The Latest on Pumps and CGMs

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Disclosure

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

Many Thanks

To
Animas Canada,
and especially Richard Forster, Robin Dales, and Lorraine Anderson

What We’ll Cover

- Actual Pump Practices Study Results
- Importance of the Total Daily Dose
- Handling Insulin Stacking
- Infusion Set Issues
- CGMs for Better Control

Terms

- TDD – total daily dose (all basal and boluses) of insulin
- Basal – background insulin released slowly through the day
- Bolus – a quick release of insulin – Carb boluses cover carbs and Correction boluses lower high readings
- Bolus Calculator (BC) – what calculates bolus recommendations
- Correction Target – the BG aimed for with correction bolus
- Bolus On Board (BOB) – bolus insulin still active from recent boluses, active insulin, insulin on board
- Duration of Insulin Action (DIA) – how long a bolus will lower the BG – used to measure BOB

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 – BG, Basal & Carb Results**

<table>
<thead>
<tr>
<th>Insulin Use</th>
<th>Group: 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>184 mg/dl (10.2 mmol)</td>
<td>144 mg/dl (8.0)</td>
<td>181 mg/dl (10.0)</td>
<td>227 mg/dl (12.6)</td>
</tr>
<tr>
<td>BG Tests/Day</td>
<td>4.38</td>
<td>4.73</td>
<td>4.41</td>
<td>4.01</td>
</tr>
<tr>
<td>TDD</td>
<td>49.4</td>
<td>47.9</td>
<td>49.1</td>
<td>51.1</td>
</tr>
<tr>
<td>Basal %</td>
<td>47.6%</td>
<td>47.6%</td>
<td>47.2%</td>
<td>47.8%</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>

**Unexpected APP Study Results**

- Between low, medium, and high glucose groups:
  - Basal averaged 48% in each group and had no impact on glucose outcomes
  - No difference in grams of carb eaten, or in the number of carb boluses and correction boluses given per day
  - Glucose tests per day were “significant” but had no meaningful impact on glucose outcomes – the highest third tested their glucose almost as often
  - Infusion set failures and occlusions significantly raised the average glucose
- The third with highest BG used MORE insulin – they either need more insulin OR they need to stop losing it


**APP Study – What Doses Did Successful Pumpers Use?**

<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>9.2%</td>
<td>6.2% to 11.3%</td>
</tr>
</tbody>
</table>

*Carb Factor Number* = 1960 mg/dl per unit (QIR = 1432 to 2315)

*Significant factor of average insulin in the third (132 pumps) with the lowest average glucose in APP Study*


**APP Study – CarbF Settings In Pumps**

Carb factors are not evenly distributed.

*“Magic” numbers – like 5, 10, 15, and 20 g/unit are preferred.

Use formulas for setting accuracy – much better than WAG!


*J. Walsh, D. Wroblewski, and TS Bailey: Insulin Pump Settings – A Source For Insulin Dose Errors, Diabetes Technology Meeting 2007*
Bolus Overrides – By BC or User?

Who Makes Bolus Adjustments?

<table>
<thead>
<tr>
<th></th>
<th>Bolus Calculator</th>
<th>Pump Wearer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowered for BOB</td>
<td>1.4 u/day</td>
<td>0.09 u/day</td>
</tr>
<tr>
<td>Lowered for Low BG</td>
<td>0.27 u/day</td>
<td></td>
</tr>
<tr>
<td>Raised for High BG</td>
<td>4.18 u/day</td>
<td>0.56 u/day</td>
</tr>
</tbody>
</table>

The bolus calculator* makes most of the dose decisions!

HOW it calculates doses IS IMPORTANT!

* Bolus dose adjustments in the lowest glucose tertile.

Small CarbF Changes Have A Big Impact

- Small CarbF changes can make a big difference in the glucose.
- Example: a person weighs 73 kg (160 lbs) and has a TDD of 40 units. A change in CarbF from 1 u/10 grams to 1 u/9 grams will lower the glucose
  - By an extra 1.8 mmol/L (33 mg/dl) for meals with 60 grams of carb, or
  - Or by 3.0 mmol/L (54 mg/dl) for every meal with 100 grams of carb.

CarbF and CorrF Accuracy Is Important

- Don’t use “magic” numbers for CarbFs and CorrFs
- Small changes in factors can have a big impact
- Always use formulas to select these settings

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

APP Study – Adjusted CarbFs Used

CarbFs actually used – calculated as bolus given for carbs in each meal

- 85% of improvement comes when the BC reduces carb doses for BOB and hypoglycemia

Select Appropriate Goals

<table>
<thead>
<tr>
<th>ADA Age-Appropriate A1c And Meter Goals</th>
<th>ADA Age-Appropriate A1c And Meter Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>A1c</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>Less than 6</td>
<td>7.5% to 8.5%</td>
</tr>
<tr>
<td>6 to 12</td>
<td>8% or less</td>
</tr>
<tr>
<td>Over 12</td>
<td>7.5% or less</td>
</tr>
<tr>
<td>Over 19</td>
<td>7% or less</td>
</tr>
<tr>
<td>AACE: Over 19</td>
<td>6.5% or less</td>
</tr>
</tbody>
</table>

* With only premeal BGs, meter average would be lower than these values.

ADA Age-Appropriate A1c and Meter Goals

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
Dose For Success

1. Stop lows first
2. Find an iTDD – for normal, stable BGs
3. Set & test basal – keeps overnight readings level
4. Set & test CarbF – fine-tune premeal BGs
5. Lower post meal BGs – bolus early, low GI foods, Symlin, 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

To Set Up Your Pump BC Correctly

Your health care professional will determine:
- An accurate TDD (MAJOR factor)
- Accurate basal (~50% of TDD)
- An accurate CarbF
- An accurate CorrF
- An accurate DIA (from research studies)

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

What To Do – Reactive Rene

A1c is 6.9%.
Wt = 70 kg
Her "expected" insulin dose = 70 kg/1.9 = 36.8 u/day
Actual TDD = 50.5 u

Speed of drop in glucose suggests she is taking correction dose AND covering carbs from prior meal.

Find An iTDD* To Correct Glucose Problems

* improved Total Daily Dose of Insulin

Your TDD

- Controls the average glucose
- Makes it easy to find accurate basal rates, CarbF, and CorrF
- These allow lower and more stable BGs

Use pattern management to fine tune doses & settings
APP Study – Pump Setting Formulas

Basal = ~ 48% of TDD

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

Corr. Factor = $110/\text{TDD}$ (mmol/L) or $1960/\text{TDD}$ (mg/dl)

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

Or use the Pump Settings Tool at www.diabetesnet.com/diabetes_tools/pumpsettings


Find the iTDD

If current BGs are not great:
1. Lower the current TDD by about 5% for:
   - Frequent lows
   - Or highs AND lows IF lows come first
2. 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
3. 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.

The iTDD Table For High Avg. BGs

For frequent highs and few lows, use this table to improve (increase) the current TDD using a meter’s 14 day average BG or recent A1c

What To Do?

~ 2 lows a day

For frequent lows ➔ lower the average TDD

70 mg/dl (3.9 mmol)

What To Do?

For frequent highs ➔ raise the average TDD

Clever Pump Trick – How Many Carbs Do You Need to Treat a Low?

1. 10 grams for each 35 kg or 75 lb of weight
2. PLUS grams = the current BOB* x CarbF

Example:
1. Amy weighs 70 kg (20 grams of carb)
2. And she has 2 units of BOB with a CarbF of 8 grams/unit
3. So, for the low she needs: 20 g + 16 g = 36 grams

Add extra carbs as needed for recent or planned exercise.

* To get an accurate BOB, the pump’s DIA time setting must be accurate.
TDD Before & After Adjustment

Start TDD = 36 u
1. Raised basal by 0.05 u/hr all day (+1.2 u/day)
2. Lowered carb factor from 1u/13g to 1u/12g (+1.8 u/day)
End TDD = 39 u

Highs And Lows – But With A Pattern

5 day average:
Avg BG: 203.4 (11.3)
Range: 39 to 401 (2.2 to 22.3)
SD: 89.9

Frequent lows and highs needs slightly higher average TDD, and either a lower night basal or smaller correction boluses at night

Ensure that Pump Settings “Fit the TDD”

<table>
<thead>
<tr>
<th>TDD or TDD change</th>
<th>Basal rates</th>
<th>Basal amount</th>
<th>Carb Ratio in grams</th>
<th>Carb Ratio in mL</th>
<th>Carb Ratio in percentage</th>
<th>Carb Ratio in units</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>7.7</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
<tr>
<td>36</td>
<td>15.4</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
<tr>
<td>54</td>
<td>15.4</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
<tr>
<td>72</td>
<td>23.1</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
<tr>
<td>90</td>
<td>23.1</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
<tr>
<td>108</td>
<td>23.1</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
<tr>
<td>126</td>
<td>23.1</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
<tr>
<td>144</td>
<td>23.1</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
<tr>
<td>162</td>
<td>23.1</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
<tr>
<td>180</td>
<td>23.1</td>
<td>0.6</td>
<td>1.5</td>
<td>4.3</td>
<td>7.9</td>
<td>11.5</td>
</tr>
</tbody>
</table>

Change The TDD 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

Don’t wait until the next clinic visit!

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

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 = 173 mg/dl – is there an insulin or a carb deficit?

Disparate Bolus on Board Recommendations in Insulin Pump Therapy by J Walsh, D Wroblewski, T Bailey. Poster 2007 AACE Meeting

What Would You Do?

Your daughter’s glucose is 6.7 mmol/L (121 mg/dl) at bedtime and she wants a 40 gram snack and has 4 units of BOB.

CarbF = 10 g/u, CorrF = 3 mmol/L (54 mg/dl)
Target = 6.7 mmol/L (120 mg/dl)

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?

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 you change the DIA setting in your pump!

Problem

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

Take Home: Choose combo foods to lengthen carb digestion time

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

Typical Carb Digestion Times

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

Take Home: Choose combo foods to lengthen carb digestion time
Clever Pump Trick –
Bolus Early To Stop Meal Spiking

Figure shows rapid 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.

No Two Pump BCs Give Same 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>Medtronic</th>
<th>Omnipod</th>
</tr>
</thead>
<tbody>
<tr>
<td>CarbF = 10</td>
<td>119 mg/dl</td>
<td>0 u</td>
<td>0 u</td>
<td>5 u</td>
</tr>
<tr>
<td>CorF = 50</td>
<td>121 mg/dl</td>
<td>0 u</td>
<td>5 u</td>
<td>5 u</td>
</tr>
<tr>
<td>Target = 100</td>
<td>200 mg/dl</td>
<td>2 u</td>
<td>5 u</td>
<td>5 u</td>
</tr>
<tr>
<td>DIA = 5 hrs</td>
<td>300 mg/dl</td>
<td>4 u</td>
<td>5 u</td>
<td>5 u</td>
</tr>
</tbody>
</table>

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

How To Get Accurate Boluses

1. Add Carb and Correction Boluses together and
2. Subtract BOB
3. To get an accurate bolus!

Examples:
1. Carb bolus = 3 u, corr bolus = 1 u, BOB = 4 u
   \[3 + 1 = 4, 4 - 4 = 0\]  No bolus needed
2. Carb bolus = 2 u, corr bolus = 1 u, BOB = 4 u
   \[2 + 1 = 3, 3 - 4 = -1\]  More carbs are needed

Clever Pump Trick –
Quick Way to an Accurate Bolus

1. Is BOB larger or smaller than the correction bolus?
2. If BOB is smaller, pump’s recommendation is correct
3. If BOB is larger, subtract BOB from the combined carb and correction boluses

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>Estimate Of Insulin On Board Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 hr</td>
<td>0 u</td>
</tr>
<tr>
<td>4.5 hr</td>
<td>2.5 u</td>
</tr>
<tr>
<td>5 hr</td>
<td>3.4 u</td>
</tr>
<tr>
<td>5.5 hr</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
Recommended Boluses Can Be Changed

A Paradigm user can scroll down 3 times to see active insulin, then adjust dose:

<table>
<thead>
<tr>
<th>Est. Total</th>
<th>3.0U</th>
<th>0.0 g</th>
<th>160</th>
<th>1.5U</th>
<th>4.5U</th>
<th>3u + 1.5 - 4.5 = 0 u bolus</th>
</tr>
</thead>
</table>

The Correction Target

Where In Correction Target Range Does The Pump Aim?

<table>
<thead>
<tr>
<th>Range</th>
<th>Animas</th>
<th>Middle</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-10 mmol/L</td>
<td>Not Corrected</td>
<td></td>
</tr>
<tr>
<td>5.6-6.7 mmol/L</td>
<td>Adjusted</td>
<td></td>
</tr>
</tbody>
</table>

Use a single correction target, like 6.1 mmol/L (110 mg/dl), or narrow correction range, like 5.6-6.7 mmol/L (100-120 mg/dl).

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:
1. Amy weighs 70 kg (150 lbs) = 20 grams of carb
2. And she has 2 units of BOB with a CarbF of 8 grams/unit
3. For this low she needs: 20 g + 16 g = 36 grams

Add extra carbs as needed for recent or planned exercise.

To get an accurate BOB, the pump’s DIA time setting must be accurate.

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


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

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

Don’t take combo/extended boluses without a clear reason.

Infusion Sets

The Achilles Heel of Pumps
Glucoses Following A Set Change

- Change is the average glucose during each 6 hr interval following (and just before) the infusion set is changed in 396 insulin pumps.

Infusion Set Failure – Patrice

Infusion Set Failure – Patrice

Why Infusion Sets & Patch Pumps Fail:
- Leaking from site (or hub)
- Not taping down the infusion line (tugging)
- Auto-inserters → bent or kinked Teflon
- Detachment
- Bleeding (hematoma)
- Clogging, blockage, occlusion

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 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
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>146.6</td>
<td>181.6</td>
<td>229.3</td>
</tr>
<tr>
<td>BGs/day</td>
<td>4.74</td>
<td>4.52</td>
<td>4.22</td>
</tr>
<tr>
<td>Blocks/month</td>
<td>1.30</td>
<td>3.04</td>
<td>3.57</td>
</tr>
</tbody>
</table>

Occlusions / Blockages

Should not happen!
More than once a month?
- Change infusion set type
- Or brand of insulin (rare)

More Reliable Infusion Sets

- Sure-T
- Sof-Set
- Silhouette

ALWAYS anchor the Sof-Set with the Sof-Set Adhesive Patch, and the Silhouette infusion line with 1" tape. These steps minimize site irritation and reduce tugging that can cause leaks.

CGMs For Better Control

CGM by Jackson Pollack

One Pollack painting sold for $140 million in 1996!

Make Your Own Jackson Pollack

Only $1,000!
CGM Ingredients

Sensor

Receiver

Transmitter

Dexcom sensor on left. Comfort infusion set on right from insulinfactor.com

CGM Benefits

Real-Time
- The way most CGMs are used
- Tracking and trending – fewer extremes
- Shows the direction you’re going
- Helps avoid lows, especially night lows
- Avoid foods that spike glucose
- Immediate feedback to change behavior

CGM Systems

DexCom™ SEVEN® PLUS

Medtronic MiniMed Revel® REAL-Time®

CGM Displays

On-Screen Reports
- 1, 3, 6, 12, 24-hr graphs
- Updates every 5 minutes
- Hi/Low alerts
- Rate of Change alerts
- Immediate feedback from screen

CGM And Pump Choices

<table>
<thead>
<tr>
<th>CGM:</th>
<th>Pump:</th>
<th>Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dexcom 7+ or Gen 4</td>
<td>Animas</td>
<td>2013</td>
</tr>
<tr>
<td></td>
<td>Insulet</td>
<td>2013</td>
</tr>
<tr>
<td></td>
<td>Tandem</td>
<td>2013</td>
</tr>
<tr>
<td></td>
<td>AccuCheck</td>
<td>2013</td>
</tr>
<tr>
<td>Paradigm Rt</td>
<td>Medtronic</td>
<td>now</td>
</tr>
</tbody>
</table>

DexCom™ Seven Plus®
Animas Vibe

From www.tudiabetes.org/forum/topics/animas-vibe-first-cgmenabled:
Dude on June 5, 2011 said, "I only just got My Ping, but I would change to this new one in a heartbeat! Please let it come to Canada soon!"
Mozey on March 26, 2012 said, "I would love to upgrade to this, Govt of Canada dept are sooooooo slow to approve, we need a system like Europe for these types of advances.....sitting here waiting"

CGM Benefits

Retrospective View
- See patterns
- Test and tune basals, CarbF, CorrF
- Avoid night lows and hypo unawareness

Why Combine Pumps And CGMs?

Precise insulin delivery plus accurate glucose trends. Someone on a pump is more likely to handle 2nd device well.
CGM helps with:
- dislodged infusion sets, missed meal boluses, detecting lows, lowering highs, basal and bolus testing, glucose stability, exercise, and stress, overriding bolus recommendations

Confidence In Performance

CGM As Behavior Mod Tool:
First Two Days On CGM

Chef with Type 1 Diabetes for 13 years on insulin pump

Chef’s CGM Next Two Days

A chef can eat when he wants to control his CGM readings!
Clinical Indications For CGMs

- Frequent hypoglycemia (< 60 mg/dl, 3.3 mmol)
- Hypoglycemia unawareness, pregnancy
- Elevated A1c
- Glycemic variability
- Gastroparesis
- Lives alone
- Presence of complications
- Small children not yet able to recognize and vocalize they are low

Patients With A1c <7.0 With GCM

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥25</td>
<td>50%</td>
</tr>
<tr>
<td>15 - 24</td>
<td>40%</td>
</tr>
<tr>
<td>8 - 14</td>
<td>10%</td>
</tr>
</tbody>
</table>

DexCom™ 7 STS®

- Dexcom DM2 Download Reports
- Hourly Stats
- Glucose Trend
- BG Distribution
- Trend Analysis

CGM Benefits

Real-Time
- The way most CGMs are used
- Tracking and trending – fewer extremes
- Avoid lows, especially night lows
- Avoid foods that spike glucose
- Immediate feedback – behavior mod made easy
- Shows direction you’re going
Where To Set Starting CGM Alerts

LOW: 4.4 mmol/L (80 mg/dl)
Less than 4.4 in pregnancy
Higher for young children, high risk jobs

HIGH: 11.1 mmol/L (200 mg/dL) to start
Gradually lower to 10, 8.9, 7.8
The lower the high alert is, the earlier the wearer gets alerted to a rising BG


Consistent Trend Data

Two Dexcom sensors worn by the same person
A trend line with +/- 1.6 mmol/L accuracy is OK for dosing!


Real Time Data – Off The Screen

- Glucose read every 5 min – 288 readings/day
- Trends
- Rate of change arrows
- Alarms – highs, lows, rate of change, predicted high or low

Types Of Alarms

High and low alarms are set by user – features such as predictive alarms and alarm volume vary by manufacturer

CGM Benefits

Retrospective View
- NOT used enough
- See patterns
- Test and tune basals, CarbF, CorrF
- Avoid night lows and hypo unawareness
- Peace of mind from fear of lows
DexCom™ 7 STS®

Dexcom DM2 Download Reports

Hourly Stats

Glucose Trend

DexCom™ 7 STS®

BG Distribution

Trend Analysis

Retrospective Data From Download

Glucose Patterns

Glucose Trends

Excess low-to-higos

Control improves by avoiding both

Excess high-to-lows

Hourly Stats Give Insight

Hourly Statistics from 12/11/2007 12:00 AM to 12/19/2007
Hourly Stats For One Month

Hourly Statistics from 7/9/2008 12:00 AM to 8/8/2008 12:00 AM

Verify CGM with Fingerstick

- Before driving
- For the first 12 to 24 hours
- When readings differ by 1.7 mmol/L (30 mg/dl) or more
- If CGM readings are erratic or don’t seem right
- If CGM remains low 20 or more min. after treating low
- When MAD (mean absolute difference) is above 20%
- Before treating unexplained highs

CGM Calibration Tips

- Use a VERY accurate meter
- Use good technique – clean fingers, no expired strips, enter reading right away
- Follow manufacturer’s instructions
- Calibrate Dexcom as often as you like, or Medtronic up to 4 times a day when the glucose is flat (no arrows)

Still The Best Way To Learn

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