

# CHAPTER 5:

## BASAL INSULIN RATES

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### DEFINING BASAL INSULIN

The **basal rate** refers to the small amount of rapid-acting insulin delivered by the pump every few minutes throughout the day and night. It is similar to the basal insulin secreted by the normal human pancreas every five to eleven minutes. It is expressed for pump purposes as “units of insulin per hour.” The two major functions of basal insulin are:

1. Turning off sugar production by the liver
2. Preventing fat breakdown and ketone production

Prior to starting on an insulin pump, most people will have received one of the two injectable basal insulins, Lantus® or Levemir®. The pump basal insulin is similar but different. Some of the main ways that pump basal insulin is different are as follows:

1. The pump basal insulin is solely from a rapid-acting insulin (Humalog®, NovoLog® or Apidra®).
2. Rather than having one basal rate all day (as with Lantus or Levemir), the basal rates on a pump can be varied many times during the day. This allows for fine-tuning of the insulin dose to fit a given individual.
3. The basal rate on a pump can be suspended (e.g., for low blood sugars or exercise) at any time during the day. The basal insulin that is missed while the pump is suspended can also be compensated for by a bolus either before or after suspension. In contrast, once an injection of Lantus or Levemir is given, the insulin activity cannot be reversed or altered until the insulin runs out.

4. The pump temporary basal rates can be used at any time during the day to increase or decrease the insulin activity for as long as is desired (up to 24 hours). The temporary increases may help with infections, monthly menstrual periods, stress or any cause of high blood sugar levels. The temporary basal rate decreases are most often used for exercise or periods of low blood sugar.

### DETERMINING THE BASAL DOSE

The diabetes physician provides initial basal dosages, which are then programmed into the pump (usually at the time of the Saline Pump Start Visit). The initial basal rates are calculated in different ways:

1. A common method is to calculate the average total insulin dose a person receives in a day (the sum of rapid-acting, intermediate [NPH/Lente] and basal insulins). The dose is then reduced by either 20% or 30% (for safety). Approximately half of the 70% or 80% of the previous daily total is then given as the basal insulin and half as boluses.
2. The dose of injected basal insulin (Lantus or Levemir) the person currently receives, or a slightly lower dose, may be used as the starting total pump basal insulin dose. The amount to be given as basal insulin is divided by 24 to get the approximate rate per hour.
3. Some physicians give this single rate all day long and then make adjustments for periods of high or low blood sugar levels. Other physicians adjust the basal rates in two- or three-hour time periods (see Table 1). This allows for initially reducing the dose during the night and/or for giving a higher dose after meals (as most people

underestimate carbs). Some adolescents also need higher basal rates in the 4 a.m. to 9 a.m. period to counter the increased growth hormone output at this time (called the “dawn phenomenon”).

## ADJUSTING THE BASAL RATES

A major goal during the first one to two weeks after initiating pump therapy is to properly adjust the basal rates. This requires frequent blood sugar checking, usually a minimum of seven or eight times per day. A minimum of one or two of these checks are during the night to adjust nighttime basal rates.

## BASAL RATE CHECKING

Basal rate checking refers to checking blood sugar levels when other factors that influence the blood sugar levels are absent. These factors include food, exercise, infections, menses and stress. Basal rate checking determines if the blood sugars stay in range (generally between 70 mg/dl [3.9 mmol/L] and 150 mg/dl [8.3 mmol/L]) when all other influences are removed. Basal rates control blood sugar levels between meals, during the night or when fasting.

Many physicians request basal rate checking at regular intervals, whereas others request it only when there is a question about control. It is usually not done until a person has been on a pump for at least a week, so that other body hormones will have adjusted to the new insulin patterns. During the period of basal rate checking, the blood sugars should remain in the desired range for the person's age and not decrease below 70 mg/dl (3.9 mmol/L). If the blood sugar level does drop below this level, the check should be discontinued and the person should eat. The basal rate for that period then should be reduced. If the blood sugar value becomes high (e.g., above 250 mg/dl [13.9 mmol/L]), it may be necessary to discontinue the check, take a correction bolus and increase the basal rate for that period. The basal rates should then again be rechecked after several days to see if the decrease or increase in basal rate was adequate.

There are three periods for checking basal rates:

**1. 7 a.m. to noon.** This is an important period to check because most people sleep in on occasion. This is particularly true for college students who are often on variable schedules. It is important to know that the blood sugar is in the desirable range if breakfast is delayed or omitted. To do the basal rate check, the person sleeps late and has someone check the blood sugar every one to two hours. Breakfast and other food is omitted (unless a low blood sugar). Likewise, exercise is avoided. Alcohol must not be consumed the previous night, as this could cause hypoglycemia in the morning hours.

**2. 7 p.m. to 7 a.m.** This is a very important time to check as one wants to be safe during the night. Eat a dinner with known carbohydrate content (e.g., commercially prepared frozen meal) so that the I/C ratio for the dinner bolus is correct. Do not eat or exercise after dinner. Check blood sugar values every two to four hours to make sure they remain in range for age. Note: Some physicians recommend separate 7 p.m. to 10 p.m. and 10 p.m. to 7 a.m. basal rate checks.

**3. Noon to 7 p.m.** Many people do not check the basal rate during this period, as eating and exercise are so frequent. If the basal rate is checked, the person skips lunch and checks blood sugar levels every one to two hours until dinner. Again, exercise is avoided.

## REASONS FOR CHANGING BASAL RATES

There are many reasons for changing basal rates, although most rates remain relatively similar on most days. The three most common variations are described below:

### 1. Changing the basal pattern to correct blood sugar trends

The basal rate is changed to correct high or low blood sugar levels that are being experienced consistently. These are not changes that are made due to a temporary condition, such as a cold or a day of extra activity (see temporary basal rates). Frequent blood sugar checking

allows the pump user to set the basal rates accurately. For children and adolescents, a common reason for making these changes is growth. The general rule is that for every two pounds (one kg) gained, a person needs an extra one unit of insulin per 24 hours. With teenagers there is an additional factor of insulin resistance that develops due to high levels of growth hormone and other hormones. A study of basal checking in people of different ages found that teenagers had the highest hourly basal rates of any age group throughout the day. (8)

## 2. Setting temporary basal rates

Temporary basal rate decreases are used most frequently for managing periods of exercise. As the insulin does not peak for 100 minutes, it may be necessary to begin the temporary basal rate decrease prior to the beginning of exercise. It is important to remember that if one enters the amount "80%," it means that 80% of the usual basal rate will be given (i.e., not an 80% decrease) However, the Animas pump would display minus (-) 20% if the desired basal rate is 80%. Most pumps allow the user to decrease basal rates to 0%. The number of minutes or hours that the decreased basal rate is to be in effect also needs to be entered. The advantage of using a temporary basal rate of 0%, rather than turning off the pump, is that the pump will automatically resume the previous basal rate after the allotted time elapses. This avoids forgetting to turn the pump back on.

Temporary basal rate increases (e.g., 120% which is a 20% increase) are most commonly used with illnesses that increase the blood sugar levels. Basal rate increases may help with long car trips (i.e., reduced activity), menstrual periods, stress or anything else that increases blood sugar levels. Most pumps allow up to a 200% basal rate (i.e., double the usual rate).

## 3. Alternate basal rates

Most pumps have additional 24 hour basal rate settings (e.g., an "A" setting, or "B" setting) that the person/family can use as needed. Some people will preprogram a second basal rate for weekend days, heavy exercise days or menstrual periods.

## SUMMARY

The pump allows many options for basal infusion rates. The person and family members must learn these options in order to benefit to the fullest. The purpose of all of the options is to make life easier and safer for the pump user.

## DEFINITIONS

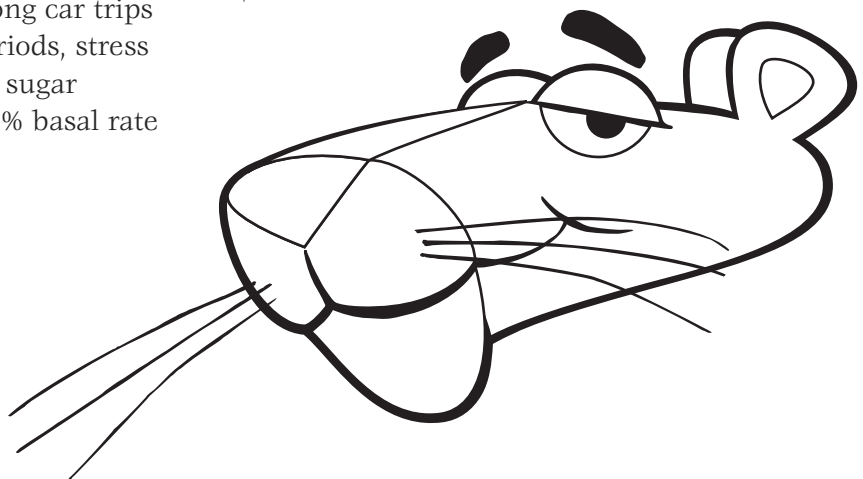
**Basal rate:** The small amount of insulin continuously delivered by the pump on a pre-programmed basis.

**Basal rate checking:** A method to determine if the basal rates are set correctly (described in detail in the text).

**Temporary basal rate:** A temporary decrease or increase in the basal rate. A temporary basal rate setting of 80% means that 80% of the usual dose will be given (not an 80% decrease). Some pumps (e.g., the Animas) just state -20% for the same reduction.

## REFERENCES

8. Scheiner and Boyer, *Diabetes Res Clin Pr* 69; 14, 2005.



## TABLE 1: INSULIN DOSES

Name \_\_\_\_\_ Date\* \_\_\_\_\_  
 (\*For insulin start)

### STARTING BASAL RATE(S)

Start Time	Units per Hour	Start Time	Units per Hour
1. _____	_____	7. _____	_____
2. _____	_____	8. _____	_____
3. _____	_____	9. _____	_____
4. _____	_____	10. _____	_____
5. _____	_____	11. _____	_____
6. _____	_____	12. _____	_____
Total _____			

### CARB COUNTING

Starting Bolus Dosages

Time	Insulin/Carb Ratios	Time	Insulin/Carb Ratios
1. _____	_____	3. _____	_____
2. _____	_____	4. _____	_____

### Insulin Sensitivity Ratio

Time	1 unit lowers BG by:	Time	1 unit lowers BG by:
1. _____	_____ mg/dl (mmol/L)	3. _____	_____ mg/dl (mmol/L)
2. _____	_____ mg/dl (mmol/L)	4. _____	_____ mg/dl (mmol/L)

### TARGET BLOOD SUGAR LEVELS

Time	Target BG	Time	Target BG
1. _____	_____	3. _____	_____
2. _____	_____	4. _____	_____

Duration of Insulin Action: \_\_\_\_\_ Hours

If you have any questions, please contact your healthcare provider:

MD: \_\_\_\_\_ Phone: \_\_\_\_\_  
 RN: \_\_\_\_\_ Phone: \_\_\_\_\_

Remember, you must call or fax blood sugar records in daily for the first 1-2 weeks after your pump start. Discuss this with your MD or RN at your Insulin Pump Start Visit.