INTENSIVE INSULIN THERAPY

BOULDER ENDOCRINOLOGY ASSOCIATES

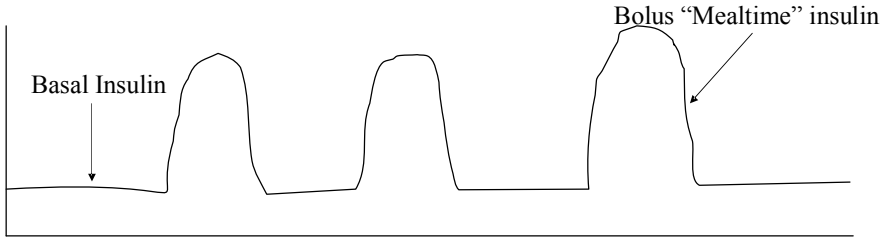
INTRODUCTION

Intensive insulin therapy attempts to provide insulin to the body in a manner similar to the way insulin is delivered by the normal pancreas.

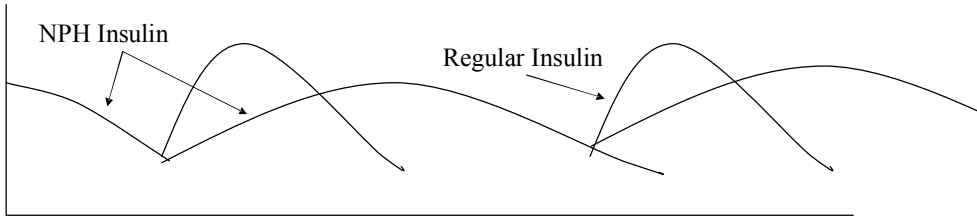
There is always a small amount of insulin in the blood, called the background or *basal* insulin. The basal insulin regulates how the liver breaks down protein and fat and turns these into glucose (sugar). An elevated fasting blood sugar is very often due to inadequate basal insulin.

In addition to the basal insulin, any time that carbohydrate (sugar or starch) is eaten, there is a rise in insulin level that peaks in about 30 minutes and lasts 1-2 hours. This is the "bolus" or *mealtime* insulin.

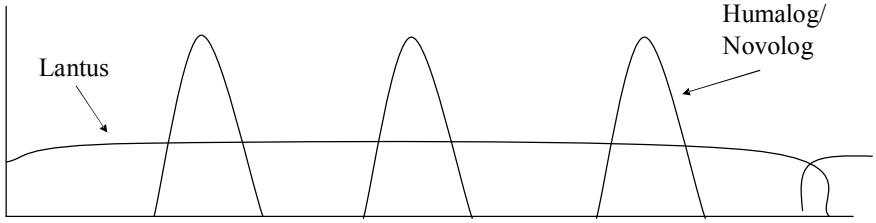
Examples of normal insulin secretion and of typical insulin regimens are shown in the figure.



Normal Insulin Secretion (or insulin pump)



NPH and Regular Twice Daily



Lantus and Humalog/Novolog

Intensive insulin regimens use multiple injections of insulin to closely match the typical profile of insulin in the body. These regimens have several advantages:

- Individual doses of insulin can be adjusted to allow for more precise control of glucose levels
- There is a great deal of flexibility such that insulin can be easily adjusted to account for varying mealtimes, amount of food eaten, missed meals, and exercise
- Intensive insulin regimens generally allow for better control of blood sugar with less hypoglycemia than other regimens

Intensive insulin regimens require frequent blood sugar measurements (generally a minimum of 4 times per day), multiple insulin injections or insulin pump therapy, and careful attention to the amount of carbohydrate in foods eaten.

BASAL INSULIN DOSE

- Basal insulin is generally given as one or two injections of long-acting insulin daily.
- The dose(s) of basal insulin generally should be the same each day, and should not be adjusted for a one-time high or low blood sugar. (However, the dose of basal insulin may need to be adjusted, to help the blood sugars to return to the target range, if there is a pattern of high or low blood sugars.)
- The fasting blood sugar is usually the best marker of whether the basal insulin dose is correct or needs to be adjusted. *If the bedtime sugar is well controlled* and low blood sugar is not occurring during the night, a consistently high fasting blood sugar typically means the dose of basal insulin should be increased.

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MEALTIME INSULIN DOSE

- The mealtime insulin dose can be calculated using one of two strategies, (1) fixed mealtime dosing or (2) carbohydrate counting.
- For fixed mealtime dosing, a set amount of insulin is taken before each meal. For example, someone may take 5 units with breakfast, 7 units with lunch, and 8 units with dinner/supper each day.
    - When using this strategy, it is important to try to eat the same amount of carbohydrate at each mealtime each day (that is, the carbohydrate at breakfast should be consistent day-to-day, the carbohydrate at lunch should be consistent, etc. The amount of carbohydrate does not necessarily have to be the same at breakfast as it is at lunch or dinner/supper).
- If using carbohydrate counting, the dose of mealtime insulin is determined by several factors: (1) amount of food to be eaten, (2) current blood sugar, and (3) anticipated level of activity.
    - Amount of food – the blood sugar response is mainly determined by the amount of *carbohydrate* in the meal. By knowing the amount (grams) of carbohydrate in food to be eaten, and the *insulin-to-carbohydrate ratio* ("carb" ratio), the insulin dose required to cover the meal can be calculated. This ratio describes the number of grams of carbohydrate that are covered by one unit of insulin. For example, if you have a carbohydrate ratio of 1 unit to 8 grams of carbohydrate, and are planning to eat a meal containing 40 grams of carbohydrate, then 5 units (40 ÷ 8 = 5) of insulin should be injected to cover this meal.
        - The carbohydrate ratio can be adjusted by monitoring the postprandial (after meal) blood sugar. 1-2 hours after a meal, the blood sugar should not rise above 180 and after 4-5 hours it should return to within 40 points of the pre-meal sugar value. If the glucose is rising more than this, the carbohydrate ratio can be increased (for example, change from ratio of 1 to 10 to a ratio of 1 to 8). If the sugar is dropping too much after a meal, the ratio can be decreased (for example, change from a ratio of 1 to 12 to a ratio of 1 to 15).
        - Some people find that they need a different ratio for different meals (for example, a ratio of 1 to 10 with breakfast, and a ratio of 1 to 12 with lunch and dinner/supper).
    - Current blood sugar – in addition to covering the carbohydrates to be eaten, insulin may be added to help return a high sugar to normal, or subtracted to allow a low sugar to rise to normal. The amount to be added (or subtracted) is determined by the *correction factor* (CF). The CF is a ratio that describes how many points one unit of insulin will drop the blood sugar (for example, an CF of 1 to 50 means that one extra unit of insulin will lower the blood sugar on average by 50 points. By selecting a *target blood sugar*, and knowing the before meal blood sugar, the insulin dose can be adjusted for a blood sugar that is not in the target range. As an example, if your pre-lunch blood sugar is 300, your CF is 1 to 50, and your target blood sugar is 100, then you would take an extra 4 units (300 – 100 = 200 points above target. 200 ÷ 50 = 4) of insulin to bring that high blood sugar back to the target of 100.
    - Anticipated level of activity – this is harder to quantify but the idea is that increased activity will, in general, cause you to need less insulin. If you know you are going to exercise, you may want to decrease your pre-meal bolus insulin dose by 1 or 2 units to avoid having a low sugar (if you have increased activity you did not plan for, you can also avoid a low sugar by having a small snack, with 15-30 grams of carbohydrate, before the activity). You should plan to test your blood sugar before and every 1-2 hours during exercise until you are more comfortable with how your body will respond to exercise.
    - The insulin dose before a meal will take into account all of these factors. That is, the actual dose given should include the amount of insulin needed for the food to be eaten *plus* any insulin needed to correct an elevated glucose (plus an adjustment for exercise if needed).

INTENSIVE INSULIN WORKSHEET

NAME AND DATE _____

STARTING INSULIN DOSES

BASAL INSULIN DOSE:

☐ LANTUS (GLARGINE) INSULIN _____ UNITS AT _____

- NOTE THAT LANTUS INSULIN SHOULD NOT BE MIXED WITH ANY OTHER INSULIN

☐ OTHER _____

MEALTIME INSULIN DOSE:

RAPID-ACTING INSULIN – ☐ HUMALOG (LISPRO) INSULIN ☐ NOVOLOG (ASPART) INSULIN

STRATEGY:

☐ CARBOHYDRATE COUNTING – INSULIN DOSE TAKEN AT MEALTIMES

- CARBOHYDRATE RATIO – 1 UNIT OF INSULIN FOR EVERY _____ GRAMS OF CARBOHYDRATE
- CORRECTION FACTOR – 1 UNIT OF INSULIN FOR EVERY _____ POINTS THE GLUCOSE IS ABOVE A TARGET OF _____ (INSULIN CAN BE SUBTRACTED FOR GLUCOSE VALUES BELOW THE TARGET)
- MEALTIME DOSE CALCULATED BY ADDING THE INSULIN REQUIRED FOR CARBOHYDRATES *PLUS* THE INSULIN REQUIRED FOR CORRECTION OF HIGH BLOOD SUGAR. IF NEEDED, AN ADJUSTMENT CAN ALSO BE MADE FOR ANTICIPATED EXERCISE.

☐ FIXED INSULIN – INSULIN DOSE TAKEN AT MEALTIMES

- BREAKFAST ___ UNITS LUNCH ___ UNITS DINNER/SUPPER ___ UNITS
- CORRECTION FACTOR – 1 *EXTRA* UNIT OF INSULIN FOR EVERY ___ POINTS THE BLOOD SUGAR IS ABOVE A TARGET OF ___
- PLEASE TRY TO MAKE SURE THAT BREAKFAST EACH DAY HAS A CONSISTENT AMOUNT OF CARBOHYDRATE DAY-TO-DAY, LUNCH HAS CONSISTENT CARBOHYDRATE DAY-TO-DAY, AND DINNER/SUPPER HAS A CONSISTENT AMOUNT OF CARBOHYDRATE DAY-TO-DAY

BLOOD SUGAR CHECKS:

PLEASE CHECK YOUR BLOOD SUGAR DAILY, USING YOUR METER, AT THE FOLLOWING TIMES:

☐ BEFORE BREAKFAST ☐ BEFORE LUNCH ☐ BEFORE EVENING MEAL

☐ AT BEDTIME ☐ 1-2 HOURS AFTER MEALS INTERMITTENTLY

☐ ANYTIME YOU SUSPECT YOUR BLOOD SUGAR IS LOW

COMMUNICATION WITH DOCTOR:

☐ CALL IF YOU HAVE MORE THAN ONE GLUCOSE BELOW 70, OR IF YOU HAVE ANY HYPOGLYCEMIA (LOW SUGAR) THAT YOU CANNOT TREAT BY YOURSELF

☐ RECORD YOUR GLUCOSE VALUES AND INSULIN DOSES (AND CARBOHYDRATE EATEN IF YOU ARE USING CARBOHYDRATE COUNTING) AND FAX THESE TO THE CLINIC (303-586-5201) IN 1 WEEK. YOU MAY COPY AND USE THE FORM ON THE BACK AS NEEDED (KEEP A BLANK FORM TO COPY AS NEEDED)

☐ PLEASE ASK THE OFFICE STAFF TO ARRANGE AN APPOINTMENT WITH OUR DIETICIAN AS SOON AS POSSIBLE TO DISCUSS ☐ CARBOHYDRATE COUNTING ☐ CONSISTENT CARBOHYDRATE INTAKE

☐ PLEASE SCHEDULE AN APPOINTMENT WITH YOUR DOCTOR IN ___ WEEKS

Boulder Endocrinology, PLLC
Blood Glucose Values

To: **Christopher R. Fox, MD**
Fax#: 303-586-5201

From: ____________________
Phone: ____________________

Date _____	Breakfast		Lunch		Dinner		Bedtime	Notes
	Before	After	Before	After	Before	After		
Glucose								
Insulin								
Carbs								

Date _____								
Glucose								
Insulin								
Carbs								

Date _____								
Glucose								
Insulin								
Carbs								

Date _____								
Glucose								
Insulin								
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Note: Please keep one blank copy, and make copies of blank sheet as needed. Additional copies can also be downloaded from www.boulderendo.com as needed.