Insulin Management

Marie Russell, MD, MPH
Objectives

• Important Studies
• Approach to Hyperglycemia Management
• Pathophysiology of Insulin
• Types of Insulin
• Side Effects of Insulin
• Insulin Regimens
• Case Studies
UKPDS

- Retinopathy, nephropathy, and possibly neuropathy benefit by lowering blood glucose levels in type 2 diabetes with intensive therapy, which achieved a median HbA\textsubscript{lc} of 7.0\% compared with conventional therapy with a median HbA\textsubscript{lc} of 7.9\%. The overall microvascular complication rate was decreased by 25\%.

- Continuous relationship between the risks of microvascular complications and glycemia, such that for every percentage point decrease in HbA\textsubscript{lc} (e.g., 9 to 8\%), there was a 35\% reduction in the risk of complications.

- Risks of complications can be significantly lowered even in the range of hyperglycemia where HbA\textsubscript{lc} levels are <8.0\%. There was no evidence of any glycemic threshold for any of the microvascular complications above normal glucose levels (i.e., HbA\textsubscript{lc} >6.2\%).

- No significant effect of lowering blood glucose on cardiovascular complications was observed. A 16\% reduction (which was not statistically significant, \( P = 0.052 \)) in the risk of combined fatal or nonfatal myocardial infarction and sudden death was observed.
ACCORD

• The Action to Control Cardiovascular Risk in Diabetes (ACCORD) trial was designed to determine whether a strategy of targeting normal glycated hemoglobin levels (i.e., <6.0%) would reduce the risk of serious cardiovascular events in middle-aged and elderly people with type 2 diabetes mellitus, glycated hemoglobin levels of 7.5% or more, and additional cardiovascular risk factors.

• Trial terminated at 3.5 years because of finding of no significant reduction in cardiovascular events but a higher mortality in intensive group

• Of note:
  • Study involved patients who had diabetes for median of 10 years, HgbA1c of 7.5%, and had high risk of cardiovascular disease
Figure 1—Depiction of the elements of decision making used to determine appropriate efforts to achieve glycemic targets. Greater concerns about a particular domain are represented by increasing height of the ramp. Thus, characteristics/predicaments toward the left justify more stringent efforts to lower HbA1c, whereas those toward the right are compatible with less stringent efforts. Where possible, such decisions should be made in conjunction with the patient, reflecting his or her preferences, needs, and values. This “scale” is not designed to be applied rigidly but to be used as a broad construct to help guide clinical decisions. Adapted with permission from Ismail-Beigi et al. (20).
Not One Size Fits All

- Glycemic Target
  - Duration of DM
  - Age
  - CVD
- Readiness for change
- Predisposition to hypoglycemia
- Important Co-morbidities
- Resources
Clinical Inertia
Clinical Inertia

### Table 2—Probability at end of follow-up/median time (in years) of going from HbA1c above cutoff to intensification, reaching glycemic target, or end of follow-up data

<table>
<thead>
<tr>
<th>Cutoff HbA1c</th>
<th>Number of OADs*</th>
<th>Patients with treatment intensified with additional OAD</th>
<th>Patients with treatment intensified with insulin</th>
<th>Patients with treatment intensified with additional OAD or insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥7% (≥53 mmol/mol)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 35,988</td>
<td>1</td>
<td>65.0, 2.9</td>
<td>6.5, &gt;7.2*</td>
<td>71.5, 2.2</td>
</tr>
<tr>
<td>n = 21,858</td>
<td>2</td>
<td>31.5, &gt;7.2*</td>
<td>13.7, &gt;7.2*</td>
<td>45.2, &gt;7.2*</td>
</tr>
<tr>
<td>n = 5,050</td>
<td>3</td>
<td>—</td>
<td>17.5, &gt;7.1*</td>
<td>17.9, &gt;7.1*</td>
</tr>
<tr>
<td>≥7.5% (≥58 mmol/mol)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 31,375</td>
<td>1</td>
<td>66.9, 1.9</td>
<td>7.6, &gt;7.1*</td>
<td>74.5, 1.5</td>
</tr>
<tr>
<td>n = 20,164</td>
<td>2</td>
<td>32.1, &gt;7.2*</td>
<td>17.1, &gt;7.2*</td>
<td>49.2, &gt;7.2*</td>
</tr>
<tr>
<td>n = 4,733</td>
<td>3</td>
<td>—</td>
<td>20.6, &gt;6.1*</td>
<td>20.6, &gt;6.1*</td>
</tr>
<tr>
<td>≥8% (≥64 mmol/mol)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 25,096</td>
<td>1</td>
<td>67.0, 1.6</td>
<td>8.8, &gt;6.9*</td>
<td>75.8, 1.1</td>
</tr>
<tr>
<td>n = 16,991</td>
<td>2</td>
<td>30.1, &gt;6.9*</td>
<td>20.2, &gt;6.9*</td>
<td>50.3, 6.3</td>
</tr>
<tr>
<td>n = 4,112</td>
<td>3</td>
<td>—</td>
<td>22.0, &gt;6.0*</td>
<td>22.0, &gt;6.0*</td>
</tr>
</tbody>
</table>

*Data are probability (%), median (years) unless otherwise indicated. *The symbol > indicates that <50% of subjects have intensified treatment. Differences in this value are due to variation between subcohorts.*
ADA-EASD Position Statement: Management of Hyperglycemia

3. Antihyperglycemic Therapy

• Therapeutic options: *Lifestyle*
  • Weight Optimization
  • Healthy Diet
  • Increased Activity Level

*Diabetes Care, Diabetologia. 19 April 2012*
Main Pathophysiological Defects in T2DM

Adapted from: Innocchi SE, Sherwin RS in: CecilMedicine 2011
ADA/EASD Antihyperglycemic Therapy in Type 2 Diabetes

Diabetes Care, Volume 35, June 2012
Goal of Insulin Therapy

We are trying to duplicate how the pancreas works in releasing insulin for someone who does not have diabetes.
Physiologic Insulin Secretion

![Graph showing Physiologic Insulin Secretion: 24-Hour Profile](image)

- **Insulin (μU/mL)**: Peaks during meals (Breakfast, Lunch, Dinner) and baseline (Basal insulin).
- **Glucose (mg/dL)**: Fluctuates with peaks at mealtimes (Breakfast, Lunch, Dinner) and a flat baseline (Basal glucose).

**Time of day**: AM 7-9, 10-11, 12-1, 2-3, 4-5, 6-7, 8-9 PM
### Type 2 DM – Insulin

#### Basal Insulin – Intermediate to long acting insulin

<table>
<thead>
<tr>
<th>Insulin</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPH (Novolin N®)</td>
<td>1-3 hours</td>
<td>6-10 hours</td>
<td>12-20 hours</td>
</tr>
<tr>
<td>Levemir (Detemir®)</td>
<td>1 hour</td>
<td>None</td>
<td>12-24 hours</td>
</tr>
<tr>
<td>Gliargine (Lantus®)</td>
<td>1 hour</td>
<td>None</td>
<td>24 hours</td>
</tr>
</tbody>
</table>

#### Bolus Insulin – shorter acting insulin

<table>
<thead>
<tr>
<th>Insulin</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspart (Novolog®)</td>
<td>15-30 min</td>
<td>30-90 min</td>
<td>3-5 hours</td>
</tr>
<tr>
<td>Lispro (Humalog®)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glulisine (Apidra®)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular (Novolin R®)</td>
<td>30-60 min</td>
<td>1-2 hours</td>
<td>5-8 hours</td>
</tr>
<tr>
<td>(Humulin R®)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Premixed Insulin – longer and shorter acting

Consider for people who cannot use insulin, use an insulin pen, or whose stable dose of insulin is the same as the premix.

<table>
<thead>
<tr>
<th>Insulin, Novolog 70/30</th>
<th>Onset</th>
<th>Peak</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPH (Novolin N®)</td>
<td>30 min</td>
<td>2-5 hours</td>
<td>18-24 hours</td>
</tr>
<tr>
<td>Humulin 50/50</td>
<td>30 min</td>
<td>2-4 hours</td>
<td>14-24 hours</td>
</tr>
<tr>
<td>Humalog 75/25</td>
<td>15 min</td>
<td>1-2½ hrs</td>
<td>16-20 hours</td>
</tr>
</tbody>
</table>

*Drugs names in italics are not on the National Core Formulary*

3. ANTI-HYPERGLYCEMIC THERAPY

- Therapeutic options: **Insulin**
Glargine vs Detemir
PIMC Experience

• In February 2011 detemir added as formulary long acting insulin and all patients on glargine required to switch
• Anectodotally, patients were not as well controlled after switch
• RPMS search was used to identify patients with prescriptions for both glargine and detemir from March 2011-April 2012
• Inclusion criteria
  • Patients with type 2 diabetes
  • Prescribed glargine insulin for at least 6 months
  • Converted to detemir insulin
• Exclusion criteria
  • Patients less than 18 years of age
  • Pregnant
  • Lack of follow-up within one year of switching insulins
  • Discontinuation of detemir before 3 months of use
  • Absence of “paired” glycosylated hemoglobin (HbA1c) values (while on glargine and after at least 3 months of treatment with detemir)
Primary Outcome

<table>
<thead>
<tr>
<th></th>
<th>6-12 months before switch</th>
<th>Glargine (baseline)</th>
<th>Detemir 3 months after</th>
<th>Detemir 12 months after</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1C (%) values</td>
<td>9.1</td>
<td>9.4</td>
<td>9.6</td>
<td>9.3</td>
</tr>
</tbody>
</table>
Impact on Weight

![Weight Chart]

- **Weight**
  - Pounds:
    - 229
    - 228
    - 227
    - 226
    - 225
    - 224
    - 223
    - 222
    - 221
    - 220
  - 6-12 months before switch, baseline, 3 months after, 1 yr or dc

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Dose Requirements
Summary

- **Effectiveness:**
  - At 3 months, A1c values showed a statistically significant increase for patients switched to detemir compared to baseline. However, A1c at 1 year compared to baseline was not statistically significant.

- **Safety:**
  - 12.21% (74) of patients discontinued detemir
  - Most common reason for discontinuation:
    - Poor glucose control (52.7% of ADRs)
    - Of note, some uncommon ADRs were seen such as leg stiffness, jittery feeling, palpitations, and metallic taste

- **Insulin requirements:**
  - Long-acting insulin requirements increased at 3 months and 1 year, by a statistically significant amount (detemir is less potent)
  - Total daily dose of insulin increased at all time frames

- **Dosing Frequency:**
  - 43.4% of patients went from once daily to twice daily dosing

- **Amount saved:**
  - $224,883 after switching from glargine to detemir at 1 year
  - -
Basal Insulins

- **NPH**
  - Longest history with most experience
  - Cheapest
- **Detemir**
  - Potentially less weight gain
  - Really needs to be used twice daily
- **Glargine**
  - Once daily dosing
  - Less hypoglycemia
  - Most Costly
  - Cancer Risk?
Short Acting Insulin

• **Novolog/Humalog**
  • Food on fork
  • Better match to action time with meals
  • Less activity before bedtime so less likely to have nighttime hypoglycemia
  • Less likely to “stack”

• **Regular insulin**
  • Less costly
## IHS Cost of Insulin

<table>
<thead>
<tr>
<th>Type of Insulin</th>
<th>Cost/vial (1000 units/vial)</th>
<th>Cost/pen (300 units/pen)</th>
<th>Cost/1000 units via pen</th>
<th>IHS National Core Formulary (vials)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPH</td>
<td>$ 4.79</td>
<td>$ 3.42</td>
<td>$ 11.40</td>
<td>yes</td>
</tr>
<tr>
<td>Detemir (Levemir®)</td>
<td>$ 19.99</td>
<td>$ 8.00</td>
<td>$ 26.66</td>
<td>yes</td>
</tr>
<tr>
<td>Glargine (Lantus®)</td>
<td>$ 48.23</td>
<td>$ 21.63</td>
<td>$ 72.10</td>
<td>no</td>
</tr>
<tr>
<td>Regular</td>
<td>$ 4.79</td>
<td>N/A</td>
<td>N/A</td>
<td>yes</td>
</tr>
<tr>
<td>Aspart (Novolog®)</td>
<td>$ 19.81</td>
<td>$ 5.94</td>
<td>$ 19.81</td>
<td>yes</td>
</tr>
<tr>
<td>Lispro (Humalog®)</td>
<td>$ 42.84</td>
<td>$ 16.06</td>
<td>$ 53.53</td>
<td>no</td>
</tr>
</tbody>
</table>
Hypoglycemia

- Signs/Symptoms
  - Shakiness
  - Nervousness or anxiety
  - Sweating, chills and clamminess
  - Irritability or impatience
  - Confusion, including delirium
  - Rapid/fast heartbeat
  - Lightheadedness or dizziness
  - Hunger and nausea
  - Sleepiness
  - Blurred/impaired vision
  - Tingling or numbness in the lips or tongue
  - Headaches
  - Weakness or fatigue
  - Anger, stubbornness, or sadness
  - Lack of coordination
  - Nightmares or crying out during sleep
  - Seizures
  - Unconsciousness

- Treatment
  - Consume 15-20 grams of glucose or simple carbohydrates
    - 15 grams of simple carbohydrates commonly used:
      - glucose tablets (follow package instructions)
      - Gel tube (follow package instructions)
      - 2 tablespoons of raisins
      - 4 ounces (1/2 cup) of juice or regular soda (not diet)
      - 1 tablespoon sugar, honey, or corn syrup
      - 8 ounces of nonfat or 1% milk
      - hard candies, jellybeans, or gumdrops (see package to determine how many to consume)

  - Recheck your blood glucose after 15 minutes
  - If hypoglycemia continues, repeat.
  - Once blood glucose returns to normal, eat a small snack if your next planned meal or snack is more than an hour or two away.
Weight Gain

• In general, 2-4kg increase in body weight
• Mechanism Unclear - Possibly explained by reductions in glucosuria and resting energy expenditure when glycemic control is improved
• Perhaps less with detemir than NPH or glargine
Sequential Insulin Strategies

Diabetes Care, Volume 35, June 2012
Algorithm for Adding/Intensifying Insulin

### Start Basal (Long-Acting Insulin)

**A1c < 8%**
- TDD: 0.1–0.2 U/kg

**A1c > 8%**
- TDD: 0.2–0.3 U/kg

**Insulin titration every 2–3 days to reach glycemic goal:**
- Fixed regimen: Increase TDD by 2 U
- Adjustable regimen:
  - FBG > 180 mg/dL: add 4 U
  - FBG 140–180 mg/dL: add 2 U
  - FBG 110–139 mg/dL: add 1 U
- If hypoglycemia, reduce TDD by:
  - BG < 70 mg/dL: 10%–20%
  - BG < 40 mg/dL: 20%–40%

Consider discontinuing or reducing sulfonyloyurea after basal insulin started (basal analogs preferred to NPH)

**Glycemic Goal:**
- For most patients with T2D, an A1c < 7%, fasting and premeal BG < 110 mg/dL in the absence of hypoglycemia.
- A1c and FBG targets may be adjusted based on patient’s age, duration of diabetes, presence of comorbidities, diabetic complications, and hypoglycemia risk.

### Intensify (Prandial Control)

**Add GLP-1 RA or DPP-4i**

**Add Prandial Insulin**
- TDD: 0.3–0.5 U/kg
  - 50% Basal Analog
  - 50% Prandial Analog
- Less desirable: NPH and regular insulin or premixed insulin

**Insulin titration every 2–3 days to reach glycemic goal:**
- Increase basal TDD as follows:
  - Fixed regimen: Increase TDD by 2 U
  - Adjustable regimen:
    - FBG > 180 mg/dL: add 4 U
    - FBG 140–180 mg/dL: add 2 U
    - FBG 110–139 mg/dL: add 1 U
- Increase prandial dose by 10% for any meal if the 2-hr postprandial or next premeal glucose is > 180 mg/dL.
- Premixed: Increase TDD by 10% if fasting/premeal BG > 180 mg/dL.
- If fasting AM hypoglycemia, reduce basal insulin
- If nighttime hypoglycemia, reduce basal and/or pre-supper or pre-evening snack short/rapid-acting insulin
- If between meal daytime hypoglycemia, reduce previous premeal short/rapid-acting insulin
Type 2 DM – Insulin

STEP 1: Target Fasting Plasma Glucose with Basal insulin
Fasting Plasma Glucose (FPG) Target = 70-130mg/dl*

HS Basal insulin – start 10 units or 0.2 units/kg

Increase dose 2 units every 3 days until FPG is 70 - 130mg/dl*
May increase by 4 units every 3 days if FPG is > 180mg/dl*

STEP 2: Target Premeal Glucose (target one at a time)
Premeal Glucose Target = 70-130mg/dl*

If Pre-lunch glucose > 130mg/dl*
Start 4 units Bolus insulin before breakfast

If Pre-supper glucose > 130mg/dl*
Start 4 units Bolus insulin before lunch
OR Add/Increase morning NPH/levelemir

If Bedtime glucose above target (e.g. > 140mg/dl*), Start 4 units Bolus insulin before supper OR Increase evening NPH/levelemir

Increase Bolus insulin by 2 units every 3 days
As insulin doses get larger, (over 10 units), begin to change insulin dose by 10-20%

STEP 3: If A1c not at goal: Target Post-Prandial Glucose
with Bolus premeal insulin
2 Hour Post-Prandial Glucose Target < 160-180mg/dl*

* Glucose targets should be individualized based on patient comorbidities, needs, and response to blood glucose lowering.
### Table 1. Selected barriers to insulin injection therapy among patients, providers, and health care system

<table>
<thead>
<tr>
<th>PATIENT BARRIERS</th>
<th>PROVIDER BARRIERS</th>
<th>SYSTEM BARRIERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psychological resistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myth-based fear of insulin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fear of hypoglycemia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concern about weight gain</td>
<td></td>
<td></td>
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<tr>
<td>Fear of needles and pain</td>
<td></td>
<td></td>
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<tr>
<td>Self-blame</td>
<td></td>
<td></td>
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<tr>
<td>Loss of control</td>
<td></td>
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<tr>
<td>Social stigma</td>
<td></td>
<td></td>
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<tr>
<td>Poor self-efficacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifestyle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time-consuming; inconvenient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel issues</td>
<td></td>
<td></td>
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<tr>
<td>Physical/mental</td>
<td></td>
<td></td>
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<tr>
<td>Poor recall/cognitive impairment</td>
<td></td>
<td></td>
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<tr>
<td>Visual/hearing/dexterity impairment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning difficulties; low literacy/numeracy skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reimbursement issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived patient resistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient’s adherence behavior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Belief that patient’s improved status negates need to start insulin therapy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concerns about adverse effects (hypoglycemia; weight gain)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provider time constraints (instruction; titration)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of resources/organizational structure to facilitate guideline adherence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overburdened workload among providers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limited training of providers in injection technique</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underutilization of resources (within clinical practices, hospitals, and community)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reimbursement issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor follow-up system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Suboptimal team collaboration; poor chronic care model</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**TABLE 3  General strategies for initiating insulin therapy**

- Invite the patient to take an active role in treatment decisions.
- Remind the patient that type 2 diabetes is primarily self-managed.
- Discuss the progressive nature of β-cell dysfunction in type 2 diabetes.
- Emphasize the physiologic role of insulin to maintain glucose homeostasis.
- Discuss that insulin will help to achieve glycemic control and minimize the risk for long-term complications.
- Discuss that treatment will be modified as needed to maintain glycemic control and to best meet their needs, capabilities, and interest.
- Utilize insulin pen devices whenever possible.
- Emphasize the importance of lifestyle management.
- Ask if hearing other patients talk of their experiences with insulin therapy would be helpful; consider a group office visit.
- Discuss and provide the patient with an individualized, written action plan that includes insulin dosing, self-monitoring of blood glucose, and signs/symptoms of hypoglycemia and other adverse events with appropriate action(s) to take.
- Simplify diabetes (and comorbidities) treatment whenever possible.
Case Study #1

- 52 year old male with 10 year h/o Type 2 DM.
- Current Medications:
  - Glucophage 1000 mg po bid
  - Glypizide XL 20 mg po qd
- Glycemic Control:
  - HgbA1c 9.3%
  - Fasting Blood sugars are 250

What do you do next?
Type 2 DM – Insulin

STEP 1: Target Fasting Plasma Glucose with Basal insulin
Fasting Plasma Glucose (FPG) Target = 70-130mg/dl*

- HS Basal insulin – start 10 units or 0.2 units/kg

- Increase dose 2 units every 3 days until FPG is 70-130mg/dl*
- May increase by 4 units every 3 days if FPG is > 180mg/dl*

STEP 2: Target Premeal Glucose (target one at a time)
Premeal Glucose Target = 70-130mg/dl*

- If Pre-lunch glucose > 130mg/dl*
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- If Pre-supper glucose > 130mg/dl*
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  OR Add/Increase morning NPH/levemir

- If Bedtime glucose above target
  (e.g. > 140mg/dl*), Start 4 units Bolus Insulin before supper
  OR Increase evening NPH/levemir

- Increase Bolus insulin by 2 units every 3 days
  As insulin doses get larger, (over 10 units), begin to change insulin dose by 10-20%

STEP 3: If A1c not at goal: Target Post-Prandial Glucose
with Bolus premeal insulin
2 Hour Post-Prandial Glucose Target < 160-180mg/dl*

* Glucose targets should be individualized based on patient comorbidities, needs, and response to blood glucose lowering
Oral Medication and Bedtime Insulin

“I take diabetes pills and one shot of insulin”

<table>
<thead>
<tr>
<th>Oral medications and bedtime insulin</th>
<th>Start Phase</th>
<th>Adjust Phase</th>
<th>Maintain Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fasting daily for 1 week – return to clinic for adjustments</td>
<td>Fasting daily for 1-2 weeks – AND – Before and after an event 1-2 days/week</td>
<td>Fasting and 1 test before and 1 test after an event each week</td>
</tr>
</tbody>
</table>

“Events”

1) Meal or Snack* - a “snack” is 100 calories or less
2) Exercise ** - ask your doctor for an exercise plan
3) Low blood sugar symptoms (Hypoglycemia)

The purpose of the bedtime insulin is to control the blood sugar while you are asleep. Checking your blood sugar before you eat breakfast will tell you if the dose is correct.

Don’t hesitate to check your blood sugar if you wake up in the middle of the night and are shaky, hungry, having nightmares, etc.

* Remember – if your blood sugar before your meal is at goal, and it’s too high after your meal, think about what kind of food you just ate, and how much.
  • Did you drink something with sugar in it?? (regular soda, tea, Gatorade, coffee with “real” sugar)
  • Did you eat too much starchy food? (Bread, tortilla, potato, pasta)

** Remember – when you first begin to exercise, you MAY see your blood sugar go up a little bit… your body thinks you need extra energy to deal with this “stress”… Just stay with your exercise plan, and you’ll see your blood sugars start to go down after exercise.

*** Remember – if you are dizzy, shaky, have blurred vision or frequent urination or you feel “some way” - test your blood sugar. If blood sugar is below 70 mg/dl, drink ½ glass (4 oz) of juice or regular soft drink or 1 glass (8 oz) of milk or eat some soft candies (not chocolate!).

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Case Study #1

• Patient returns for f/u after 1 week:

<table>
<thead>
<tr>
<th>Day</th>
<th>Fasting Blood sugar</th>
<th>Insulin dose</th>
<th>Dose Adjustment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>230</td>
<td>10 units qhs</td>
<td>None</td>
</tr>
<tr>
<td>Day 2</td>
<td>225</td>
<td>14 units qhs</td>
<td>Increase by 4 units</td>
</tr>
<tr>
<td>Day 3</td>
<td>207</td>
<td>14 units qhs</td>
<td>None</td>
</tr>
<tr>
<td>Day 4</td>
<td>199</td>
<td>14 units qhs</td>
<td>None</td>
</tr>
<tr>
<td>Day 5</td>
<td>179</td>
<td>16 units</td>
<td>Increase by 2 units</td>
</tr>
<tr>
<td>Day 6</td>
<td>160</td>
<td>16 units</td>
<td>None</td>
</tr>
</tbody>
</table>
Beware

- **Early morning hypoglycemia**
  - Patient might need to take NPH later (around 11 pm) to delay peak
  - Reduce nighttime dose of insulin
  - Over correction of counter regulatory hormones can result in fasting hyperglycemia

- **Fasting hyperglycemia**
  - If can’t figure out why, make sure you ask about early morning hypoglycemia
  - Alternatively could be due to just taking nighttime insulin too early or needing to increase dose
Case Study #2

- 54 year old male with 12 year h/o Type 2 DM.
- Current Medications:
  - Glucophage 1000 mg po bid
  - Glypizide XL 20 mg po qd
  - NPH 40 units bid
- Glycemic Control:
  - HgbA1c 8.9%

What do you do next?

<table>
<thead>
<tr>
<th>Day</th>
<th>Fasting Blood Sugar</th>
<th>Pre-meal blood sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 7</td>
<td>145</td>
<td>L - 200</td>
</tr>
<tr>
<td>Day 10</td>
<td>152</td>
<td>D - 210</td>
</tr>
<tr>
<td>Day 14</td>
<td>133</td>
<td>L - 193</td>
</tr>
<tr>
<td>Day 18</td>
<td>129</td>
<td>D - 220</td>
</tr>
<tr>
<td>Day 23</td>
<td>141</td>
<td>L - 201</td>
</tr>
<tr>
<td>Day 30</td>
<td>137</td>
<td>D - 250</td>
</tr>
</tbody>
</table>
Case Study #2

- Multi-Daily Dosing-
  - Most complicated
  - Most time intensive
  - Most like our pancreas
  - Not for everyone
Insulin Plan
“I take insulin every day”

<table>
<thead>
<tr>
<th></th>
<th>Start Phase</th>
<th>Adjust Phase</th>
<th>Maintain Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insulin</strong></td>
<td>4 times or more daily –</td>
<td>2-4 times daily – before and</td>
<td>2-4 times per day at least 2</td>
</tr>
<tr>
<td></td>
<td>before and after an event</td>
<td>after an event</td>
<td>days per week. – before and</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>after an event</td>
</tr>
</tbody>
</table>

“Events”
1) Meal or Snack* - a “snack” is 100 calories or less
2) Exercise ** - ask your doctor for an exercise plan
3) Low blood sugar symptoms (Hypoglycemic)

* - Remember – if your blood sugar before your meal is at goal, and it’s too high after your meal, think about what kind of food you just ate, and how much.
  - Did you drink something with sugar in it?? (regular soda, tea, Gatorade, coffee with “real” sugar)
  - Did you eat too much starchy food? (Bread, tortilla, potato, pasta)

** - Remember – when you first begin to exercise, you MAY see your blood sugar go up a little bit… your body thinks you need extra energy to deal with this “stress”…. Just stay with your exercise plan, and you’ll see your blood sugars start to go down after exercise

*** Remember – if you are dizzy, shaky, have blurred vision or frequent urination or you feel “some way” - test your blood sugar. If blood sugar is below 70 mg/dl, drink ½ glass (4 oz) of juice or regular soft drink or 1 glass (8 oz) of milk or eat some soft candies (not chocolate!).

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## Carb Counting and Insulin Bolusing

<table>
<thead>
<tr>
<th>Sample Meal</th>
<th>Sample Meal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 c. orange juice 30 g</td>
<td>2 slices wheat bread 30 g</td>
</tr>
<tr>
<td>2 slices toast 30 g</td>
<td>2 oz. turkey breast</td>
</tr>
<tr>
<td>½ c. oatmeal 15 g</td>
<td>Lettuce leaf, tomato slice</td>
</tr>
<tr>
<td>1 soft-cooked egg</td>
<td>1 tsp mayonnaise</td>
</tr>
<tr>
<td>1 tsp margarine</td>
<td>6-8 3-ring pretzels 15 g</td>
</tr>
<tr>
<td>Coffee &amp; 1 T cream</td>
<td>2 small choc cookies 15 g</td>
</tr>
<tr>
<td></td>
<td>Diet soda, 16 oz</td>
</tr>
<tr>
<td><strong>Total CHO:</strong> 75 g</td>
<td><strong>Total CHO:</strong> 60 g</td>
</tr>
<tr>
<td><strong>Insulin bolus:</strong> 5 units</td>
<td><strong>Insulin bolus:</strong> 4 units</td>
</tr>
</tbody>
</table>

1 unit insulin: 15 grams CHO
Case Study #2

- Add 4 units regular insulin before largest meal
  - Patient to check BS pre and 2 hr post prandial of all meals (6 accuchecks/day)
  - Increase bolus insulin by 2 units every 3 days until 2 hr post prandial <180
  - Add in regular to before meals based on BS readings
  - Teach carb counting
    - Use Corrective dosing NOT Sliding scale when possible
Case Study #3

- 56 y/o female long standing DM on NPH 100 units bid and Regular insulin 100 units bid. Patient has surgical procedure planned for tomorrow.
- What do you tell the patient to do with her insulin in the 24-hour period prior to surgery?
Insulin Therapy before surgery

• Three Basic Steps
  • Ascertain the type of diabetes
  • Adjust the basal insulin dose
  • Stop the prandial insulin

• Hyperglycemia in perioperative period can
  • Result in delay of surgery
  • Delayed wound healing
  • Wound infection
  • Fluid and electrolyte shifts
  • Diabetic Ketoacidosis/Hyperosmolar states

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### Pre-Operative Basal Insulin Adjustment

<table>
<thead>
<tr>
<th>Basal Insulin</th>
<th>Regimen</th>
<th>Preoperative Adjustment</th>
<th>Morning of Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Acting</td>
<td>Equal basal (nighttime) and prandial</td>
<td>Full Basal Dose given</td>
<td>None</td>
</tr>
<tr>
<td>Long Acting</td>
<td>Disproportionately more basal (nighttime)</td>
<td>50% Total daily dose</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>than prandial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Acting</td>
<td>Basal dose given in morning</td>
<td>None</td>
<td>50%</td>
</tr>
<tr>
<td>Long Acting</td>
<td>Twice daily</td>
<td>50% (night before surgery)</td>
<td>50%</td>
</tr>
<tr>
<td>Intermediate Acting</td>
<td>Twice daily</td>
<td>Full dose</td>
<td>50%</td>
</tr>
<tr>
<td>70/30</td>
<td>Twice daily</td>
<td>None</td>
<td>50% Total daily dose as basal only</td>
</tr>
</tbody>
</table>

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Insulin Before Surgery

- If patient has tendency for hypoglycemia reduce an additional 25%
- Post surgery, restart normal regimen that evening
  - Resume prandial insulin once on regular diet
- Key: Patients require some form of basal insulin even in fasting state
Case Study #3

• 56 y/o female long standing DM on NPH 100 units bid and Regular insulin 100 units bid. Patient has surgical procedure planned for tomorrow.

• Pre-Operative Plan:
  • Day prior to Surgery – Normal regimen
  • Morning of Surgery
    • No prandial insulin
    • NPH 50 Units
Summary

• Good Glucose control = improved outcomes
• Diabetes management can be complicated….but doesn’t have to be
• One size does not fit all – individualize treatment plan
• Don’t let your patients be victims of clinical inertia
• It takes a team!
Care Model for the Indian Health System

Chronic Care Model developed by MacColl Institute
Questions??????

Marie.russell@ihs.gov