Insulin Pump Therapy

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Disclosures

• Member of Clinical Advisory Panel for Tandem
• Work on a variety of clinical trials funded by or supported by Medtronic
Objectives

• Discuss insulin pumps, features, and who may benefit from their use.
• Patient selection, education, and resources.
• Discuss insulin pump therapy in different populations:
  – Newly diagnosed
  – T2DM
  – Pregnancy
  – Children
• Review common patterns in glycemic control in people on insulin pump therapy.
• Strategies for optimization of pump therapy now and in the future
Why Pump Therapy?

• Less injections
• Flexibility in eating, exercise, and sleeping
• Bolus calculator and IOB/BOB
• More fun
• More physiologic
• Enables fine-tuning of insulin doses
• Software can provide accurate record of doses and often BG

Image: medgadget.com/2011/12/insulin-pump-tattoos-ma...
Pizza at 12 Noon...Who Knew?
Insulin Pump Therapy...

- A recent Cochrane review of 23 RCTs with 976 participants with T1D compared CSII and MDI (at least 3 injections per day).
  - There was a statistically significant mean difference in HbA1c of -0.3% in CSII users.
  - Reduced occurrence of severe hypoglycemia in CSII users
  - Improved QofL measures in CSII users

Pump Therapy in Pregnancy

• In pregnancy, achieving normoglycemia is paramount
• Clinical trials are challenging to conduct in this population
• Pump therapy is best started pre-conception, recommend not starting in the first trimester.
• Due to heightened concern for hyperglycemia and DKA in pregnancy paper suggests using NPH at hs and adjusting insulin accordingly.

Potential Pitfalls in Pump Therapy

• Risk of DKA
• There is an additional device to wear/ use
• Cost
• Solid foundation in diabetes education is key
• You must use it for it to be effective!
13 y.o. male, A1c=8.8, Daily Summary

Glucose (mg/dL)

Insulin Delivery

Carbohydrates and Exercise
Missed Meal Bolus
Burdick, Chase, Pediatrics 113: e221, 2004

• 65% missed more than 1 meal bolus/week
• 2 missed meal bolus/week caused A1c to increase ½%
Fig 1. HbA1c levels correlated with the number of missed meal insulin boluses per day (r = .4)

Burdick, J. et al. Pediatrics 2004;113:e221-e224
“Have you thought about an insulin pump upgrade?”
<table>
<thead>
<tr>
<th>Pump</th>
<th>Reservoir Size</th>
<th>Basal</th>
<th>Smallest Bolus Increment</th>
<th>Food Database</th>
<th>Integrated BG Meter</th>
<th>Integrated CGM</th>
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<tr>
<td>AccuMed</td>
<td>315 units</td>
<td>0.1-25 u/hr</td>
<td>0.1</td>
<td>Yes, PDA</td>
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<td></td>
<td>0.1 u/incr</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>300 units</td>
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<td>0.1 up to 10</td>
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<td>1 unit for 10-87 u</td>
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<td></td>
<td>523: 176 u</td>
<td>0.025-35 u/hr</td>
<td>0.025 upto</td>
<td>No</td>
<td>Yes OT Ultra Link</td>
<td>Yes</td>
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<td></td>
<td>723: 300 u</td>
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<td></td>
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<td>0.975</td>
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<td></td>
<td>0.05</td>
<td></td>
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<td></td>
<td>200 units</td>
<td>0.05-30 u/hr</td>
<td>0.05</td>
<td>Yes in PDM</td>
<td>Yes, FreeStyle Meter in PDM</td>
<td>No</td>
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<td>0.05 u/incr</td>
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<tr>
<td></td>
<td>200 units</td>
<td>0.025-25 u/hr</td>
<td>0.05</td>
<td>Yes, Meter Remote</td>
<td>Yes, OT Ultra Ping</td>
<td>No</td>
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<tr>
<td></td>
<td></td>
<td>0.025 u/incr</td>
<td></td>
<td></td>
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</tbody>
</table>

At what age should CSII be initiated?

- My take: At any age person with diabetes and if applicable the family seem ready, willing and able to do so.
- At younger ages care must be taken to be sure that there is adequate training and provision for management of pump.
  - Daycare
  - School
  - Babysitter
  - Safety with the pump itself (lockout etc)
Pump Therapy in Youth: SEARCH Study

• The largest review to date focused on insulin pump therapy in children and adolescents (N=2,743) found that pump therapy was associated with the lowest A1c levels across all ages.

Starting CSII Early Is Not New...

• Over 20 years ago, an RCT evaluated the impact of a 2 week trial of CSII in newly diagnosed adolescents with T1D:
  – Resulted in both improved metabolic control and beta cell preservation 1 year later than participants on MDI
  – (Shah et al., 1989)

• A smaller RCT pilot trial (N=24) of kids 8-18 years of age compared MDI to CSII started with in 1 month of diagnosis:
  – Trend of increased c-peptide over 1 year in CSII but not statistically significant
  – Improved glycemic control, was well tolerated and had higher reported patient satisfaction.
  – (Thraikill et al., 2011)

My experience....

• Currently I work on a study that starts newly diagnosed adults and children on an artificial pancreas followed by CGM and CSII use within 7 days of diagnosis of T1D.
  – While a challenging time to learn both families and children
  – Flexibility of therapy is helpful especially at the time of diagnosis when glucose and insulin needs are variable.
  – Injection or pen technique is still critical but not facing multiple injections is often a big motivator for kids and parents.
  – Using pump that can assist in calculations is often helpful at this time (IOB/ BOB).
What happens over-time?

- A retrospective chart review of 113 youth with T1D on pump therapy for up to 7 years found that:
  - Baseline HbA1c of ≤ 7.5%
  - Duration of T1D ≤ 1 year
  - Younger age at initiation of pump therapy
  - All were independently associated with Lowed HbA1c during long-term follow up.

When to start CSII?

• When the person with diabetes decides it is the best option for them and when in your opinion they are ready.
  – Testing BG frequently (at least 4-6 x day).
  – Able to count carbohydrates
  – Able to identify patterns and initiate changes in therapy
  – Demonstrate ability to program pump and prepare and insert infusion set.
  – Able to verbalize risk mitigation and management of DKA.
  – Reliable with follow up.
Potential Sources of Variability in Pump Therapy
1. CARBS: How many carbs?

- Double Double with Onion
- French Fries
- Chocolate Shake

http://perezsolomon.com/wp-content/uploads/2010/05/in_and_out1.jpg
Survey Says

• Which of the following is your best estimate of the total number of carbs in this meal?
  a. 103 grams
  b. 136 grams
  c. 165 grams
  d. 181 grams

• Would you consider this high fat and or high protein?

• How would you bolus for this meal?
  – Normal
  – Extended
  – Dual 50/50
  – Dual 70/30
  – Dual other
## Nutritional Facts State...

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<tr>
<th>Food</th>
<th>Grams of CHO</th>
<th>Grams of Fat</th>
<th>Grams of Protein</th>
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<tr>
<td>Double Double with Onion</td>
<td>39</td>
<td>41</td>
<td>37</td>
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<tr>
<td>French Fries</td>
<td>54</td>
<td>18</td>
<td>7</td>
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<tr>
<td>Chocolate Shake</td>
<td>72</td>
<td>29</td>
<td>10</td>
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<td><strong>TOTAL</strong></td>
<td><strong>165</strong></td>
<td><strong>88</strong></td>
<td><strong>54</strong></td>
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</table>
2. INFUSION
Infusion Sets and Site Location

• Variability in speed of absorption
• Variability in patency of infusion set (kinking or crystallization)
• Variability in tissue
• Variability by frequency of infusion set change
Frequency of Site Changes
3. BOLUS TIMING
TDD = 40 units

I:CHO Ratio at Breakfast 1:10 grams all other meals 1:12 grams

Delivers bolus immediately before or just after the start of the meal.
3 Months Later:
Boluses 5-15 min Pre-Meal Unless Low..

Sensor Overlay by Meal for Subject 12150 1254
Oct 4 - Oct 10, 2007
(7 days)

HbA1c: No Data
Pump: Paradigm 722
Sensor: In use
#414689

Overlay by Meal Event (mg/dL)

Breakfast
Lunch
Dinner

Sleeping 3:00 AM - 6:00 AM
Before Breakfast
After Breakfast
Before Lunch
After Lunch
Before Dinner
After Dinner
Evening 11:00 PM - 3:00 AM
All Time Periods

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<th>Range</th>
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<th>70 - 130</th>
<th>100 - 160</th>
<th>70 - 130</th>
<th>100 - 160</th>
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<th>100 - 160</th>
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<td>151</td>
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<td>126</td>
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<td>Low SG</td>
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<td>50</td>
<td>70</td>
<td>68</td>
<td>70</td>
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<tr>
<td>Standard Dev.</td>
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<td>79</td>
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<td>28</td>
<td>39</td>
<td>51</td>
<td>46</td>
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<tr>
<td># of Readings</td>
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<td>116</td>
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<td>120</td>
<td>60</td>
<td>120</td>
<td>195</td>
<td>913</td>
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</table>
4. Type of Food and Bolus
When Would I Use a Dual or Square Wave Bolus?
Extended/ Square Wave Bolus

- Delivers insulin evenly over a programmed time
- Potential uses:
  - Gastroparesis
  - Very low carb meal that is high in fat/protein
- You can deliver a “normal” bolus while you are delivering an extended bolus
Combo/Dual Wave Bolus

• A combination of a normal bolus plus an extended bolus

• Potential uses:
  – Meals that are high in fat/protein but have carbs
  – Gastroparesis
5. Frequency of BG Testing
Mathematical Model to Predict Effects of SMBG Frequency on HbA1c

- N= 1, 255 subjects
- Patients on CSII benefitted the most from increased frequency of BG testing


6. Education
Suggestions for Education

• Online pump trainings by manufacturer
• Favorite for patients:
  – Hans
CASE STUDIES
What’s New and Next in Pump Therapy
Slide courtesy of Tandem
t:slim™ Insulin Delivery System

Bolus Screen – Entering a BG value
t:slim™ Insulin Delivery System

**Bolus Screen**

![Image of the t:slim™ Bolus Screen]

- **3.6** units
- **30** grams
- **127** mg/dL

**View Calculation**
mySentry Components

Monitor

Outpost

Power Supply

Slide Courtesy of Medtronic
Glucose Snapshot Screen

Slide Courtesy of Medtronic
Sensor Glucose Graphs

Slide Courtesy of Medtronic
Baby Steps.. Medtronic Veo: LGS

The Low Glucose Suspend in focus**

- Insulin infusion stopped
- Insulin infusion resumed

Glucose - mg/dL (mmol/L)

Time

1. Insulin infusion stopped (LGS in action)
2. Insulin infusion resumed

** Illustrative purposes only

Accessed 7.12.2010
What is an Artificial Pancreas?
Questions

- THANK YOU
- Email: jblock@stanford.edu