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 Miracle of Insulin

Patient J.L., December 15, 1922
February 15, 1923

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

Frederick G. Banting
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
Size Does Matter

- 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

Physiologic Insulin Secretion: 24-Hour Profile
**Insulin Action Teams**

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

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**Cost Per Insulin 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>
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<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>Levemir</td>
<td>$300</td>
<td>$300</td>
<td>$300</td>
</tr>
<tr>
<td>Lantus</td>
<td>$226</td>
<td>$221</td>
<td>$206</td>
</tr>
</tbody>
</table>

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**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>

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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

Know your AFREZZA® inhaler:

Replace inhaler every 15 days – Do not wash

Afrezza – Strengths

There are two strengths of AFREZZA® cartridges:

- One blue cartridge approximates 4 units of injected insulin.
- One green cartridge approximates 8 units of injected insulin.

Let insulin cartridges and inhaler sit at room temp for 10 minutes before using
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

Case Study

- 70 yr old, weighs 100kg
- History of CABG, tobacco
- A1c – 11.3%, BG 400-500 for past weeks
- Insulin – 100+ units Lantus at hs (solostar)
- Oral Meds: Metformin, Invokana
- What is a better insulin dosing strategy?
- Pt can’t afford insulin pen – what other option
- Diabetes Meds on a Budget - 2014 - provides practical and affordable strategies to manage hyperglycemia
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<tr>
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<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>Levemir</td>
<td>$800</td>
<td>$800</td>
<td>$800</td>
</tr>
<tr>
<td>Lantus</td>
<td>$226</td>
<td>$221</td>
<td>$206</td>
</tr>
</tbody>
</table>

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 – 70 - 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>8 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>4 uR</td>
<td>6 uR</td>
<td>4 uR</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>2 uR</td>
<td>4 uR</td>
<td>2 uR</td>
<td>4 uR</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>6 uR</td>
<td>none</td>
<td>6 uR</td>
</tr>
</tbody>
</table>

Basal Insulins
(½ of total daily dose)

Intermediate Acting  Peak Action  Duration
- NPH  4-12 hrs  12-24 hrs

Long Acting  Peak Action  Duration
- Detemir (Levemir)  Peakless  20 hrs
- Glargine (Lantus)  No peak  24 hrs

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
### Basal Only
**Type 2, 60kg – A1c 8.7%**

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<th>Dinner</th>
<th>HS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo 1</td>
<td>170s</td>
<td></td>
<td></td>
<td>298 10uLan</td>
</tr>
<tr>
<td>Mo 2</td>
<td>180s</td>
<td></td>
<td>233</td>
<td>20uLan</td>
</tr>
<tr>
<td>Mo 3</td>
<td>140s</td>
<td>283</td>
<td>265</td>
<td>30uLan</td>
</tr>
</tbody>
</table>

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### Insulin Dosing Type 1 & 2

- **U-500 Insulin: When More With Less Yields Success:** Diabetes Spectrum March 20, 2009 vol. 22 no. 2 116-122

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### More than 200 units a day?

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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 Insulin: When More With Less Yields Success: Diabetes Spectrum March 20, 2009 vol. 22 no. 2 116-122
AACE Algorithm

**ALGORITHM FOR ADDING/INTENSIFYING INSULIN**

**START BASAL** (long-acting insulin)

- Add 0.5 units/kg/day after 7 days of basal coverage.
- Adjust dose based on pre-breakfast BG.
- Adjust dose based on 1 hour post-breakfast BG.
- Adjust dose based on 1 hour post-lunch BG.
- Adjust dose based on 1 hour post-dinner BG.
- Adjust dose based on overnight BG.

**INTENSIFY** (prandial insulin)

- Add Insulin Mix 70/30 to reach A1C goal.
- Add Insulin Mix 50/50 to reach A1C goal.

**Considerations:**
- Pre-mixed, difficult to fine tune therapy.
- Adjust dose based on pre-breakfast BG.
- Adjust dose based on 1 hour post-breakfast BG.
- Adjust dose based on 1 hour post-lunch BG.
- Adjust dose based on 1 hour post-dinner BG.
- Adjust dose based on overnight BG.

**Combos Sub-Q Insulin**

<table>
<thead>
<tr>
<th>Insulin Type</th>
<th>Onset</th>
<th>Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humalog Mix 75/25, 25% NPL, 75% lispro</td>
<td>0.25 - 0.5 hr</td>
<td>0.5 - 6.5 hrs</td>
</tr>
<tr>
<td>50/50: 50% NPL, 50% lispro</td>
<td>0.25 - 0.5 hr</td>
<td>0.5 - 6.5 hrs</td>
</tr>
<tr>
<td>NovoLog Mix 70/30, 70% NPA, 30% aspart</td>
<td>0.25 - 0.5 hr</td>
<td>1 - 4 hrs</td>
</tr>
<tr>
<td>NPH + Reg Combo 70/30, 70% NPH / 30% R</td>
<td>0.5 - 1.0 hr</td>
<td>2 - 16 hrs</td>
</tr>
<tr>
<td>50/50: 50% NPH / 50% R</td>
<td>0.5 - 1.0 hr</td>
<td>2 - 16 hrs</td>
</tr>
</tbody>
</table>

**10u 70/30 BID**

**Patterns? Changes needed?**

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<tbody>
<tr>
<td>Day 1</td>
<td>102</td>
<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>
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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<tbody>
<tr>
<td>Day 1</td>
<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>84</td>
<td>81</td>
<td></td>
<td>242</td>
</tr>
<tr>
<td>Day 4</td>
<td>159</td>
<td>43</td>
<td></td>
<td>211</td>
</tr>
</tbody>
</table>
Basal Bolus – What Adjustments?
Pt weighs 80kg

<table>
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<tr>
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<th>Dinner</th>
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</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>69</td>
<td>79</td>
<td>245</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td>7H</td>
<td>5H</td>
<td>8H</td>
<td>22u</td>
</tr>
</tbody>
</table>

Day 2
|       | 81    | 87    | 170    | 133  |
|       | 7H    | 5H    | 8H     | 22u   |

Day 3
|       | 73    | 94    | 194    | 110  |
|       | 7H    | 5H    | 8H     | 22u   |

Day 4
|       | 62    | 83    | 211    | 127  |
|       | 7H    | 5H    | 8H     | 22u   |

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

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
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 – 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>
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</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>20 u Det</td>
</tr>
<tr>
<td>Day 2</td>
<td>81</td>
<td>97</td>
<td>107</td>
<td>133</td>
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<td>6H</td>
<td>7H</td>
<td>7H</td>
<td>20u Det</td>
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<td>79</td>
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<td>193</td>
</tr>
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<td></td>
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<td>7H</td>
<td>7H</td>
<td>20u Det</td>
</tr>
</tbody>
</table>

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</th>
<th>Bolus Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 70</td>
<td>Subtract 1 unit</td>
</tr>
<tr>
<td>70-150 mg/dl</td>
<td>0 units</td>
</tr>
<tr>
<td>151-200 mg/dl</td>
<td>1 unit</td>
</tr>
<tr>
<td>201-250 mg/dl</td>
<td>2 units</td>
</tr>
<tr>
<td>251-300 mg/dl</td>
<td>3 units</td>
</tr>
<tr>
<td>301-350 mg/dl</td>
<td>4 units</td>
</tr>
<tr>
<td>351-400 mg/dl</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?
- Pre meal target BG is 120
- Post meal goal < 180.
- Carb ratio: 1 unit for every 15 gms
- Hyperglycemic correction factor is one unit for every 55 above goal (she uses Humalog and 1700 rule)

Correction Bolus for Cindy
Analog Insulin (1 unit:55 mg/dl-120)

<table>
<thead>
<tr>
<th>BG range</th>
<th>Insulin dose</th>
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<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>
</tr>
<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>
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</table>

Adjusting Cindy’s Bolus Insulin With Ratios

BG before lunch 285, she plans to eat 45 gms of carbohydrate.
285-120 = 165 over target, 165/55 = 3
45gms / 15 = 3
- 3 units bolus insulin to correct to target
- 3 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

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)

Thank You

- Questions?
- Email bev@diabetesed.net
- Web www.diabetesed.net