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Pump Therapy Initiation

Criteria for Selection of a Pump Candidate Patient Success Requires:

- Family support
- Financial resources
- Psychological and emotional stability
- Intellectual, physical, and technical ability to use the pump
- Motivation
- Realistic expectations
- Knowledge to manage diabetes - Multiple daily injections (MDI), frequent SMBG and interpretation of results
- Ability to carb count effectively (see below)

Is Your Potential Pumper Ready?

Months/weeks before pump therapy initiation:

- MDI and carbohydrate counting
- Bolus calculations
- Pump education

Medical Benefits Of An Insulin Pump

- More closely simulates the body's insulin release
- Decreases hypoglycemia
- Reduces wide fluctuations in blood sugars
- Delivers more accurate amounts of insulin for children and insulin-sensitive individuals
- Reverses hypoglycemia unawareness (loss of body's mechanism for correcting low blood sugars)
- Prevents, delays, or reverses complications of diabetes
- Allows better control of the Dawn Phenomenon (early morning rise in blood sugar)
- Improves blood sugar control during adolescent growth spurts
- Better controls blood sugars during pregnancy resulting in less problems for mother and baby
- Helps stabilize erratic food absorption in diabetics with gastroparesis
- Benefits for Individuals with diabetes include: freer lifestyle, improved HbA1c, meal flexibility, better control of blood sugar with exercise, better control when traveling or when working unpredictable hours and overall feeling better.

Carbohydrate Counting

- Based on the simple premise that ALL carbohydrate-containing foods eventually break down into glucose.
- A "carb" (carb unit, carb choice, or carbo) = 15 grams of carbohydrate
- Allows more precise matching of insulin / bolus doses to food
- The total amount of carbohydrate is MORE important than the source of the carbohydrate
- Published studies report no adverse effect when sucrose (white table sugar) was substituted for other carbohydrates in the diets of people with diabetes.
- Various ratios of complex/simple carbohydrate within isocaloric diets indicate no significant difference in the glycemic index
- Increases flexibility in food choices and the amounts of foods consumed
- Well accepted because patients feel more "in charge"

Carbohydrate Counting Facts

- Knowledge of portion sizes: Underestimating by 15 grams of CHO can elevate blood glucose by 50+ mg/dl
- Unaccounted CHO: large amounts of vegetables or "free" foods can add up to a CHO serving
- Fat content of foods: may delay absorption of CHO
- Fiber content: foods with 5+grams of fiber require less insulin
- Body weight changes: insulin requirements will change
- Individual CHO tolerances/Glycemic index: (www.diabetesnet.com/gi.html) may require adjustments in boluses and/or timing
- Gastroparesis: requires adjustments in boluses/timing

Insulin:Carb Bolus Tips

- Use pre-pump MDI insulin-to-CHO ratio for boluses if it has been successful
- Try to keep CHO amount consistent at meals (consume same amount of CHO for each breakfast, each lunch, etc.)
- Avoid excessive protein, high fat content, meals, alcohol, and foods not usually consumed

Carb Counting and Insulin Bolusing

1 unit insulin: 15 grams CHO

(Insulin to Carb Ratio)

Sample Meal		Sample Meal	
1 cup orange juice	30g	2 slices wheat bread	30g
2.slices toast	30g	2 oz. turkey breast	
½ cup oatmeal	15g	1 lettuce leaf, tomato slice	
1 soft cooked egg		1 tsp mayonnaise	
1 tsp margarine		6-8 3-ring pretzels	15 g
Coffee & 1 T cream		2 small choc cookies	15 g
		Diet soda (16 oz)	
Total CHO	75g	Total CHO	60g

Insulin bolus	5 units	Insulin bolus	4 units
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Calculation of Bolus Doses

Bolus Dose: amount of insulin given just prior to eating to cover carbohydrates to be eaten (50-60% of the TDD)

Three methods can be used to estimate a starting insulin to carb ratio:

- Use patient's pre-pump (MDI) successful insulin to carb ratio
- Formula: 500 Rule
- Weight chart as a starting point (see below)

500 Rule

- Divide 500 by Total Daily Dose (TDD)
- 1 unit of insulin to ____grams of CHO as a bolus before a meal
- $500 / 34 = 15$ (Bolus ratio is 1 unit of insulin for every 15 grams of CHO)

(1 unit of insulin: 15 gm carbohydrate is a safe starting point for most patients)

Determination of Insulin-to-Carb Ratio	
Weight (lb)	Insulin u: CHO gm
100-109	1:16
110-129	1:15
130-139	1:14
140-149	1:13
150-169	1:12
170-179	1:11
180-189	1:10
190-199	1:9
200+	1:8

Insulin Sensitivity Factor

(amount of insulin needed to decrease high blood sugar)

1 unit of insulin decreases blood glucose _____ mg/dl

1. Humalog insulin: 1800 Rule

2. Regular insulin: 1500 Rule

1800 Rule: $1800 / 34 = 53$

1 unit of Humalog decreases BS 53 mg/dl

1500 Rule: $1500 / 34 = 44$

1 unit of Regular decreases BS 44 mg/dl

(see table below)

How To Test Your Point Drop Per Unit On Humalog	
Prepare	<p>With your doctor, decide on a target blood sugar level before meals (usually 90 to 140 mg/dl, or 5 to 7.8 mmol): _____ mg/dl = my target</p> <p>Use Table 10.1 or Table 12.1 and your physician's help to decide how many points your blood sugar is likely to drop per unit of Humalog. _____ mg/dl = my point drop/unit of H (A)</p> <p>Be sure 3.5 hours have passed since your last bolus and 3 hours since eating food.</p>
<p>Start When your blood sugar is above 200 mg/dl (11.1 mmol) and you can wait 3.5 hours to eat.</p>	
Do The Math	<p>1. From your current high reading, subtract your target blood sugar: My current blood sugar: _____ mg/dl Minus my target blood sugar: _____ mg/dl Equals: _____ points to drop (B)</p> <p>2. Divide the points you want to drop (B) by how many points your blood sugar is likely to drop per unit (A): $B / A =$ a bolus of: _____ units of Humalog needed to lower your blood sugar to your target</p>
<p>Take Bolus Take this bolus to correct high blood sugar, unless it seems to be wrong!</p>	
Check Blood Sugars	<p>1 hour = _____ mg/dl 2 hours = _____ mg/dl 3 hours = _____ mg/dl 3.5 hours = _____ mg/dl</p> <p>Check more often if your blood sugar is dropping quickly or may go low. Stop the test if your blood sugar does not come down or is low.</p>
<p>Analyze After 3.5 hours, are you within 30 points (1.7 mmol) of your target?</p> <p>No, I'm more than 30 points below my target – Retest another time using a larger point drop number – ie, if it was IH/40 pts, use IH/43 pts</p> <p>Yes – You have the correct ratio for your point drop per unit of H. Test again to verify, then use it to set up your personal high blood sugar bolus scale in Workspace 12.2</p> <p>No, I'm more than 30 points above my target – Retest another time using a smaller point drop number – ie, if it was IH/40 pts, use IH/37 pts</p>	

Calculation of Basal Rates

The basal rate is a continuous 24-hour delivery of insulin that matches background insulin needs. When the basal rate is set properly, the blood sugar does not rise or fall during periods in which the

pump user is not eating. Start with 50% of your TDD divided in equal units per hour around the clock.

Basal rates are given as units/hour with average rates between 0.4 u/hr to 1.6 u/hr. A single basal rate is the easiest way to start. After blood sugar testing has been checked using that single rate, multiple rates can be set up to fine tune blood sugar control. It is common to have as many as 8 different basal rates over a 24-hour period.

For this TDD:	At 50% Basal, Avg. Basal is:	Carb Boluses:	High BG Boluses:
16 units	0.33 u/h	1 u/31 grams	1 H/112 pt. drop
18 units	0.38 u/h	1 u/28 grams	1 H/100 pt. drop
20 units	0.42 u/h	1 u/25 grams	1 H/90 pt. drop
22 units	0.46 u/h	1 u/23 grams	1 H/82 pt. drop
24 units	0.50 u/h	1 u/21 grams	1 H/75 pt. drop
26 units	0.54 u/h	1 u/19 grams	1 H/69 pt. drop
28 units	0.58 u/h	1 u/18 grams	1 H/64 pt. drop
30 units	0.62 u/h	1 u/17 grams	1 H/60 pt. drop
32 units	0.67 u/h	1 u/15 grams	1 H/56 pt. drop
36 units	0.75 u/h	1 u/14 grams	1 H/50 pt. drop
40 units	0.83 u/h	1 u/12 grams	1 H/45 pt. drop
44 units	0.92 u/h	1 u/11 grams	1 H/41 pt. drop
48 units	1.00 u/h	1 u/10 grams	1 H/38 pt. drop
52 units	1.08 u/h	1 u/10 grams	1 H/35 pt. drop
56 units	1.16 u/h	1 u/9 grams	1 H/32 pt. drop
60 units	1.25 u/h	1 u/8 grams	1 H/30 pt. drop
65 units	1.35 u/h	1 u/8 grams	1 H/28 pt. drop
70 units	1.46 u/h	1 u/7 grams	1 H/26 pt. drop
75 units	1.56 u/h	1 u/7	1 H/24 pt.

		grams	drop
80 units	1.67 u/h	1 u/6 grams	1 H/22 pt. drop
90 units	1.88 u/h	1 u/6 grams	1 H/20 pt. drop
100 units	2.08 u/h	1 u/5 grams	1 H/18 pt. drop

What Percentage Of Your TDD Should Be Basal?

Research studies show that the nondiabetic individual uses about 45% of the body's total daily insulin production as basal insulin. Some people on a pump do well with their basal at 45% of TDD, but others do better at 50% or even 60%. Someone who exercises a lot may need the lower percent of TDD for the basal rate.

A basal rate higher than 50% works better for many other people because it cuts down on post-meal spiking. With a slightly higher basal rate, less insulin is given as boluses and blood sugar control improves with fewer ups and downs.

A person who snacks or grazes during part of the day may want a larger percentage of the TDD as basal. People with a strong Dawn Phenomenon or with significant insulin resistance, may find they need as much as 60% of their TDD as basal. Teens with high levels of hormones especially benefit from a basal that is 60% of TDD. Because this pattern is based on 60% of the TDD, meal boluses are slightly lower. Many clinicians suggest starting at 50% of the TDD as basal, and adjusting as necessary.

How To Test Your Basal Rates

It is critical to test blood sugars in the first few days on the pump and then periodically retest afterwards. You may not discover the best pattern until you have tested and adjusted the basal rates several times.

Test	Preparation	BG Tests	What To Do With Test Results
Night Basal	Start at least 3.5 hours after your last Humalog bolus, when your bedtime blood sugar is between 100 mg/dl and 150 mg/dl (5.6 to 8.3 mmol).	Test at bedtime, at 2 AM, and on waking	A good basal rate will keep your blood sugar level or make it fall no more than 30 points during 8 hrs. of sleep. If your blood sugar rises, raise your basal rate slightly and retest. If it falls over 30 points, reduce the basal rate and retest. With a good result, retest to verify.
Day Basal,	Start when your blood sugar is between 100 mg/dl and 150 mg/dl	Test at start,	A good basal rate will keep your blood sugar level or

1st part	(5.6 to 8.3 mmol) on waking. Skip breakfast and breakfast bolus, and begin test.	and every hour for 5 hrs.	make it fall no more than 30 points during 5 hrs. of fasting. If your blood sugar rises, raise your basal rate slightly and retest. If it falls over 30 points, reduce the basal rate and retest. With a good result, retest to verify.
Day Basal, 2nd part	Start when you blood sugar is between 100 mg/dl and 150 mg/dl (5.6 to 8.3 mmol) before lunch. Skip lunch and lunch bolus, and begin test.	Test at start, and every hour for 5 hrs	Same
Day Basal, 3rd part	Start when you blood sugar is between 100 mg/dl and 150 mg/dl (5.6 to 8.3 mmol) before dinner. Skip dinner and dinner bolus, and begin test.	Test at start, and every hour for 5 hrs	Same
End your test and eat at any time your blood sugar goes low. Take a bolus and end test if your blood sugar goes above 190 mg/dl. Timing for tests may vary depending on your normal schedule.			

A basal pattern designed to offset the Dawn Phenomenon (early morning rise in blood sugar) and extra calorie intake at dinner when more insulin is commonly needed is called the Bicyclic Basal Pattern.

This pattern has a higher basal rate in the early morning hours to offset the Dawn Phenomenon. Around 70% to 90% of Type 1 diabetics with some Dawn Phenomenon plus most people with Type 2 diabetes need a higher basal during the early morning hours. This rate also has a higher rate during the dinner hours when carb and calorie intake is usually highest. Many people eat most of their carbs late in the day. They could balance the extra insulin needed around dinner time with carb boluses, but better control usually results when the basal is raised slightly to cover part of this need and the rest is covered by smaller carb boluses.

Lower rates are used during the night from about 8 p.m. to 2 a.m. when sensitivity to insulin is naturally at its highest, and from about 10 a.m. to 4 p.m. when sensitivity is high because people are more active.

To set up the Bicyclic Basal Pattern for normal sleep hours, the lower basal is used from about 2 hours before bedtime until 3 to 4 hours after going to sleep, and again from around 10 a.m. until 4 p.m.

People who have the Dawn Phenomenon often raise their basal rate starting between 2 a.m. and 3 a.m. (Humalog) or 1 a.m. and 3 a.m. (Regular), and then lower it between 9 a.m. and 11 a.m. The rise in the blood sugar starting at about 3 a.m. or 4 a.m. is caused by an increased release of growth hormone, which blocks the action of insulin. This blockage triggers the liver to release glucose. If the insulin level is kept high, the liver will not release glucose.

A high basal rate is used during the early morning/breakfast period and again through dinner. Make

sure the higher rate causes the blood sugar to drop no more than 30 mg/dl over a 5 hour period during the day, and no more than 30 mg/dl over eight hours of sleep. When you set basals slightly higher during breakfast and dinner, set boluses for all meals slightly lower.

Preventing Nighttime And Afternoon Lows

Whether you start with a Constant Basal Pattern or the Bicyclic Basal Pattern, you may need slight adjustments to your basal pattern to prevent nighttime or afternoon lows. The lowest blood sugar of the day for people with diabetes is most likely to occur around 2 a.m. In one study of people on both conventional injections and multiple daily injections, researchers found that people with Type 1 diabetes had a low blood sugar every fourth night on average." Nighttime lows are more common in Type 1 diabetes, but they also occur in those with Type 2 diabetes.

People are more prone to lows in the middle of the night because the body is most sensitive to insulin between midnight and 3 a.m. The liver increases its glucose production 2 to 4 hours before waking. If lows happen in the middle of the night, the basal rate needs to be reduced by 9 p.m. or 10 p.m. to prevent the drop.

Extended Bolus Option

Equally divides, or spreads one bolus amount over a specific number of hours. Use for:

- long meals (parties or holidays)
- high fat meals (pizza)
- delayed digestion (gastroparesis)

Split Bolus Option

- Patient divides bolus into 2 separate bolus amounts
- Use for continuous snacking, high fat meals or snacks
- Initial bolus: 30-50% of total bolus
- Second bolus: remainder, 2 to 4 hours later

Insulin Pump Companies

Animas (West Chester, PA: 877-767-7373): www.animascorp.com

Disetronic www.disetronic-usa.com

Minimed www.minimed.com

Information adapted from "Pumping Insulin" by John Walsh, P.A., C.D.E. and Ruth Roberts, M.A. Everything You Need For Success With An Insulin Pump

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