palpitations
  - Anxious
  - Tingling

- Late
  - Tired/Drowsy
  - Difficulty Thinking/Confused
  - Difficulty Speaking
  - Blurred, Darkened Vision
  - Stuporous
  - Seizures

Circumstances of Disabling Hypoglycemia

- Brittle Type 1 Diabetes
- History of Hypoglycemic Impairment
- Aggressive Treatment Program
Disabling Hypoglycemia Risk Factors

- Excessive Insulin Dose
- Decreased Food Intake
- Increased Utilization
- Decreased Endogenous Production
- Increased Sensitivity to Insulin
- Decreased Clearance of Insulin

Simulator Studies: Findings

- **Blood Sugar 62 – 72 mg %**
  - Examiners detect driving impairment
  - Subjects detect driving impairment
  - Increased theta-wave activity on EEG

- **Blood Sugar 50 mg %**
  - Subjects delayed self-treatment until below this level
  - Greatest theta-wave activity on EEG

- **Blood Sugar 40 – 50 mg %**
  - Cognitive motor impairment precludes appropriate corrective action
**Caveat**

There is no “legally hypoglycemic” blood level.

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**Diabetes and Driving Mishaps**

A Retrospective Multicenter Multinational Survey

<table>
<thead>
<tr>
<th></th>
<th>Non-Diabetic Spouse</th>
<th>Type 2</th>
<th>Type 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Crash</td>
<td>8%</td>
<td>12%</td>
<td>19%</td>
</tr>
<tr>
<td>Moving Violation</td>
<td>10%</td>
<td>8%</td>
<td>15%</td>
</tr>
<tr>
<td>Hypoglycemic Stupor</td>
<td>-</td>
<td>5%</td>
<td>18%</td>
</tr>
<tr>
<td>Required Assistance</td>
<td>-</td>
<td>5%</td>
<td>17%</td>
</tr>
<tr>
<td>Mild Symptom Hypo</td>
<td>-</td>
<td>4%</td>
<td>22%</td>
</tr>
</tbody>
</table>

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**Driving Mishaps Among Diabetics**

- Although greater than non-diabetic spouse group, various reports indicate the increased risk to be less than that seen in other chronic medical conditions such as:
  - Attention Deficit Hyperactivity Disorder¹
  - Sleep Apnea²
  - Alcohol Abuse³

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**Avoidance of Driving Mishaps**

**Driving Under the Influence of Insulin**

- Education by Physician
- Test Before Driving and Periodically on Long Trips
- Maintain Vigilance for Early Symptoms
- Stop Driving and Ingest Sugar Promptly

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