The Latest on Insulin Pumps

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John Walsh, PA
jwalsh@diabetesnet.com
(619) 497-0900
Advanced Metabolic Care +
Research
700 West El Norte Pkwy
Escondido, CA 92126
(760) 743-1431

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View slides at www.diabetesnet.com/diabetes-resources/diabetes-presentations
Disclosure

- Book sales – all pump companies
- Advisory Boards – Tandem Diabetes, Convatec, Halozyme, AgaMatrix, PicoLife Technologies
- Consultant – Bayer, Roche, BD, Abbott, Tandem Diabetes, Acon Laboratories
- Speakers Bureau – Tandem Diabetes, Animus
- Sub-Investigator – Glaxo Smith Kline, Animus, Sanofi-Aventis, Bayer, Biodel, Dexcom, Novo Nordisk, Halozyme
- Pump Trainer – Accu-Chek, Animas, Medtronic, Omnipod, Tandem
- Web Advertising – Sanofi-Aventis, Sooil, Medtronic, Animas, Accu-Chek, Abbott, etc.
What We’ll Cover

- Actual Pump Practices Study Results
- Tuning The Bolus Calculator
- Handling Insulin Stacking
- TDD and Best BC Settings
- Infusion Set Issues
The Challenge Of Diabetes
Bringing the A1c down smoothly takes effort

...for this you need ADVANCED therapy

Uncontrolled A1C \( \sim 9\% \)

“Controlled” A1C <7%

A1C \( \sim 6\% \)

Normal A1C 4%–6%

BG in mg/dL (mmol)
Select Appropriate Goals

<table>
<thead>
<tr>
<th>Age</th>
<th>A1c</th>
<th>Approx. Avg. Meter Glucose *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 6</td>
<td>7.5% to 8.5%</td>
<td>168 to 197 (10 mmol/L)</td>
</tr>
<tr>
<td>6 to 12</td>
<td>8% or less</td>
<td>183 or less (9.4 mmol/L)</td>
</tr>
<tr>
<td>Over 12</td>
<td>7.5% or less</td>
<td>168 or less (8.9 mmol/L)</td>
</tr>
<tr>
<td>Over 19</td>
<td>7% or less</td>
<td>154 or less (8.3 mmol/L)</td>
</tr>
<tr>
<td>AACE: Over 19</td>
<td>6.5% or less</td>
<td>140 or less (7.8 mmol/L)</td>
</tr>
</tbody>
</table>

Most adults aim for a meter average of 8.6 mmol/L (154 mg/dl) or less.

ISPAD goal is ≤ 7.5% for everyone, with few hypos.

* With only premeal BGs, meter average would be lower than these values.
Ways To Get To Goal
Pump Advantages

- Reliable, precise insulin action
- Ease of use (fewer missed doses)
- Less insulin and less insulin stacking
- Easier to exercise
- Lower A1c & less severe hypoglycemia*
- Less glucose exposure and variability
- Better atch for variable basal insulin need
- Less social limitation
- Better data access for HCPs and parents

A pump’s basals and boluses provide a better match.
The Actual Pump Practices Study

In the APP Study, we looked retrospectively at over a thousand pump wearers across the U.S. to find out:

- How pumps are actually used and
- What influences success
APP Study Background

- Data from Deltec Cozmo insulin pumps were downloaded during a routine software upgrade in 2007.
- 396 pumps that had BG values directly entered from an attached CozMonitor Freestyle meter were chosen.
- An average of over 73 days of data and over 300 glucose tests per pump.
- Pumps were divided into thirds by average glucose.

APP Study

- Two types of results
  - Typical behaviors of all 396 pumpers
  - Behaviors and data from third with lowest avg BG

- Basal %, CarbF and CorrF formulas were derived from the third with the lowest avg. BG

- 92.7% of pump wearers used the BC to cover carbs (> 2 meals a day)

- 96.5% used the BC to correct high readings

APP Study –
BGs and Basal Rates

<table>
<thead>
<tr>
<th>Glucose, Insulin and Carb Data</th>
<th>Group:</th>
<th>All 396 Pumps</th>
<th>Low Third</th>
<th>Mid Third</th>
<th>High Third</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg. Meter BG</td>
<td>144 mg/dL</td>
<td>181 mg/dL</td>
<td>227mg/dL</td>
<td>144 mg/dL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8.0 mmol/L</td>
<td>10.0 mmol/L</td>
<td>12.6 mmol/L</td>
<td>8.0 mmol/L</td>
<td></td>
</tr>
<tr>
<td>BG Tests/Day</td>
<td>4.38</td>
<td>4.73</td>
<td>4.41</td>
<td>4.01</td>
<td></td>
</tr>
<tr>
<td>TDD</td>
<td>49.4</td>
<td>47.9</td>
<td>49.1</td>
<td>51.1</td>
<td></td>
</tr>
<tr>
<td>Basal %</td>
<td>47.6%</td>
<td>47.6%</td>
<td>47.2%</td>
<td>47.8%</td>
<td></td>
</tr>
</tbody>
</table>

### Glucose, Insulin and Carb Data

<table>
<thead>
<tr>
<th>Group:</th>
<th>All 396 Pumps</th>
<th>Low Third</th>
<th>Mid Third</th>
<th>High Third</th>
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<tr>
<td>Avg. Meter BG</td>
<td>184 mg/dl</td>
<td>144 mg/dl</td>
<td>181 mg/dl</td>
<td>227 mg/dl</td>
</tr>
<tr>
<td></td>
<td>10.2 mmol/L</td>
<td>8.0 mmol/L</td>
<td>10.1 mmol/L</td>
<td>12.6 mmol/L</td>
</tr>
<tr>
<td>CarbBolus U/d</td>
<td>20.4 u</td>
<td>20.9 u</td>
<td>20.4 u</td>
<td>19.8 u</td>
</tr>
<tr>
<td>CarbBolus/Day</td>
<td>4.14</td>
<td>4.07</td>
<td>4.20</td>
<td>4.14</td>
</tr>
<tr>
<td>CarbGram/Day</td>
<td>189.9</td>
<td>185.2</td>
<td>196.3</td>
<td>187.9</td>
</tr>
<tr>
<td>CarbF</td>
<td>11.4</td>
<td>10.8</td>
<td>12.2</td>
<td>11.2</td>
</tr>
</tbody>
</table>

APP Study – Unexpected Results

- Basals averaged 48% in low, medium, and high glucose groups – no impact on glucose outcomes

- No difference in grams of carb eaten or number of carb boluses and correction boluses given per day

- Glucose tests per day showed “significance” but had no meaningful impact on glucose outcomes – the high BG group tested BGs almost as often as low

- Occlusions significantly raised avg BG

- Those with highest BGs used MORE insulin → they either need more insulin OR need to stop losing it

APP Study – Major Conclusion

- Find an accurate TDD
- Then get pump settings from it

Pattern management starts once TDD is accurate.
Tips –
Dose For Success

1. Stop lows first
2. Find an iTDD – for normal, stable BGs
3. Set & test basals – keeps overnight readings level
4. Set & test CarbF – fine-tune premeal BGs
5. Lower post meal BGs – bolus early, low GI foods, add fiber, Symlin, GLP-1 agonist, etc.
6. Set & test CorrF – to bring highs down safely

Enjoy good control or return to #1

Brittle diabetes or frequent highs? Usually = the wrong settings!
Tips –
The Other Things You Need

- Check glucose 6 x a day or wear a CGM
- Use the bolus calculator for all boluses
- Cover all carbs with a bolus before eating, unless there’s a good reason not to
- Don’t over-treat lows with carbs
- Don’t over-treat highs with insulin
- Don’t give blind boluses
Tuning the Bolus Calculator
## Bolus Calculator Settings

<table>
<thead>
<tr>
<th>This Setting</th>
<th>Assists</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal rates</td>
<td>Safe sleep (~50% of TDD)</td>
</tr>
<tr>
<td>CarbF or I:C ratio</td>
<td>Cover carbs well</td>
</tr>
<tr>
<td>CorrF or ISF</td>
<td>Lower highs safely</td>
</tr>
<tr>
<td>Target glucose</td>
<td>Correct to specific goal</td>
</tr>
<tr>
<td>DIA</td>
<td>Accurately measure IOB to minimize insulin stacking</td>
</tr>
</tbody>
</table>

### Average TDD
- controls the frequency of low and high glucose levels

### BOB (IOB, active insulin)
- units of glucose lowering activity left from recent boluses
Bolus Calculator

Input: Current glucose  Grams of carb

Output: A recommended bolus with display of units for carbs, correction (if any), and remaining IOB (if any)
Set Correction Target with Care

| Where In Correction Target Range Does The Pump Aim? | BGs inside target range are *not corrected*. For range of 4-10 mmol/L (70 to 180 mg/dl), BGs of 4.1 to 9.9 mmol/L are *not corrected*.
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Animas, Omnipod</td>
<td>Middle</td>
</tr>
<tr>
<td>Medtronic</td>
<td>Top or Bottom</td>
</tr>
<tr>
<td>Tandem</td>
<td>3.9 mmol/L (70 mg/dl)</td>
</tr>
</tbody>
</table>

Bottom Line: Use a single correction target (ie, 6.1 mmol/L or 110 mg/dl), OR a narrow correction range (ie, 5.6-6.7 mmol/L or 100-120 mg/dl).
DIA, BOB, and Insulin Stacking

Duration Of Insulin Action (DIA)
How long a bolus lower the glucose

Bolus On Board (BOB)
Bolus insulin still active from recent boluses
Duration Of Insulin Action (DIA)

Rapid insulin lowers the glucose for 4.5 to 6.5 hrs. This is physiologic – it DOES NOT CHANGE in the body when the DIA is changed in the pump!
Recommended DIA Times

Set DIA to 4.5 to 6 hrs for accurate calculation of BOB and bolus doses

Graphic adapted from Mudaliar et al: Diabetes Care, 22: 1501, 1999
# Typical Carb Digestion Times

<table>
<thead>
<tr>
<th>Food Digestion Time</th>
<th>Food Digestion Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>water</td>
<td>fish</td>
</tr>
<tr>
<td>0 m</td>
<td>30-60 m</td>
</tr>
<tr>
<td>fruit/veg juice</td>
<td>milk/cot cheese</td>
</tr>
<tr>
<td>5-20 m</td>
<td>90 m</td>
</tr>
<tr>
<td>fruit/veg salad</td>
<td>legumes/beans</td>
</tr>
<tr>
<td>20-40 m</td>
<td>2 hr</td>
</tr>
<tr>
<td>melons/oranges</td>
<td>egg</td>
</tr>
<tr>
<td>30 m</td>
<td>45 m</td>
</tr>
<tr>
<td>apples/pears</td>
<td>chicken</td>
</tr>
<tr>
<td>40 m</td>
<td>1.5-2 hr</td>
</tr>
<tr>
<td>broccoli/caulif</td>
<td>seeds/nuts</td>
</tr>
<tr>
<td>45 m</td>
<td>2.5-3 hr</td>
</tr>
<tr>
<td>raw carots/beets</td>
<td>beef/lamb</td>
</tr>
<tr>
<td>50 m</td>
<td>3-4 hr</td>
</tr>
<tr>
<td>potatoes/yams</td>
<td>cheese</td>
</tr>
<tr>
<td>60 m</td>
<td>4-5 hr</td>
</tr>
<tr>
<td>cornmeal/oats</td>
<td></td>
</tr>
<tr>
<td>90 m</td>
<td></td>
</tr>
</tbody>
</table>

**Take Home:** Choose combo foods to lengthen carb digestion time.
Most Carbs are Faster than “Rapid” Insulin

An hour later, half of most meal’s glucose rise has occurred, but 80% of rapid insulin activity remains.

Time over which most meals affect the BG

% bolus activity remaining

Take Home:
- Bolus 15 to 30 minutes before meals
- Use extended and combo boluses sparingly

From *Pumping Insulin*
Clever Pump Trick – Bolus Early To Stop Meal Spiking

Figure shows Regular insulin injected 0, 30, or 60 min before a meal

Normal glucose and insulin profiles in the shaded areas

Even though, best glucose occurred with 60 minute bolus – too risky to recommend!!!

Early boluses – the best-kept secret for better control

Insulin Stacking

- Happens anytime two or more boluses overlap
- Measured in pump as bolus on board (BOB, IOB, active insulin)
- Used in new bolus calculation **once a glucose is entered**
- Impact of a bolus can’t be measured accurately against BG value until 90 to 120 minutes after it was given
- The safest way to minimize insulin stacking is to subtract BOB from correction bolus first, then from a carb bolus if there is BOB remaining
Insulin Stacking

Bedtime BG = 10 mmol/L (180 mg/dl) – is there an insulin or a carb deficit?
A Short DIA Hides Insulin Stacking

3 hours after a 10 unit bolus, this shows how much BOB a pump will think is left with each DIA time:

<table>
<thead>
<tr>
<th>For a DIA setting =</th>
<th>3 hr</th>
<th>4.5 hr</th>
<th>5.0 hr</th>
<th>5.5 hr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated IOB =</td>
<td>0 u</td>
<td>2.5 u</td>
<td>3.4 u</td>
<td>4.0 u</td>
</tr>
</tbody>
</table>

Always set the DIA from an insulin’s real action time

*Do not change DIA to fix control problems*
Pump BCs May at Times Give Excess Bolus Recommendations

Two hours after dinner when she has 5 u of BOB left, a pump user eats a 50 gram dessert on 4 consecutive nights. Her glucose and the bolus recommendations from different pumps are shown.

<table>
<thead>
<tr>
<th>Glucose</th>
<th>Actual Need</th>
<th>Animas</th>
<th>Other Pumps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Night 1: BG = 6.6 mmol/L</td>
<td>0 u</td>
<td>0 u</td>
<td>5 u</td>
</tr>
<tr>
<td>Night 2: BG = 6.8 mmol/L</td>
<td>0 u</td>
<td>5 u</td>
<td>5 u</td>
</tr>
<tr>
<td>Night 3: BG = 11.1 mmol/L</td>
<td>2 u</td>
<td>5 u</td>
<td>5 u</td>
</tr>
<tr>
<td>Night 4: BG = 16.7 mmol/L</td>
<td>4 u</td>
<td>5 u</td>
<td>5 u</td>
</tr>
</tbody>
</table>

CarbF = 10 gr/u; CorrF = 2.8 mmol/L; Target = 6.7; DIA = 5 hrs
What Would You Do?

Your daughter’s glucose is 6.8 mmol/L (122 mg/dl) at bedtime and she wants a 40 gram snack with 4.0 units of BOB.

CarbF = 10   CorrF = 3.0   Target = 6.7   DIA = 5

Would you:

A. Cover her bedtime carbs with a 4.0 u bolus?
B. Give a smaller bolus for these carbs?
C. Give no carb bolus?
When to Override a Recommended Bolus

- A pump doesn’t know everything – override a bolus recommendation when the situation demands

- Dr. Irl Hirsch suggests that about 25% of all bolus recommendations will be changed when the user knows what they’re doing

- Look at the CGM’s trend arrow and check the BOB for guidance on overrides
Clever Pump Trick – Get Accurate Boluses

1. If BOB is SMALLER than the correction bolus, pump’s recommendation is CORRECT

2. If BOB is LARGER than the correction bolus, subtract BOB from the combined carb plus correction bolus

Example: Carb bolus = 4.0 u
Corr bolus = 1.0 u
BOB = 2.0 u  **BOB larger than Corr bolus**

Accurate bolus = 4 + 1 – 2 = 3 units
Example –
Recommended Bolus May Be Changed

Find IOB or active insulin, then adjust dose:

3.0U
30 gr
160
3U
1.5U
4.5U

\[ 3 + 1.5 - 4.5 = 0 \text{ u bolus} \]
The TDD and Best BC Settings

- The TDD controls the average glucose
- An accurate TDD makes it easy to find accurate basal rates, CarbF, and CorrF
- More accurate BC settings allow BGs to be lower and more stable
APP Study –
Doses Used By Successful Pumpers

<table>
<thead>
<tr>
<th>Insulin Source</th>
<th>% of TDD</th>
<th>Interquartile Range (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basal</td>
<td>47.8%</td>
<td>39.6% to 54.9%</td>
</tr>
<tr>
<td>Carb Boluses</td>
<td>43.1%</td>
<td>35.6% to 51.2%</td>
</tr>
<tr>
<td>Corr Boluses</td>
<td>9.0%</td>
<td>6.2% to 11.3%</td>
</tr>
</tbody>
</table>

CorrF Rule Number* = 1960 mg/dl per unit (IQR = 1413 to 2151)

* CorrF Rule Number = Avg CorrF x Avg TDD


Insulin use in the third (132 pumps) with the lowest average glucose in APP Study
APP Study – Pump Setting Formulas

**Basal** = $\sim 48\%$ of TDD

**CarbF** = $5.7 \times \frac{Wt(kg)}{TDD}$ or $2.6 \times \frac{Wt(lbs)}{TDD}$

**Corr. Factor** = $110/TDD$ (mmol/L) or $1960/TDD$ (mg/dl)

The correction factor is inversely related to TDD and to avg. BG

Or use the Pump Settings Tool at


---

Size Up the Glucose Problem

- **Severe** – An improved TDD (iTDD) will correct most major glucose problems
  - Select new pump settings from the iTDD

- **Moderate** – use pattern management to fine tune doses and pump settings

- **Mild** – tweak pump settings

  If it ain’t broke, don’t fix it!
Tips – Steps To Control

- Stop lows first
- Take a bolus for every bite
  - Except for carbs used to treat a low BG
  - Or for carbs used to compensate for exercise
  - Check BG before every bolus – Don’t blind bolus
- Bolus 15 to 30 min before meals if possible
- Periodically check basal/carb bolus balance
- Look for and correct unwanted patterns
Critical Pump Data – Avg. TDD and Basal/Bolus Balance

$TDD = 35.19 \text{ u}$

**Basal** % is low at 36%

2 grams of carb/day means Bolus Wizard is not being used
Verify the TDD

- Compare TDD to weight(kgs)/1.8
- Contrast TDD with A1c & avg. BG on meter, and check frequency and severity of lows
- Then decide if TDD should be increased or decreased
Find an Improved TDD (iTDD)

If current BGs are not great:

- Lower the current TDD by about 5% for:
  - Frequent lows
  - Or highs AND lows IF lows come first

- Raise the TDD, using the iTDD Table on next slide to adjust for high A1c or high meter average
  - Increase TDD by 1% for each 0.3 mmol/L drop in avg BG

- This gives the improved TDD (iTDD)

  Keep basal and carb bolus totals balanced

Avg BG on pumps is 183.9 mg/dl (10.2 mmol) – most need larger TDD.
Stop Frequent Lows

- You cannot tell how much excess insulin there is!
- Start with a 5% or 10% reduction in the TDD
- Compare the current TDD to an “ideal” TDD for weight.
  - Divide weight(kgs) by 1.8 to see what TDD would use if they have an average sensitivity to insulin

**Example:** Someone who weighs 72 kg would be expected to have a TDD of 40 units (72/1.8 = 4.0).
Example – Hypoglycemia

41 yo female with A1c = 6.9%

156lb/4 = 38.0 u/d

Actual TDD = 50.5 u/d
Stop Frequent Highs

When average BG is high with few lows:

Raise TDD by 1% for each 0.33 mmol/L (6 mg/dl)
or for each 0.2% in the A1c
you want to lower the average glucose

Example: Amy’s avg TDD is 40 u/day, avg BG is 12 mmol/L (217 mg/dl) with few lows, and her avg BG goal is 8 mmol/L (145 mg/dl):

\[
12 \text{ mmol/L} - 8 \text{ mmol/L} = 4 \text{ mmol/L}
\]

\[
4 \text{ mmol/L} \div 0.33 = 12\% \text{ rise needed in TDD}
\]

\[
40 \text{ units} \times 1.12 = 44.8 \text{ units}
\]
Example – Hyperglycemia
TDD Before & After Adjustment

**Start TDD = 36 u**
- Raised basal by 0.05 u/hr all day (+1.2 u/day)
- Lowered carb factor from 1u/13g to 1u/12g (+1.8 u/day)

**End TDD = 39 u**
Check that Pump Settings Fit the TDD

### 9.5 Master List for Bolus Calculator Settings:
Find Your Basal Rates, CarbF, and CorrF from Your TDD (or iTDD) and Weight

<table>
<thead>
<tr>
<th>TDD or iTDD u/day</th>
<th>Basal u/day</th>
<th>Basal u/hr</th>
<th>Carb Factor&lt;sup&gt;1&lt;/sup&gt; in grams/u</th>
<th>CorrF&lt;sup&gt;2&lt;/sup&gt; (mg/dl) / u</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>7.7</td>
<td>0.32</td>
<td>16.3</td>
<td>17.9</td>
</tr>
<tr>
<td>20</td>
<td>9.6</td>
<td>0.40</td>
<td>13.0</td>
<td>14.3</td>
</tr>
<tr>
<td>24</td>
<td>11.5</td>
<td>0.48</td>
<td>10.8</td>
<td>11.9</td>
</tr>
<tr>
<td>28</td>
<td>13.4</td>
<td>0.56</td>
<td>9.3</td>
<td>10.2</td>
</tr>
<tr>
<td>32</td>
<td>15.4</td>
<td>0.64</td>
<td>8.1</td>
<td>8.9</td>
</tr>
<tr>
<td>36</td>
<td>17.3</td>
<td>0.72</td>
<td>7.2</td>
<td>7.9</td>
</tr>
<tr>
<td>40</td>
<td>19.2</td>
<td>0.80</td>
<td>6.5</td>
<td>7.2</td>
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<tr>
<td>45</td>
<td>21.6</td>
<td>0.90</td>
<td>5.8</td>
<td>6.4</td>
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<tr>
<td>50</td>
<td>24.0</td>
<td>1.00</td>
<td>5.2</td>
<td>5.7</td>
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<td>26.4</td>
<td>1.10</td>
<td>4.7</td>
<td>5.2</td>
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<td>60</td>
<td>28.8</td>
<td>1.20</td>
<td>4.3</td>
<td>4.8</td>
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<td>65</td>
<td>31.2</td>
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<td>4.0</td>
<td>4.4</td>
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<td>70</td>
<td>33.6</td>
<td>1.40</td>
<td>3.7</td>
<td>4.1</td>
</tr>
<tr>
<td>80</td>
<td>38.4</td>
<td>1.60</td>
<td>3.3</td>
<td>3.6</td>
</tr>
<tr>
<td>90</td>
<td>43.2</td>
<td>1.80</td>
<td>2.9</td>
<td>3.2</td>
</tr>
<tr>
<td>100</td>
<td>48.0</td>
<td>2.00</td>
<td>2.6</td>
<td>2.9</td>
</tr>
</tbody>
</table>

<sup>1</sup> Basal = TDD x 0.48  
<sup>2</sup> Carb Factor = 10.8 x insulin sensitivity = (2.6 x Wt(Lbs))/TDD  
<sup>3</sup> Correction Factor = 1960/TDD

For exact calculations, use the Pump Setting Tool at opensourcediabetes.org

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J Walsh and R Roberts: Pumping Insulin (5th ed), 2012
TDD and Pump Settings Change for:

- Frequent lows or frequent highs
- Going on or off a diet
- Loss or gain of weight
- Seasonal changes
- Change in activity or sports
- Vacation
- Growth spurts
- Puberty and menses

Do not wait until the next clinic visit!
Basal Rates

Keep the glucose flat overnight or when a meal is skipped (with no BOB)

Easy to check – don’t eat

Best basals: ~50-55% of TDD usually gives best results

<50% for young children, some elderly, high carb diet
>55% for low carb diet, insulin resistant

See *Pumping Insulin* 5th ed, 2012, for details
How Many Basals?

Percentage of pumpers who use 1 to 10 basals per day from self reports of several hundred pumpers at insulin-pumpers.org

Basal changes take at least 3-5 hours to have their full effect* when basal rates are doubled, so >5 basals has dubious benefit

Basal Tips

• 50% Rule: basals usually make up 40 to 65% of an accurate TDD

• Basal rates should be similar, such as between 0.45 to 0.7, or 1.0 to 1.4 u/hr

• Adjust basal rates in small steps – usually 0.05 or 0.1 u/hr

• Change basal rates **3 to 8 hours** before the need arises

• Don’t stop (suspend) pump longer than 30 min.
Carb Counting

- Accounts for half the day’s control
- Use accurate carb counts to match boluses and carbs for post-meal control and lower A1c
- Use automatic carb bolus calculations on pump
Carb factors are not evenly distributed.

People prefer “Magic” numbers – like 5, 10, 15, and 20 g/u.

Always use formulas to select settings -> much better than WAG!

Carb Bolus Tips

- Make sure the carb factor works for LARGE carb meals: test with carb grams = half the body weight (lbs)
- Is carb counting accurate?
- Are boluses given 20 min before meals when glucose is normal?
- Try not to eat until below 7 mmol/L (140 mg/dl)

For frequent lows after meals → raise carb factor #
For frequent highs after meals → lower carb factor #
Small CarbF Change = Large BG Change

<table>
<thead>
<tr>
<th>Meal Size</th>
<th>BG Change per meal *</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 grams</td>
<td>0.67u x 49 = − 33 mg/dl</td>
</tr>
<tr>
<td>100 grams</td>
<td>1.1u x 49 = − 54 mg/dl</td>
</tr>
</tbody>
</table>

* Calculated as \[(\text{carbs in meal} - \text{carbs in meal}) \times \text{old carb factor} \times 1960 \text{ TDD}\]
Clever Pump Trick – How Many Carbs for a Low?

1. 10 grams for each 35 kg (75 lbs) of weight
2. + grams = the current BOB* x CarbF

Example:
- Amy weighs 70 kg (150 lbs) = 20 grams of carb
- And she has 2 units of BOB with a CarbF of 8 grams/unit
  \[2 \text{ u} \times 8 \text{ g/u} = 16 \text{ grams}\]
- For this low she needs:
  \[20 \text{ g} + 16 \text{ g} = 36 \text{ grams}\]

Add extra carbs as needed for recent or planned exercise.

* DIA time setting must be accurate to get an accurate BOB.
Types of Carb Boluses

Regular
- Taken immediately – for most meals

Combo / dual wave
- Some now, some later – bean burrito, some pastas and pizzas, Symlin

Extended / square wave
- Extended over time – gastroparesis, Symlin, GLP-1 agonist

Don’t take combo/extended boluses without a clear reason.
Clever Pump Trick – Stop Post Meal Spikes

- Count carbs carefully
- Bolus 15 to 30 min before meals if possible
- Use combo bolus (part now/part later) with picky eaters
- When high, wait till below 8 mmol/L (144) before eating
- Eat low GI foods, fewer carbs
- Add fiber/psyllium/acarbose/Symlin/GLP-1 agonist
- Exercise after meals
- Use a Super Bolus
Clever Pump Trick –
Super Bolus – Shift Basal To Bolus

Future: Super Bolus shifts part of the next 2 to 3.5 hrs of basal insulin into the bolus with less risk of a low later.¹,²

Helps when eating over 30 to 40 grams of carb

Max carbs/meal = Wt(lb) x 0.36 to stay in control ²

Infusion Sets

The Achilles Heel of Pumps
Infusion Set Failure

Infusion sets fail from:
- Partial/complete pullouts
- Leaking around Teflon to skin (common)
- Loose hub
- Use of auto-inserter
- Pets & punctures
- Occlusions
Average BG levels during 6 hr intervals before and after infusion set change in 396 pumps with ~20 infusion set changes/pump.

Unpublished data from Actual Pump Practices Study by J Walsh, R Roberts, and T Bailey
Is There an Infusion Set Problem? Ask:

- Do sites often “go bad”? 
- Have “scarring” or “poor absorption”? 
- Two or more “unexplained” highs in a row? 
- Do highs correct when the infusion set is changed? 
- Does this happen more than once a year?

*If the answer is yes:*

- Anchor the infusion line with tape
- Review site prep technique
- Switch to a different brand of infusion set
Infusion Set Failure Shown On CGM

DIA = 5 hrs or more

Alert for rising BG. Took 1st "bolus"

2nd rising BG, BG test. Found set detached
Took "2nd" corr. bolus after set replaced
## APP – Occlusions Worsen Control

<table>
<thead>
<tr>
<th>BG Tertile</th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avg BG</td>
<td>144 mg/dl, 8.0 mmol/L</td>
<td>181 mg/dl, 10.1 mmol/L</td>
<td>227 mg/dl, 12.6 mmol/L</td>
</tr>
<tr>
<td>BGs/day</td>
<td>4.73</td>
<td>4.41</td>
<td>4.01</td>
</tr>
<tr>
<td>Blocks/month</td>
<td>1.36</td>
<td>3.04</td>
<td>3.57</td>
</tr>
</tbody>
</table>
Use Reliable Infusion Sets

ALWAYS anchor the Comfort infusion line with 1” tape to minimize site irritation and reduce tugging that can cause leaks.
Anchors – Not Just For Boats!!!

1” tape on infusion line:

• Stops movement of Teflon under the skin
• Stops “unexplained highs” from insulin leaks to skin surface
• Less irritation
• Prevents pull outs
• Tugs on Teflon

Lose tape not insulin!

No anchor!
Questions & Discussion

Slides at www.diabetesnet.com/diabetes-resources/diabetes-presentations
Books at www.diabetesnet.com/dmall/ or 800-988-4772