Hypoglycemia
Prevention & Treatment

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Owner & Clinical Director, Integrated Diabetes Services LLC
2014 AADE Diabetes Educator of the Year
Author, Think Like A Pancreas
Today’s Hot Topics

• Hypoglycemia: Definitions & Causes
• Problems Caused by Hypoglycemia
• Preventive Strategies
• Proper Treatments
Hypoglycemia: Definitions

• “Mild”: Adrenergic (BG<70) (<4mmol/l)
• “Moderate”: Cognitive (BG<50) (<3mmol/l)
• “Severe”: Unconscious (BG ???)
“His blood sugar must be low. He’s been trying to turn on the TV with his glucose meter for ten minutes.”
Hypoglycemia: Cause

- *Imbalance* between factors raising and lowering blood glucose levels
The Great Limiting Factor

- Performance Impairment
The Great Limiting Factor

- Accident Risk
The Great Limiting Factor

• Embarrassment
The Great Limiting Factor

• Lasting Damage?
• ↓ Spatial memory / performance (if before age 5)
The Great Limiting Factor

- Diminished Symptoms (Hypoglycemic Unawareness)

↑ Lactate Uptake
The Great Limiting Factor

• Rebound
The Great Limiting Factor

- Accelerated Gastric Emptying
- Post-Meal Spike
The Great Limiting Factor

• Weight Gain
Hypoglycemia: Targets/Goals

- Unable to recognize & verbalize lows: >80 (4.5 mmol/l)
- Able to recognize & verbalize lows: >70 (4 mmol/l)
- Pregnancy: >60 (3.3 mmol/l)
- No severe lows
- <10% of readings below target at each time of day
## Hypoglycemia: Targets/Goals

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<thead>
<tr>
<th></th>
<th>B</th>
<th>L</th>
<th>D</th>
<th>Bed</th>
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<td>94</td>
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<tr>
<th>Date</th>
<th>Pre-Bkfst</th>
<th>Pre-Lunch</th>
<th>Pre-Dinner</th>
<th>Bedtime Snack</th>
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Hypoglycemia Prevention Strategies

1. Insulin Program Setup (background/basal)
Hypoglycemia Prevention Strategies

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Graph showing average basal needs and morning Lantus or Levemir.
Hypoglycemia Prevention Strategies

1. Insulin Program Setup (background/basal)

Basal insulin should hold BG **STEADY** in the absence of food, exercise and bolus insulin!
1b. Insulin Program Setup (Meal/Bolus)

Blood Sugar Rise After Eating Carbs:
- Analog (Humalog or Novolog taken with meal)
- Regular (taken 30 min. pre-meal)
- NPH / Lente (taken 4 hours prior)

Only rapid analogs work when needed – right after eating!
## Hypoglycemia Prevention Strategies

### 1c. Diabetes Medication Choices

<table>
<thead>
<tr>
<th>Med Class</th>
<th>Specific Drug</th>
<th>Hypo Risk</th>
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<tr>
<td>Biguanide</td>
<td>Metformin</td>
<td>0%</td>
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<tr>
<td>Sulfonylureas</td>
<td>Glimepiride</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>Glipizide</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>Glyburide</td>
<td>21%</td>
</tr>
<tr>
<td>GLP-1</td>
<td>Exenatide</td>
<td>5%</td>
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<tr>
<td></td>
<td>Liraglutide</td>
<td>10%</td>
</tr>
<tr>
<td>TZDs</td>
<td>Pio/Rosiglitazone</td>
<td>0%</td>
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<tr>
<td>α Glucosidase Inhibitor</td>
<td>Acarbose/Miglitol</td>
<td>0%</td>
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<tr>
<td>DPP-4 Inhibitors</td>
<td>Sitagliptin</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>Saxagliptin</td>
<td>3%</td>
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<tr>
<td>Amylin</td>
<td>Pramlintide</td>
<td>17%</td>
</tr>
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*Ann Intern Med 147:386-399, 2007*
## Hypoglycemia Prevention Strategies

### 1d. “Other” Drugs

<table>
<thead>
<tr>
<th>Med Class</th>
<th>Mechanism</th>
<th>Hypo Risk</th>
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</thead>
<tbody>
<tr>
<td>ACE inhibitors</td>
<td>$\uparrow$ Muscle glucose uptake</td>
<td>Small</td>
</tr>
<tr>
<td>$\beta$-Blockers</td>
<td>Inhibits glycogenolysis</td>
<td>Small</td>
</tr>
<tr>
<td>Alcohol</td>
<td>Impairs gluconeogenesis</td>
<td>Large</td>
</tr>
<tr>
<td>Disopyramide</td>
<td>Unknown</td>
<td>Moderate</td>
</tr>
<tr>
<td>Quinolones</td>
<td>Enhanced insulin secretion (T2)</td>
<td>Small</td>
</tr>
<tr>
<td>Salicylates</td>
<td>$\uparrow$ Insulin secretion &amp; sensitivity</td>
<td>Small</td>
</tr>
</tbody>
</table>

*Endocrinol Metab Clin North Am 29:789-802, 2000*
2. Meal/Snack Timing

- Major issue with a.m. NPH/Premix
- Minor issue with Lantus, Levemir, Toujeo
- Not usually an issue with pump use
- Must remember to eat if pre-bolusing!
Hypoglycemia Prevention Strategies

3a. Proper Correction Doses

- 1500-Rule (aggressive) (83 rule)
- 1800-Rule (conservative) (100 rule)
  (Total Daily Ins.)/1500 or 1800 (83 or 100)
- May vary day vs. night
  (nighttime often 50% more than day)
Hypoglycemia Prevention Strategies

3b. Appropriate BG Targets

**Premeal:**
- 100 (5.5) (aggressive)
- 120 (6.7) (typical)
- 140-150 (7.6-8.3) (cautious)

**Postmeal (1-2 hrs):**
- <160 (9) (aggressive)
- <180 (10) (typical)
- < 200 (11) (cautious)
Hypoglycemia
Prevention Strategies

3c. Use “Floating” Targets

Severe lows are more common the day after:
- Erratic BGs
- Hypoglycemia
- Intense exercise

Adjust TODAY’s target based on yesterday’s events!
- + 10 (.5) if lows
- + 10 (.5) if heavy exer.
- - 10 (.5) if neither*

*never set target below 100 (5.5) or above 160 (9)
4. Proper Meal/Bolus Doses

- I:C Ratio that matches pre-meal BG 3-4 hours (not 2!) after eating
- I:C Ratio often varies from meal to meal
  
  (bkfst dose > lunch & dinner)
## Hypoglycemia Prevention Strategies

### 5. Account For “Unused” Insulin*

<table>
<thead>
<tr>
<th>Time since meal insulin</th>
<th>1 Hr</th>
<th>2 Hrs</th>
<th>3 Hrs</th>
<th>4 Hrs</th>
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<tbody>
<tr>
<td>Conservative Approach</td>
<td>70% left</td>
<td>40% left</td>
<td>10% left</td>
<td>0% left</td>
</tr>
<tr>
<td>Aggressive Approach</td>
<td>67% left</td>
<td>33% left</td>
<td>0% left</td>
<td></td>
</tr>
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</table>

* Newer pumps figure this automatically based on the insulin duration you set.

*Longer setting = less hypo risk*
Hypoglycemia Prevention Strategies

5. Account For “Unused” Insulin

Example:

Gave 6.0 units at 7pm, BG 200 (11) at 9pm.

Conservative approach: 40% remaining \((6 \times .4) = 2.4\) units left

Aggressive approach: 33% remaining \((6 \times .33) = 2\) units left

Subtract the unused insulin from your usual correction dose!
Hypoglycemia Prevention Strategies

6. Carb Counting Accuracy

- Proper Portion Measurement
- Look Up Unknown / Restaurant Foods
- Use Carb Factors
- Subtract 100% of Fiber
- Subtract 50% of Sugar Alcohols
Tip: Only count the carbs you actually consume!

Jackie Scheiner
Age 1
Hypoglycemia Prevention Strategies

7. The Trouble With Slow Food
Hypoglycemia
Prevention Strategies

7. Extend Meal Insulin When Necessary

Use When:
- Portions are very large
- Meal is prolonged
- Food is low-glycemic index (pasta, legumes, dairy...)

Apply Via:
- Square/Dual/Extended/Combo bolus on pump
- Delayed or Split bolus on injections
Hypoglycemia Prevention Strategies

8. Adjustment for Physical Activity

- Exercise, recreation, chores: all count!
- Reduce meal insulin (25%, 33%, 50%) for after-meal activity
- Snack prior to before/between meal activity
- Lower long-acting/basal insulin during and after prolonged activity
Hypoglycemia Prevention Strategies

8. Watch Out for D’OH!
(Delayed Onset Hypoglycemia)

- Following High-Intensity Exercise
- Following Extended Duration Activity
- May Occur Up to 24 Hours After
- Adjustments to food/insulin after activity:
  - lower basal insulin for 8-12 hours
  - low-G.I. Snacks
  - lower mealtime boluses
Hypoglycemia
Prevention Strategies

9. Effects of Alcohol

- Alcohol reduces the liver’s normal output of glucose
- Delayed BG drops can occur
- Alcohol masks and blunts hypoglycemia symptoms
9. Adjustments for Alcohol

- Drink in moderation
- Decrease basal insulin (or overnight long-acting insulin) after drinking
- Low-GI snack at bedtime (uncovered)
10. Frequent Monitoring

- Before All Meals & Snacks
- Pre/Post Exercise
- Bedtime
- 3 a.m. (occasionally)
Hypoglycemia Prevention Strategies

11. Recording & Analysis

✓ Record all pertinent data
  ▪ BGs
  ▪ Carb
  ▪ Activity
  ▪ Insulin

✓ Use an organized form or smartphone app
Hypoglycemia Prevention Strategies

11. Recording & Analysis

- Review every 7-10 days
- Look for patterns
  - > 10% below target range @ given time
  - Lows during/post-activity
  - Lows on School/Work vs. off-days
  - Lows Post-Menstrual
Hypoglycemia Prevention Strategies

12. Continuous Glucose Monitoring

- Alarms to alert user/family of pending lows
The Value of Alerts: Minimizing the DURATION and MAGNITUDE of BG Excursions
CGM Alerts Are Like BLOOD SUGAR BUMPERS!
Setting Low Alerts

- Low alert thresholds are not BG target ranges
- Take “lag time” into account ($\geq 80$ or $4.5$)
- Predictive alerts lose value the further the advance warning (keep below 10 min)
- Rate of FALL alerts helpful for hypo prevention ($>3$ mg/min or $0.17$ mmol/min)
Proven Benefit

Reduction in hypoglycemic excursions

Duration of Hypoglycemic Excursions (minutes per event)

Alert Group

Control Group

Hypoglycemia
Prevention Strategies

Pump With Low Glucose Suspend

- MiniMed 530G with Enlite (US)
- Medtronic Veo (Europe, Australia)
- ASPIRE Study
  - Less time hypo
  - Less severe hypo
  - No major rebound
HYPOGLYCEMIA TREATMENT

One Size Does NOT Fit All
Hypoglycemia Treatment

- **Mild/Moderate Low**
  - Check BG First
  - Treat w/High-Glycemic Index Food
  - Treat w/Proper Amount
  - Re-Check in 15 Minutes

**High-GI Foods**
- Glucose Tablets
- Dry Cereal
- Pretzels
- Graham Crackers
- Vanilla Wafers
- Jelly Beans
- Gatorade
Hypoglycemia Treatment

Use of Glycemic Index (contd)

Graph showing the glycemic index over time:
- High GI (red)
- Med GI (green)
- Low GI (blue)

Time points: 0 hrs, 1 hr, 2 hrs, 3 hrs, 4 hrs.
Hypoglycemia Treatment

• **DEXTROSE Rules!**

  - Glucose Tabs/Gels/Drinks
  - Sweet Tarts
  - Smarties
  - Spree
  - Air Heads
  - Nerds
  - Runts
  - Pixy Stix
Hypoglycemia Treatment

• *Always* Carry Rapid-Acting Carbs
# Hypoglycemia Treatment

<table>
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<tr>
<th>Wt-lbs (kg)</th>
<th>BG 70s (4)</th>
<th>BG 60s (3.5)</th>
<th>BG 50s (3)</th>
<th>BG 40s (2.5)</th>
<th>BG &lt;40 (2)</th>
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<tbody>
<tr>
<td>&lt;40 (&lt;19)</td>
<td>6g</td>
<td>7g</td>
<td>8g</td>
<td>9g</td>
<td>10g</td>
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<tr>
<td>40-70 (19-33)</td>
<td>7g</td>
<td>8g</td>
<td>10g</td>
<td>11g</td>
<td>13g</td>
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<tr>
<td>70-100 (33-48)</td>
<td>8g</td>
<td>10g</td>
<td>12g</td>
<td>14g</td>
<td>16g</td>
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<tr>
<td>100-160 (48-76)</td>
<td>11g</td>
<td>13g</td>
<td>16g</td>
<td>19g</td>
<td>21g</td>
</tr>
<tr>
<td>160-220 (76-105)</td>
<td>14g</td>
<td>17g</td>
<td>21g</td>
<td>24g</td>
<td>27g</td>
</tr>
<tr>
<td>&gt;220 (&gt;105)</td>
<td>20g</td>
<td>25g</td>
<td>30g</td>
<td>35g</td>
<td>40g</td>
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</tbody>
</table>

Once BG has risen, give rapid-acting insulin to cover any overtreatment!
Hypoglycemia Treatment

“Idiosyncracies”

↑ Treatment amt. for insulin on board

↑ Treatment amt. for recent exercise

↓ Treatment amt. for previous low-G.I. foods
Hypo Treatment Based on Trend

- **Predictive Hypo Alert or Hypo Alert & recovering:** Subtle Treatment
  - 50% of usual carbs
  - Med-High G.I. food

- **Hypo Alert & Dropping:** Aggressive Treatment
  - Full or increased carbs
  - High G.I. food
Hypoglycemia Treatment

- For Severe Low
  - Unconscious / Unresponsive
  - Seizure
  - Uncooperative

- May Use Lower Dose
- May Inject SC
Take-Home Messages

- Quantify Your Lows
- Strategize to Minimize
- Plan for Proper Treatment