DM Fundamentals – Class 3
Insulin Pattern Management

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President, Diabetes Education Services

Insulin Hormone Replacement Therapy – Class 3

- Incorporating national guidelines into practice
- Using basal/bolus insulin therapy to improve glucose control from hospital to home
- Glucose patterns and adjustment strategies

Insulin Therapy
From Ants to Analogs:
Insulin - the Ultimate Hormone Replacement Therapy

Objectives:
• Discuss the actions of different insulins
• Describe using pattern management as an insulin adjustment tool.

The Nobel Prize in Physiology or Medicine 1923

Born: 14 November 1891, Alliston, Canada
Died: 21 February 1941, Newfoundland, Canada
Affiliation at the time of the award: University of Toronto, Toronto, Canada
Prize motivation: “for the discovery of insulin”
Field: endocrinology, metabolism

Poll question

A patient tells you she doesn’t want to start on insulin. What is your best response?

a. The needles are so small, you won’t feel a thing.
b. You might die if you don’t take insulin.
c. Tell me why.
d. There is a doctors’ order to start insulin.
e. Not sure
Psychological Insulin Resistance (PIR)

- 50% of providers in study threatened pts “with the needle”.
- Less than 50% of providers realized insulins’ positive effect on type 2 dm.
- Most pts don’t believe that insulin would “better help them manage their diabetes”.
- Solutions: Find the root of PIR and address it, use more insulin pens.

Diabetes Attitudes, Wishes, Needs Study - Rubin

Needle Size often a Barrier

- Use more short needles – 4 mm
- Effective for pts with BMI of 24-49
- Keeps it subq
- If pt thin, inject at angle
- To avoid leakage, count to 10 before withdrawing needle
- ½ the patients who could benefit from insulin are not using it due to needle phobias

3. What best describes the role of bolus insulins?
   a. cover carbs at meals and hyperglycemia
   b. helps to lower fasting blood glucose
   c. keeps overnight blood sugars under control
   d. should be used during hypoglyemic episodes
   e. not sure
Insulin Action Teams

- **Bolus:** lowers after meal glucose levels
  - Rapid Acting
    - Aspart, Lispro, Glulisine, Afrezza
  - Short Acting
    - Regular
- **Basal:** controls glucose between meals, hs
  - Intermediate
    - NPH
  - Long Acting
    - Detemir (Levemir)
    - Glargine (Lantus)

Poll question

- Which insulins are cheapest?
  a. Lantus, Levemir
  b. Novolog, Humalog
  c. Reg, NPH
  d. Insulin pens
  e. not sure
Bolus Insulins
(½ of total daily dose ÷ meals)

<table>
<thead>
<tr>
<th>Name</th>
<th>Onset</th>
<th>Peak Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lispro (Humalog)</td>
<td>15-30 min</td>
<td>1-1.5 hrs</td>
</tr>
<tr>
<td>Aspart (NovoLog)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glulisine (Apidra)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Afrezza (Inhaled)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular</td>
<td>30 mins</td>
<td>2-4 hrs</td>
</tr>
</tbody>
</table>

Cost Per Vial in Northern CA

<table>
<thead>
<tr>
<th>Per vial cost</th>
<th>Walmart</th>
<th>Walgreens</th>
<th>Costco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular Insulin</td>
<td>$25*</td>
<td>$92</td>
<td>$99</td>
</tr>
<tr>
<td>NPH</td>
<td>$25*</td>
<td>$92</td>
<td>$99</td>
</tr>
<tr>
<td>70/30</td>
<td>$25*</td>
<td>$92</td>
<td>$101</td>
</tr>
<tr>
<td>Humalog</td>
<td>$200</td>
<td>$220</td>
<td>$178</td>
</tr>
<tr>
<td>NovoLog</td>
<td>$197</td>
<td>$217</td>
<td>$178</td>
</tr>
<tr>
<td>Apidra</td>
<td>$180</td>
<td>$246</td>
<td>$178</td>
</tr>
<tr>
<td>Lvnemir</td>
<td>$300</td>
<td>$300</td>
<td>$300</td>
</tr>
<tr>
<td>Lantus</td>
<td>$220</td>
<td>$221</td>
<td>$200</td>
</tr>
</tbody>
</table>

Afrezza – Inhaled Insulin –
Approved 2014 – Type 1 or 2

Only studied in adults over 18
Not indicated for pregnancy, while breastfeeding
Steps, Cost, Terms

- 1st step – FDA approved. Will take time to produce, market and distribute
- Pricing – similar pricing as pens ~ $300 a month
- Afrezza is regular human insulin in powder form using Technosphere technology.
- Referred to as TI in papers – “Technosphere Insulin”

Afrezza Dosing and Considerations

- Bolus regular insulin – inhaled before meals
- Dosing: 4 and 8 unit cartridges
  - Convert with 1:1 ratio to existing insulin dose
- Lung function test before start (FEV1)
  - Not for pts w/ chronic lung issues
    - Asthma, COPD, history of lung cancer, smokers
    - Can cause acute bronchospasm – Black box warning
- Side effects:
  - Hypoglycemia, sore throat, cough
  - Less hypoglycemia than injected insulin

Lung function

- Lung function diminishes over first 3 months and then stabilizes (in 2 yr study)
- Measured by Forced Expiratory Volume (FEV1)
- Measure lung function with Incentive Spirometry at baseline, 6 months and yearly
- If FEV1 declines by more than 20%, consider stopping Afrezza
- Not tested on smokers
- Enhanced absorption for those on albuterol
Afrezza Inhaler

Replace inhaler every 15 days – Do not wash.

Afrezza – Loading Cartridge into device

- Hold inhaler level
- Open inhaler by lifting white mouthpiece
- Hold insulin cartridge with cup facing down.
- Place cartridge inside and close lid. Keep level.
- Make sure cartridge has been at room temp for 10 minutes

Afrezza – Proper Inhale Technique

- Exhale
- Position inhaler in mouth (take off cover)
- Tilt inhaler down toward chin, keep head level
- Inhale deeply and hold breath for as long as comfortable
- Remove cartridge
- Replace cover
### Bolus Insulin Summary
- Regular, Novolog, Humalog, Apidra, Afrezza
- Starts working fast (15-30 mins)
- Gets out fast (3-6 hours)
- Post meal BG reflects effectiveness
- Should comprise about ½ total daily dose
- Covers food or hyperglycemia.
- 1 unit
  - Covers ≈ 10 - 15 gms of carb
  - Lowers BG ≈ 30 – 50 points

### Bolus Insulin Timing
- How is the effectiveness of bolus insulin determined?
  - 2 hour post meal (if you can get it)
  - Before next meal blood glucose
- Glucose goals (ADA) – may be modified by provider/pt
  - 1-2 hours post meal <180
  - Before next meal – 80 - 130

### Bolus – Insulin Sliding Scale
Starts at 150, 2 units for every 50 mg/dl >150

<table>
<thead>
<tr>
<th></th>
<th>Break</th>
<th>Lunch</th>
<th>Dinner</th>
<th>HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>94</td>
<td>212</td>
<td>148</td>
<td>254</td>
</tr>
<tr>
<td></td>
<td>no insulin</td>
<td>4 uR</td>
<td>no insulin</td>
<td>6 uR</td>
</tr>
<tr>
<td>Day 2</td>
<td>243</td>
<td>254</td>
<td>201</td>
<td>199</td>
</tr>
<tr>
<td></td>
<td>4uR</td>
<td>6 uR</td>
<td>4uR</td>
<td>no insulin</td>
</tr>
<tr>
<td>Day 3</td>
<td>189</td>
<td>243</td>
<td>162</td>
<td>244</td>
</tr>
<tr>
<td></td>
<td>2uR</td>
<td>4uR</td>
<td>2uR</td>
<td>4uR</td>
</tr>
<tr>
<td>Day 4</td>
<td>66</td>
<td>287</td>
<td>144</td>
<td>272</td>
</tr>
<tr>
<td></td>
<td>No insulin</td>
<td>6uR</td>
<td>none</td>
<td>6uR</td>
</tr>
</tbody>
</table>
### Basal Insulins

(½ of total daily dose)

<table>
<thead>
<tr>
<th>Intermediate Acting</th>
<th>Peak Action</th>
<th>Duration</th>
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</thead>
<tbody>
<tr>
<td>NPH</td>
<td>4-12 hrs</td>
<td>12-24</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Long Acting</th>
<th>Peak Action</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Detemir (Levemir)</td>
<td>peakless</td>
<td>20 hrs</td>
</tr>
<tr>
<td>Glargine (Lantus)</td>
<td>No peak</td>
<td>24 hrs</td>
</tr>
</tbody>
</table>

*Fasting BG reflects efficacy of basal*

### Basal Insulin Summary

- NPH, Levemir, Lantus
- Covers in between meals, through night
- Starts working slow (4 hours)
- Stays in long (12-24 hours)
  - NPH/ Lente 12 hrs
  - Levemir, Lantus 20-24 hrs
- Fasting blood glucose reflects effectiveness

### Pattern Management
Poll Question

- When looking at glucose patterns, which problem do you fix first?
  - a. Hyperglycemia
  - b. Hypoglycemia
  - c. non-compliance
  - d. legible writing
  - e. not sure

Pattern Management

- Safety 1st!! - Evaluate 3 day patterns
- Hypo: eval 1st and fix:
  - If possible, decrease medication dose
  - Timing of meals, exercise, medications
- Hyperglycemia: evaluate 2nd
  - Identify patterns
  - Before increase insulin, make sure not missing something (carbs, exercise, omission)

Type 2 – Amaryl 4mg AM, 10u Lantus pm

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<td>164</td>
<td>94</td>
<td>66</td>
<td>162</td>
</tr>
<tr>
<td>Day 2</td>
<td>169</td>
<td>59</td>
<td></td>
<td>195</td>
</tr>
<tr>
<td>Day 3</td>
<td></td>
<td>84</td>
<td>81</td>
<td>242</td>
</tr>
<tr>
<td>Day 4</td>
<td>159</td>
<td>43</td>
<td></td>
<td>211</td>
</tr>
</tbody>
</table>
Case Study

- 70 yr old, avid walker
- BMI 24, Weighs 60kg
- A1c – 9.8%, BG 250s during day for past weeks
- Insulin – 30 units Lantus (solostar pen)
- Oral Meds: glipizide 20mg
  - What medication changes?
  - What insulin changes?
  - Pt can’t afford insulin pen – what other option

Basal Only
Type 2, 60kg – A1c 9.8%

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</thead>
<tbody>
<tr>
<td>Mo 1</td>
<td>170s</td>
<td></td>
<td></td>
<td>298</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10uLan</td>
</tr>
<tr>
<td>Mo 2</td>
<td>160s</td>
<td></td>
<td></td>
<td>233</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>20uLan</td>
</tr>
<tr>
<td>Mo 3</td>
<td>140s</td>
<td>283</td>
<td>265</td>
<td>208</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30uLan</td>
</tr>
</tbody>
</table>

When is it Too much basal insulin?
Case Study

- 70 yr old, avid walker
- BMI 24, Weighs 60kg
- A1c – 9.8%, BG 300s for past weeks
- Insulin – 30 units Lantus (solostar pen)
- Oral Meds: glipizide 20mg
  - What medication changes? Stop glipizide
  - What insulin changes? Try adding 1 bolus injection at largest meal, or switch to 70/30. 2/3s am, 1/3 pre dinner = 20units 70/30 am, 10 units 70/30 pre dinner
  - Pt can't afford insulin pen – use vial and syringes
20u 70/30 am, 10u 70/30 pm
Patterns? Changes needed?

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<td>63</td>
<td>92</td>
<td>181</td>
</tr>
<tr>
<td>Day 2</td>
<td>112</td>
<td>67</td>
<td>106</td>
<td>195</td>
</tr>
<tr>
<td>Day 3</td>
<td>98</td>
<td>56</td>
<td>112</td>
<td>201</td>
</tr>
<tr>
<td>Day 4</td>
<td>99</td>
<td>71</td>
<td>132</td>
<td>211</td>
</tr>
</tbody>
</table>

Basal Bolus – What Adjustments?
Pt weighs 80kg

<table>
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<td>Day 1</td>
<td>69</td>
<td>79</td>
<td>245</td>
<td>190</td>
</tr>
<tr>
<td>Day 2</td>
<td>81</td>
<td>87</td>
<td>170</td>
<td>133</td>
</tr>
<tr>
<td>Day 3</td>
<td>73</td>
<td>94</td>
<td>194</td>
<td>110</td>
</tr>
<tr>
<td>Day 4</td>
<td>62</td>
<td>83</td>
<td>211</td>
<td>127</td>
</tr>
</tbody>
</table>

Intensive Diabetes Therapy
Insulin Dosing Strategy

**50/50 Rule**
- 0.5-1.0 units/kg day
- Basal = 50% of total
  - Glargine QD
  - NPH or Detemir BID
- Bolus = 50% of total
  - usually divided into 3 meals

**Example**
- Wt 50kg x 0.5 = 25 units of insulin/day
- Basal dose: 13 units
  - Glargine 13 units QD
  - NPH/Detemir 6u BID
- Bolus dose: 12 units
  - 4 units NovoLog, Apidra, Humalog, Regular each meal
### 50/50 Rule

- Basal = 50% of total
  - Glargine QD
  - NPH or Detemir BID
- Bolus = 50% of total
  - usually divided into 3 meals

### Example – You Try

#### Wt 60 kg x 0.5 = ___ units of insulin/day

- Basal dose: ____ units
  - Glargine ____ QD
  - NPH/Detemir ____ BID

- Bolus dose: ____ units
  - ____ units NovoLog, Apidra, Humalog, Reg each meal

---

### Example – You Try

#### Wt 60kg x 0.5 = 30 units of insulin/day

- Basal dose: 15 units
  - Glargine 15 QD or NPH/Detemir 7u BID

- Bolus dose: 15 units
  - 5 NovoLog, Apidra, Humalog, Reg each meal

---

### Basal Bolus – Using 50/50 Rule - Pt weighs 80kg

<table>
<thead>
<tr>
<th></th>
<th>Break</th>
<th>Lunch</th>
<th>Dinner</th>
<th>HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>84</td>
<td>89</td>
<td>145</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td>6H</td>
<td>7H</td>
<td>7H</td>
<td>20u Det</td>
</tr>
<tr>
<td>Day 2</td>
<td>81</td>
<td>97</td>
<td>107</td>
<td>133</td>
</tr>
<tr>
<td></td>
<td>6H</td>
<td>7H</td>
<td>7H</td>
<td>20u Det</td>
</tr>
<tr>
<td>Day 3</td>
<td>79</td>
<td>104</td>
<td>124</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>6H</td>
<td>7H</td>
<td>7H</td>
<td>20u Det</td>
</tr>
<tr>
<td>Day 4</td>
<td>89</td>
<td>103</td>
<td>208</td>
<td>193</td>
</tr>
<tr>
<td></td>
<td>6H</td>
<td>7H</td>
<td>7H</td>
<td>20u Det</td>
</tr>
</tbody>
</table>
Insulin Dosing Type 1 & 2

More than 200 units a day?

Consider u-500

- Consider U-500 (5 x’s more potent)
  - 1 unit on U-100 syringe = 5 units insulin
  - Dosing – take total daily needs and split into two doses
    - 60% am / 40% pm
  - 500 units per mL – 20 units a vial = 10,000 units per vial
  - Costs ~ $400 per vial
  - No basal insulin needed, because U-500 has bolus and basal action
  - Needs careful monitoring/ education
U-500 Dose

U-100 syringe and TB Syringe

Basal Bolus
- Carb counting
- Prandial coverage
- Correcting for hyper and hypoglycemia

Bolus Basics
- Carbohydrate/Prandial Coverage
  - Match the insulin to the carbohydrates
  - 1 unit for 15 gms - Common starting point
- Correction Bolus - targets hyperglycemia
  - 1 unit for every 30-50 points over target
- Adjust ratios depending on sensitivity and response
### Carbohydrate Ratio How does that work?

**Rapid/Fast Acting Insulin**

- **Dinner** (60 gms cho)
  - Lemon Chicken
  - 1 cup rice pilaf (45 gms cho)
  - Asparagus
  - Dinner Roll (15 gms cho)

**Blood Glucose** 165mg/dl

<table>
<thead>
<tr>
<th>Serving Size</th>
<th>Gms CHO</th>
<th>Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15 gms cho</td>
<td>1 unit</td>
</tr>
<tr>
<td>2</td>
<td>30 gms cho</td>
<td>2 units</td>
</tr>
<tr>
<td>3</td>
<td>45 gms cho</td>
<td>3 units</td>
</tr>
<tr>
<td>4</td>
<td>60 gms cho</td>
<td>4 units</td>
</tr>
</tbody>
</table>

### Adjusting Bolus and Correction Doses

**Carbohydrate-to-Insulin Ratio**

Based on three questions before meals:

1. How much carbohydrate am I going to eat?
2. What is my insulin dose for this amount of carbohydrate?
3. Should I lower the dose because I plan to be very active or have recently been active?

### Correction Bolus

**Rapid/Fast Acting Insulin (1 unit:50 mg/dl>150)**

<table>
<thead>
<tr>
<th>Blood Glucose (mg/dl)</th>
<th>Correction Bolus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 70</td>
<td>Subtract 1 unit</td>
</tr>
<tr>
<td>70-150</td>
<td>0 units</td>
</tr>
<tr>
<td>151-200</td>
<td>1 unit</td>
</tr>
<tr>
<td>201-250</td>
<td>2 units</td>
</tr>
<tr>
<td>251-300</td>
<td>3 units</td>
</tr>
<tr>
<td>301-350</td>
<td>4 units</td>
</tr>
<tr>
<td>351-400</td>
<td>5 units</td>
</tr>
</tbody>
</table>
Type 1 and a Teen

- Cindy is trying to carb count and adjust her insulin, but is still having trouble. She weighs 60kg.
- What is her daily dose of insulin?
- What is her basal dose?

1. Pre meal target BG is 120
2. Post meal goal < 180.
3. Carb ratio: 1 unit for every 15 gms
4. Hyperglycemic correction factor is one unit for every 55 above goal (she uses Humalog and 1700 rule)

**1700 Rule**

\[
\frac{1700}{TDD} = \text{insulin sensitivity} \\
1700 / 30 = 56 \\
\text{1 unit drops BG 56 points}
\]

**Correction Bolus for Cindy**

<table>
<thead>
<tr>
<th>Analog Insulin (1 unit:55 mg/dl)</th>
<th>Subtract 1 unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 70 mg/dl</td>
<td>Subtract 1 unit</td>
</tr>
<tr>
<td>70-119 mg/dl</td>
<td>0 units</td>
</tr>
<tr>
<td>120-175 mg/dl</td>
<td>1 unit</td>
</tr>
<tr>
<td>176-230 mg/dl</td>
<td>2 units</td>
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<tr>
<td>231-285 mg/dl</td>
<td>3 units</td>
</tr>
<tr>
<td>286-340 mg/dl</td>
<td>4 units</td>
</tr>
<tr>
<td>341-395 mg/dl</td>
<td>5 units</td>
</tr>
</tbody>
</table>

**Adjusting Cindy’s Bolus Insulin With Ratios**

BG before lunch 285, she plans to eat 45 gms of carbohydrate.

\[
285 - 120 = 165 \text{ over target}, \quad 165 / 55 = 3 \\
45gms / 15 = 3 \\
\quad \frac{3}{3} \text{ units bolus insulin to correct to target} \\
\quad \frac{3}{3} \text{ units bolus insulin to cover carbs in meal}
\]

Total adjusted dose: 6 units humalog insulin
Adjusting Cindy’s Bolus Insulin With Ratios - You Try

BG before lunch 230, plans to eat 60 gms of carbohydrate.

____ -120 = ____ over target, ____/55 = ____ units

____ gms / ____ = ____ units ins for carbs

# ____ units insulin to correct for hyperglycemia
# ____ units insulin to cover carbs in meal

**Total adjusted dose: ____ units humalog insulin**

---

Adjusting Cindy’s Bolus Insulin With Ratios - Answers

Fingerstick before lunch 220, plans to eat 60 gms of carbohydrate.

220 - 120 = 110 over target, 110/55 = 2

60 gms / 15 = 4 units for carbs

# 2 units insulin to correct hyperglycemia
# 4 units insulin to cover carbs in meal

**Total adjusted dose: 6 units humalog insulin**

---

Poll question

Which of the following are suggested insulin teaching keys?

a. Test, inject, eat – TIE
b. abdomen is preferred injection site
1. c. use a sharps container to dispose of needles/lancets
d. always have treatment for hypo available
e. all of the above
**Insulin Teaching Keys**

- Bolus insulin with meals
- Basal 1-2xs daily
- Abdomen preferred injection site
- Stay 1” away from previous site
- Don’t re-use ultra fine syringes
- Keep unopened insulin in refrigerator
- Toss opened insulin vial after 28 days
- Proper disposal
- Review patients ability to withdraw and inject
- Side effects include hypoglycemia/wt gain
- Insulin pens –
  - Prime needle to assure accurate insulin dose given
  - Hold needle in for 5 seconds after injection
  - Roll 70/30 pens

**Sharps Disposal: Product and Info**

- Look in the Government section white pages for a household hazardous waste listing for your city or county.
- Call 1-800-CLEANUP (1-800-253-2687)
- Search for collection centers on the California Integrated Waste Management Board (CIWMB) Web site:
  - [http://www.ciwmb.ca.gov/HHW/HealthCare/Collection/](http://www.ciwmb.ca.gov/HHW/HealthCare/Collection/)

**Thank You**

- Questions?
- Email bev@diabetesed.net
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