

"Smart Pumping" with Insulin Pumps



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During this discussion we will:

- * Review the DCCT recommendations;
- * Define "smart pumping";
- * Discuss "basal" and "bolus" insulin;
- * List the advantages, disadvantages, and needed skills for starting insulin pump therapy;
- * Explain the use of glucose sensors now and in the future.



Diabetes Control and Complications Trial (DCCT)

Multi-center, randomized
10 year trial
Funded by NIH
1441 participants
Ended early in 1993



DCCT

Conventional/Control

Goal: clinical well-being

- *BG checks 1-2x/day
- *quarterly visits and HbA1c measurements

Intensive

Goal: normalization of blood glucose

- *BG checks 4x/day minimum
- *Multiple Daily Injections or pump
- *Monthly visits and HbA1c measurements

HbA1c / Blood Glucose Comparison

A1c	←	→	BG mg/dl
4%			60
5%			90
6%			120
7%			150
8%			180
9%			210
10%			240
11%			270
12%			300
13%			330

Target Goal

DCCT Study Results*

Reduced Risk:

- Eye disease: 76%
- Kidney disease: 54%
- Nerve disease: 60%
- (Heart disease: 41%)

*NEJM 1993



Intensive Therapy

Multiple Daily Injections vs. Insulin Pump



Insulin Absorption



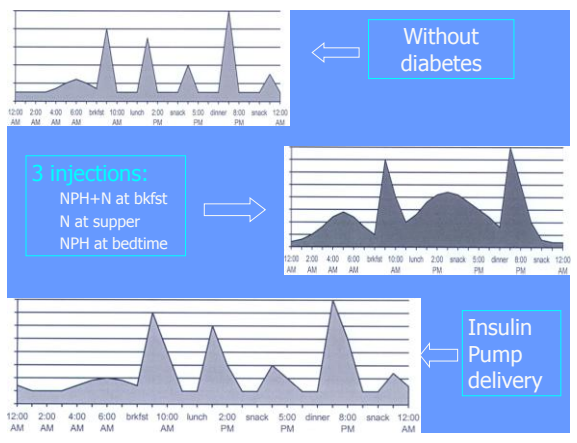
Long-acting insulin absorption may vary 10-52%

- Unpredictable.
- Tight control very difficult.




Fast-acting insulin absorption varies less than 3%

- Very predictable.
- Allows for tighter control.




The Basics



I nsulin Pumps 101

What exactly is an insulin pump?



First Insulin Pump (early 1970s)!!!

An insulin pump is:


A small computerized device that delivers insulin continuously throughout the day.




Spirit



Animas



Minimed

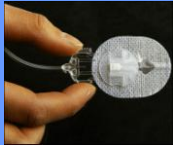


Omnipod

The pump is "attached" to you by an "infusion set" with a thin catheter that is inserted into your skin.

Infusion Sets

Comfort, Tender™/Silhouette™, Quickset



"Smart Pumping" defined:

Smart pumps have:

- Carb calculator
- Correction calculator
- Insulin on Board feature
(tracks insulin used for 2-6 hours as chosen by the pump wearer)

Bolus Wizard Calculator : meter-entered



Monitor sends BG value to pump via radio waves :
No transcribing error
Enter carbohydrate intake into pump
"Bolus Wizard" calculates suggested dose

Insulin Delivery



The pump uses only rapid acting insulin. (U300 for insulin resistan type 2)

It automatically releases small amounts of insulin continuously through the day/night (basal rate insulin)

The user enters the number of carbs to be eaten and current blood sugar. The pump calculates the insulin dose based on the carb ratio and correction factor in its programmed "brain". (bolus insulin).

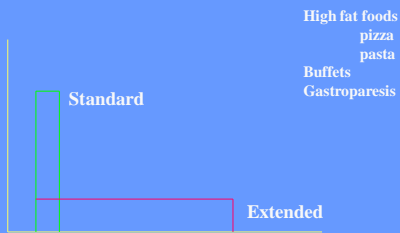
The user pushes a button to deliver the calculated amount showing on the screen.

Benefits of Advanced Pump Features

- *Extended bolus
- *Temporary basal
- *Separate basal programs



Timed Bolus



Example

David notices every time he goes out for pizza with his family his blood sugars are always high 3 hrs after the meal even though he is using a lower carb ratio and thus giving more insulin for his food.

David decides to try a combination bolus.

He gives 50% of his bolus as a standard bolus and the remaining 50% over 4 hrs. He will reassess after the 4 hrs to see if he is still high and adjust as needed.

Blood sugar 2 hrs after pizza
87

Blood sugar 4 hrs after pizza
210

Too much insulin up front

Not enough extended.

Next time

- 40% bolus now and 60% over 4 hrs.

Basal Options-Patterns

Adjusting basals (patterns)

- quiet day vs. busy day

- *Used for consistent changes from week to week
- *Same pattern with dose adjustment
- *Work and home patterns
- *School/Gym or sports days

Example

Work Day

12mn	1.0
3am	1.1
10am	1.0

Honey Do Day

12mn	0.8
3am	0.9
10am	0.8

Accounts for increased sensitivity due to exercise and prevents post activity hypoglycemia

Temporary Basal Rates

Used for limited periods of time to increase/decrease the basal rate.

- Unplanned activity
- Sick days
- Travel - when activity is decreased

May be set using dose or % for up to 24 hrs. in 30 minute increments

Hormones

- Menstrual Cycles

Usually noted few days before menstrual period
Decreased insulin sensitivity
May need to increase basal rates by 20-50%

- Steroids

Am prednisone - afternoon and evening rise
Pm prednisone - morning into early afternoon rise

Example

Michele wakes up in the morning with a bad toothache. Her blood sugar is elevated and she has small ketones. After giving a correction and pushing fluids she calls her dentist for an appointment. He agrees to see her early afternoon.

Michele knows her blood sugars run high when she is not feeling well. She sets a temporary basal rate for 130% of her basal for 6 hrs. She will reassess with frequent checks and after her dentist appointment

Advantages of Insulin Pump Therapy

Why health professionals recommend insulin pumps:



- To improve blood sugar control.
- To reduce wide fluctuations in blood sugars.
- To reduce and manage severe hypoglycemia.
- To help deal with the "dawn phenomenon."
- To help improve control during life cycle changes. (examples: growth in children , pregnancy, menopause)
- To give insulin with better blood sugar control with gastroparesis

In a study done by the members of ADA and AADE, results showed diabetes specialists treat their own diabetes according to current standards of medical care, with insulin pumps being the preferred method of insulin therapy for type 1 diabetes. (52% were on pumps)

Graf, M; Rubin, R; & Walker, Elizabeth. "How Diabetes Specialists Treat Their Own Diabetes: Findings From a Study of the AADE and ADA Membership", The Diabetes Educator, Vol 26, No 3, May/June 2000

Advantages

- *Improved absorption of insulin.
- *Ability to match insulin to food.
 - (carb counting)
- *Ability to stabilize blood sugar between meals and snacks.
- * Increase, decrease, or stop insulin delivery as situations demand. (stress, illness or exercise)



Advantages

*Pumps deliver precisely.

One can accurately deliver 0.025-35 units of insulin for a bolus.

*Bolus when you want to eat vs. chasing insulin with food to prevent low blood sugars.

*Achieve "tight control" while minimizing the risk of low blood sugars.

*More flexible lifestyle. Improved quality of life!!!

Advantages: Alarms

Bolus reminder

BG reminder

- Both are reminder alarms

Lockout features

- Prevents accidental use of the pump

Low reservoir

Low battery

Disadvantages of Pump Therapy

*Hypoglycemia

*DKA--diabetic ketoacidosis.

- life-threatening

- fever, infection, unusual stress

- pump malfunction or absorption problem

- no long-acting insulin

*Catheter-site infection

Cost and Insurance

*A pump typically lists for close to \$6500.

*Pump supplies average \$2,000/yr

*Many insurance companies cover all or most of this cost.

*Medicare and Medicaid cover pump costs



The Best Candidates

Self-motivated
Accept their diabetes
Ability to problem solve
Good common sense



- *They realize there is a learning curve
- *Frequent BG checks
- *Detailed record keeping



Poor candidates

- Do not like 'being attached'.
- Do not like others to know they have diabetes.
- Not willing to check blood sugars at least 4 times each day.
- Do not want the responsibility of problem solving and making adjustments.
- Afraid of gaining weight.
- Cost!



Myths About Pump/Sensor Therapy

- | | |
|---|--|
| *Injections will never be needed again. | *You must be admitted to a hospital to start pump therapy . |
| *You can have anything you want to eat, at any time, and in any amount. | *A pump/sensor is a constant, visible reminder of having diabetes. |
| *A pump causes weight gain. | *You are too young or too old to get a pump. |

Expectations of Pump Therapy

Realistic

I will feel better on pump or sensor therapy.

It will take several months to adjust.

Not Realistic

A pump/sensor will cure my diabetes.

I will be "fine tuned" within a week of starting.

Expectations of Pump Therapy

Realistic

I will have better glucose control.

I will need to check blood sugars at least 4 times/day.

I will have more flexibility with what I eat.

Not Realistic

I will have perfect glucose control.

I will rarely have to check blood sugars.

I can eat whatever I want.

Current typical diabetes routines

Type 1

*4-6 BG checks per day
*2 - 4 shots per day
*Scheduled meals
Planned exercise

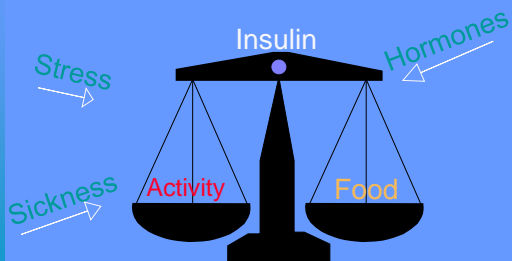
Type 2 on insulin

*3-4 checks per day
*1-4 shots per day
*Scheduled meals
*Planned exercise

Insulin Pump Routine

- *One injection every 2-3 days
- *4-8 BG checks per day
- *Meals and snacks using carb counting
- *Spontaneous Exercise/Activity

A Balancing Act





"...Doctor, I have Billy Roberts on line two who wants to know how much insulin he needs to take to cover 6 malt balls...3 chocolate bunnies...11 marshmallow eggs... oh... and a whole handful of gummi worms..."

Needed Skills: Carbohydrate Counting

Carbohydrates are found in starches and sugars

Carbohydrate is the macronutrient with the greatest impact on postprandial blood glucose

Information on carbohydrates can be found on food labels (total carbohydrates) and other published sources

Carbohydrate counting is an option for all people with diabetes

Definitions

The carb : insulin ratio assists in determining what insulin is needed for the meal.

Carbohydrate: Insulin Ratio – An Example

If a carbohydrate : insulin ratio is:

carbs 10 grams : 1 unit

For a 60 gram carbohydrate meal, the insulin need would be 6 units of Humalog, Novolog or Apidra (if pre-prandial blood glucose is in target range)

Example continued.....

If the carbohydrate is increased to 80 grams, using a 10:1 ratio what would you take for insulin?

Then.....

If the pre-prandial blood glucose is not within target range, an insulin increase or decrease is necessary.

Supplementing

The supplement is what is needed to correct for a high or low blood sugar.

Supplement/ Correction Factor

One must determine how much glucose is lowered by 1 unit of short- or rapid-acting insulin

This number is known as the correction factor (CF)

Use the 1700 rule to estimate the CF

CF = 1700 divided by the total daily dose (TDD)
example: if TDD = 36 units, then $CF = 1700/36 = \sim 50$
meaning 1 unit will lower the BG ~ 50 mg/dl

Now use your correction factor in a formula to equal the supplement

Current BG minus Ideal BG

Glucose Correction factor = supplement

Example:

- Current BG: 220 mg/dl
- Ideal BG: 100 mg/dl
- Glucose Correction Factor: 50 mg/dl

$$\frac{220 - 100}{50} = 2.4 \text{ units}$$

Sensors: The future is now

*Continuous glucose monitors are medical devices that measure a person's interstitial (fluid under the skin) glucose every 5 minutes and send this information to a receiver that displays the information.

CGMS® Continuous Glucose Sensor



A tiny, sterile, flexible electrode inserted just under the skin
Measures glucose by way of interstitial fluid

DexCom Seven Plus



Guardian RT sensor/receiver



Display real-time glucose every 5 min.
High and low alerts
CGM reports
Indicated for T1 and T2 18 and older
Controlled market release

Medtronic IPro



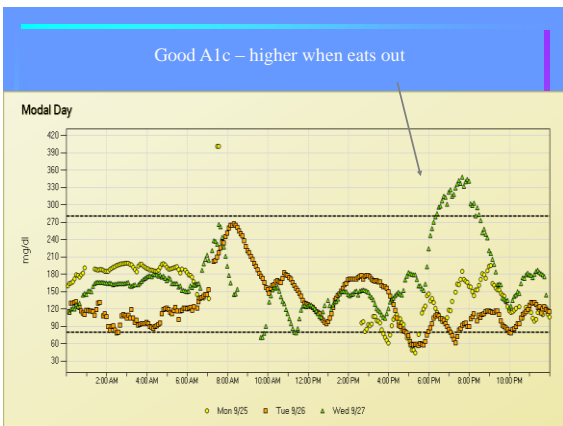
MiniMed Paradigm Real Time Revel



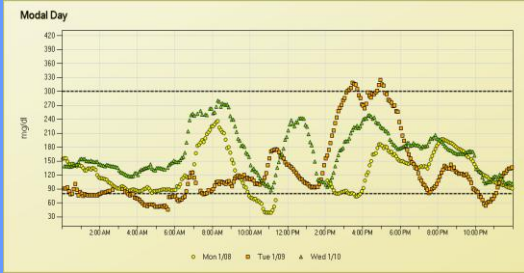
Vevo pump and Enlite Sensor
(Medtronic- Europe)



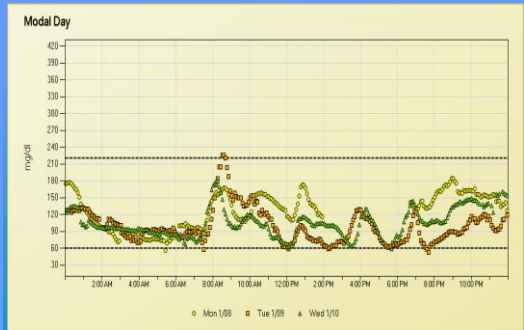
Good A1c – higher when eats out



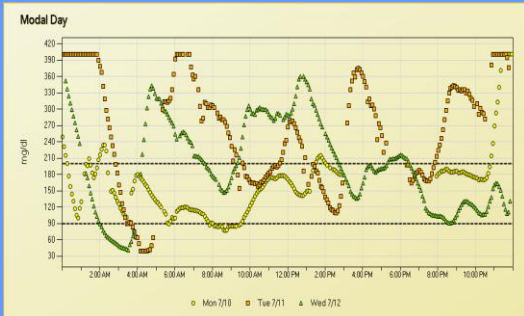
Post prandial "spikes":
- not enough bolus
- poor timing of bolus



Good A1c



All over the place



New 12 / 2011

mySentry

is a monitor with color screen that sits on a nightstand and transmits information from your child's (or yours) REVEL pump and Real Time Sensor to a Sentry monitor.



mySentry

*It transmits up to 50 feet a visual readout of the Real Time Sensor values coming from the REVEL pump.

*It alerts when predictive alarms are set or interstitial glucose is below the low target or above the high target.

*Sound is adjustable

*It has a snooze button

*Privacy screen

Pump + Sensor Programs at DHMC

* pediatric

*adult

* protocols in place to assure safety of the patient

* pre-pump instruction from dietitian, provider and educator

Pump + Sensor Programs at DHMC

Follow-up:

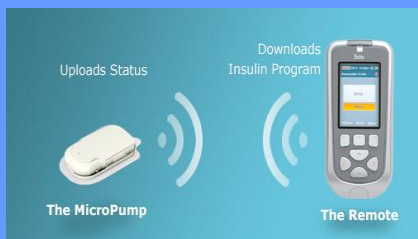
- Daily phone contact over next 6-9 days to review blood glucose and make initial adjustments in doses.
- Visit in 2-10 days (sensor trial if needed)
- Follow up appointment in 1-2 months.
- Follow-up appointment in 3 months.

The future

- *Patch pumps are the future
- *Smaller, sensor driven to a receiving computer that will infuse insulin

Accu-Chek to release their first patch pump this summer.

Solo Patch Pump



Animas Vibe and Dexcom 4 sensor- in Europe
Hopefully soon in the USA



When all is said and done...



"I finally have my blood sugar stabilized, now I just wish I could get my hair under control."

Resources

*Buckingham, B, Chase, HP, et al. Diabetes Technology and Therapy. 11:93, 2009

*Chase, Peter & Messer, Laurel. Understanding Insulin Pumps & Continuous Glucose Monitors. 2011 Children's Diabetes Foundation at Denver, Colorado

*Walsh, John & Roberts, Ruth. Pumping Insulin 4th Edition, 2006, Torrey Pines Press.

*mySentry.com
