Basal-Bolus Insulin with Multiple Daily Injections

Focus on Children & Youth

BC CHILDREN'S HOSPITAL

An agency of the Provincial Health Services Authority

Heather Nichol RN, MScN, CDE

© 2009 BC Children's Hospital

Acknowledgements:

The contributions of others to the review and development of the basal-bolus handouts are gratefully acknowledged:

- Daniel L. Metzger*, MD, FAAP, FRCPC
- Kathleen De Waele*, MD, Pediatrician, Clinical Fellow
- Cristina Pepe*, RN, BSN, CDE
- Sharleen Herrmann*, RN, BSN, CDE,

  *Endocrinology & Diabetes Unit, BC's Children's Hospital
- Judy Leonard, RN, Medical Day Unit BC's Children's Hospital
- Allison Husband, RN, MN, CDE, Diabetes Clinic, Alberta Children's Hospital
- Laurie Hasiuk, Learning & Development, Children's & Women's Health Centre of British Columbia, for desktop publishing
- A special thanks to the youth and parents who reviewed drafts of the handouts!
- LifeScan Canada is gratefully acknowledged for providing an educational grant to assist with the publication of this document.

BC CHILDREN'S HOSPITAL
An agency of the Provincial Health Services Authority

Prepared for:
British Columbia's Children's Hospital
Endocrinology & Diabetes Unit
Vancouver, British Columbia

By: Heather Nichol RN, MScN, CDE

© 2009 BC Children's Hospital

Preface

This booklet includes several handouts (information sheets) to help parents of children with diabetes and youth learn more about basal-bolus insulin with multiple daily injections (MDI). The handouts are also available on the internet at http://endodiab.bcchildrens.ca/pdf/basalbolus.htm.

Some of the handouts will help you understand what basal-bolus insulin therapy is. Others will help you decide if basal-bolus with MDI is right for you. Several examples and practice questions are also included to help you learn more about adjusting insulin and calculating insulin doses. You can read the information at your own pace and according to your own interests and learning needs. You do not need to read all of the handouts at one time.

As you read through this booklet you will notice links to other handouts that are available on the website for the Diabetes Program at British Columbia's Children's Hospital (http://endodiab.bcchildrens.ca). To access the other handouts, go to our website and click on the links of interest.

Happy Learning!

Note: The information included in these handouts is not a substitute for education or advice from your diabetes education team and health care providers.

For pricing and ordering information

C&W Bookstore
Children's & Women's Health Center of BC
4480 Oak Street, Room K2-126,
Ambulatory Care Building
Vancouver, BC V6H 3V4

Tel: (604) 875-2345 Ext 7644
Toll free: 1-800-331-1533 Ext 3
Fax: (604) 875-3455
Email: bookstore@cw.bc.ca
Web: http://bookstore.cw.bc.ca

BC CHILDREN'S HOSPITAL
An agency of the Provincial Health Services Authority

ENDOCRINOLOGY & DIABETES UNIT
Diabetes Clinic:
604-875-2868 Toll Free: 1-888-300-3088 ext: 2868
Fax: 604-875-3231
http://endodiab.bcchildrens.ca

Fast Track to Basal-Bolus Information

Click on the topics that interest you

An Introduction to Basal-Bolus Insulin with Multiple Daily Injections

Basal–bolus insulin plans for diabetes management can include the use of an insulin pump or multiple daily injections of insulin. The basal–bolus handouts in this package provide information for basal–bolus insulin with multiple daily injections (MDI). For information about insulin pumps, please see our handout *Insulin Pump Therapy*.

The handouts listed in the sidebar include information for youth and parents considering basal–bolus insulin with MDI. They can be read as a complete package or individually. There are also some exercises that you can do to help you decide if you are ready for basal–bolus insulin and to check your understanding of key points.

Click on the topics that interest you.

To download or print the entire basal–bolus package go to:

http://endodiab.bcchildrens.ca/pdf/basalbolus.htm.

Prepared by Heather Nichol, RN, MScN, CDE for BC Children's Hospital © 2009 - BCCH1410

What is a Basal-Bolus Approach to Diabetes Management?

To understand basal–bolus insulin, it is helpful to first understand what happens in the body when a person does not have diabetes. Insulin is normally produced by the pancreas and is present in the body 24 hours a day, every day. There are two major ways that insulin is provided by the pancreas: basal and bolus.

1. Basal insulin is continuous, background insulin that the body needs to keep blood sugar in control when no food is eaten. Basal insulin is working even during periods of sleep.
2. Bolus insulin is extra insulin that is released as needed to match food intake.

When a person does not have diabetes, the pancreas automatically produces the exact amount of basal and bolus insulin that is needed. The amount of insulin is adjusted for changes in activity level or food and during times of stress and illness. Because the basal–bolus system works so well when a person does not have diabetes, food can be eaten at any time and in any amount and the blood sugar will still stay in a normal range!

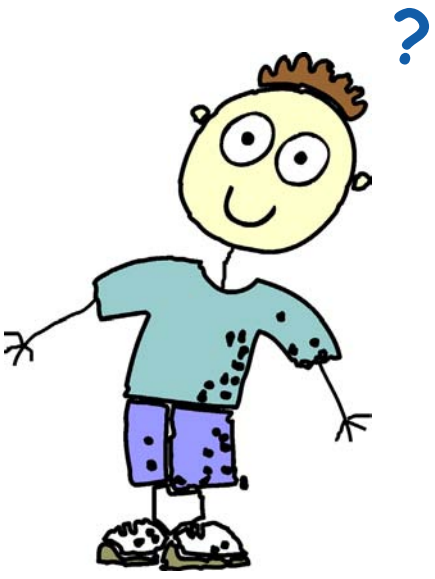
A basal–bolus approach to diabetes management tries to copy or imitate what happens in the body of a person who does not have diabetes. A long-lasting background insulin, called "basal" insulin is needed every day as well as additional "boluses" of rapid-acting insulin for food. Basal insulin usually makes up about half (50%) of the total amount of daily insulin. Bolus insulin doses match the amount of carbohydrate that is eaten. Bolus insulin doses can also be given to bring down high blood sugars. Blood sugars must be checked several times each day to make decisions about insulin doses.

There are several different combinations of insulin that can be used in a basal–bolus approach to diabetes management. There are also different ways to give insulin. Two examples of a basal–bolus approach to diabetes management are:

1. Multiple Daily Injections (MDI) with Levemir or Lantus (basal) and rapid-acting insulin (bolus)

   OR an

2. Insulin Pump that provides basal and bolus insulin using rapid-acting insulin only.



For more information on the use of Levemir or Lantus and rapid-acting insulin, see our handouts: *What Are Lantus and Levemir?* and *Why Is Rapid-Acting Insulin Also Used in a Basal–Bolus Plan?* and talk to your diabetes educator and doctor. For more information on insulin pumps, please read our handout *Insulin Pump Therapy* or talk to your diabetes doctor and nurse.

BC Children's Hospital © 2009 - BCCH1410

What are the Benefits of Basal-Bolus Insulin?

One of the goals of using basal–bolus insulin in diabetes is to keep blood sugars in a healthy range as often as possible. This is important for feeling and growing well during childhood and for preventing future health problems. Basal–bolus insulin also has other advantages including the possibility of a more flexible lifestyle. For example, there can be more flexibility with amounts and timing of food. Words that are often used to describe the rewards of effective basal–bolus therapy are "more freedom", "more flexibility" and a better "quality of life". Many people will say that more work is involved, but the health and personal rewards are worth it!

Basal–bolus insulin, combined with strong knowledge and skills, can improve:

- blood glucose control, which has immediate and long-term health benefits
- flexibility in day-to-day living with diabetes
- blood sugars during and after physical activity

A basal–bolus approach that includes Levemir or Lantus as the basal (background) insulin and rapid-acting insulin as the bolus insulin can be especially useful if you:

- are having difficulty with overnight blood glucose control
- are having problems with low blood sugars, especially during the night
- desire more flexibility in meal and snack times and amounts
- want to sleep in sometimes
- plan to travel across time zones or do shift work

To benefit fully from a basal–bolus approach to diabetes management requires motivation to:

- give basal insulin every day and rapid-acting insulin for each meal and some snacks. (This usually means giving insulin at least 4 times a day).
- check blood sugars at least four to six times each day
- record and review blood sugars
- make informed decisions about insulin, activity and food.

BC Children's Hospital © 2009 - BCCH1410

What are Lantus and Levemir?

- Lantus® (also known as insulin glargine) and Levemir® (also known as insulin detemir) are long-lasting "basal" insulins. Basal insulin is a word that is used to describe the slow, steady release of insulin that is needed even when no food is eaten. Some people refer to basal insulin as "background" insulin.
- Lantus and Levemir start to work in about 60–90 minutes and can last for up to 20 - 24 hours. Both insulins have quite a flat, steady action throughout the day and night. Because of their flat action, they are not effective in controlling blood sugars after eating. People who use Lantus or Levemir also need rapid-acting insulin when they eat.

Important information about Lantus and Levemir:

- **Do not mix Lantus or Levemir in a syringe with any other insulin.** Mixing will change the insulin actions and they will not work properly.
- **Lantus and Levemir are clear insulins.**
  - Read the label to avoid confusion with other clear insulins.
  - Do not use the insulin if it looks cloudy.
- **Start a new vial or cartridge of Lantus every 4 weeks. Start a new cartridge of Levemir every 6 weeks.** (The insulins lose strength and sterility if open longer).
- **If you are switching from NPH insulin to Lantus or Levemir insulin, your doctor may start you on a lower dose than your previous total daily dose of NPH** to help prevent hypoglycemia (low blood sugar).
- **Lantus and Levemir may not last 24 hours in all people**. Some people may need to give them twice a day. This is common when Levemir is used.
- **Give your basal insulin (Lantus or Levemir) at the same time each day**. A common time to give basal insulin once a day is at bedtime. Basal insulin that is given twice a day is often given at breakfast and at dinner or bedtime. Talk to your diabetes team about good times to give your insulin.
- The amount of *rapid-acting* insulin that is needed for food or to correct high blood sugars may be different when using Lantus or Levemir than the amount that was used when you were on NPH.
- Do not inject Lantus or Levemir into a muscle. To decrease the possibility of injecting into a muscle: 1) gently pinch up a small hill of fat at the injection site 2) avoid muscular areas where there is not much fat.
- A small number of people may feel a burning sensation where they inject Lantus.
- Lantus and Levemir are not currently approved for use in pregnancy.
- Lantus and Levemir are more expensive than NPH, and the cost may not be fully covered by BC PharmaCare or some health plans.
- Lantus and Levemir are currently licensed in Canada for children 6 years and older. Discuss this with your doctor if you are considering using either insulin in a child.

BC Children's Hospital © 2009 - BCCH1410

Why is Rapid-Acting Insulin Also Used in a Basal-Bolus Plan?

Rapid-acting insulin is used as the "bolus" part of a multiple daily injection (MDI) basal–bolus plan. It is given before carbohydrate-containing meals and snacks to keep blood sugars from rising too high after eating.

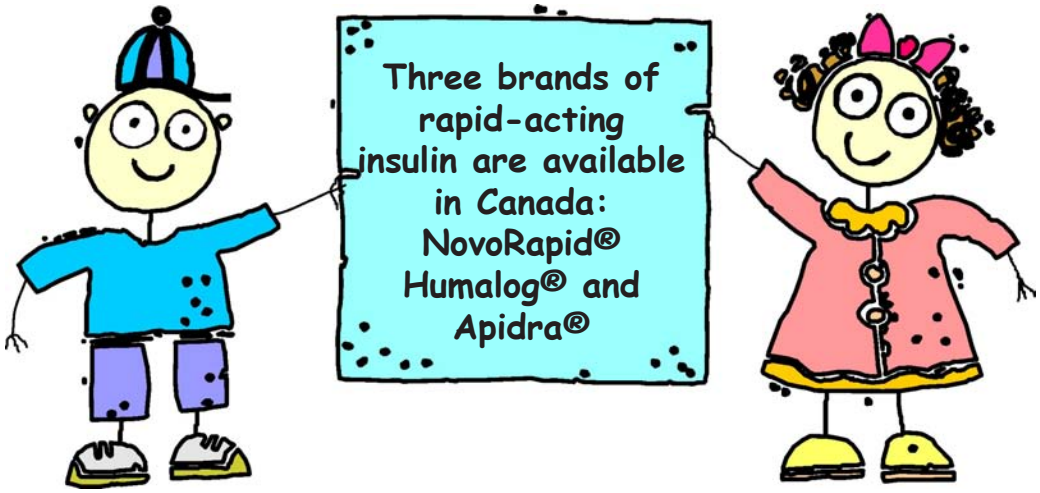
Like the pancreas, which produces extra insulin to match food that is eaten, boluses of rapid-acting insulin are given for food. Rapid-acting insulin is given when food is eaten and in amounts that match the food. This allows for more flexibility with the amounts and timing of meals and snacks. Carbohydrate counting and Insulin-to-Carbohydrate (CHO) Ratios are two important tools for matching insulin and food in a basal–bolus plan. For more information see our handouts: *Carbohydrate Counting* and *Rapid-Acting Insulin for Carbohydrate and High Blood Sugar*. You can also test your carb counting knowledge by doing the *Carb Counting Quiz* - answers are included!

Rapid-acting insulin can also be given to quickly lower high blood sugars. Rapid-acting insulin starts to work in about 15 minutes and is working very hard in about 90 minutes. Giving extra rapid-acting insulin for high blood sugars can shorten the amount of time that the blood sugar is high. (A Correction Factor or an Insulin Scale can be used to help you decide how much extra rapid-acting insulin to give for high blood sugars. For more information on Correction Factors and Insulin Scales see our handouts *What are a Correction Factor, Correction Bolus and Insulin Scale?* and *Rapid-Acting Insulin for Carbohydrate and High Blood Sugar*.)

Rapid-acting insulin only lasts for about 3–4 hours. Because of its short action, it must be used along with a longer-acting, background (basal) insulin.

Can Regular (fast-acting) insulin be used in a basal–bolus plan?

Regular fast-acting insulin (Humulin R or Novolin Toronto) may be more suitable than rapid-acting insulin for some people. For example, if a child or teen wants to eat a carbohydrate snack every morning and does not want to give a bolus of rapid-acting insulin to cover the snack, Regular insulin may be more suitable to cover both the breakfast and the snack. Discuss this with your diabetes health team.

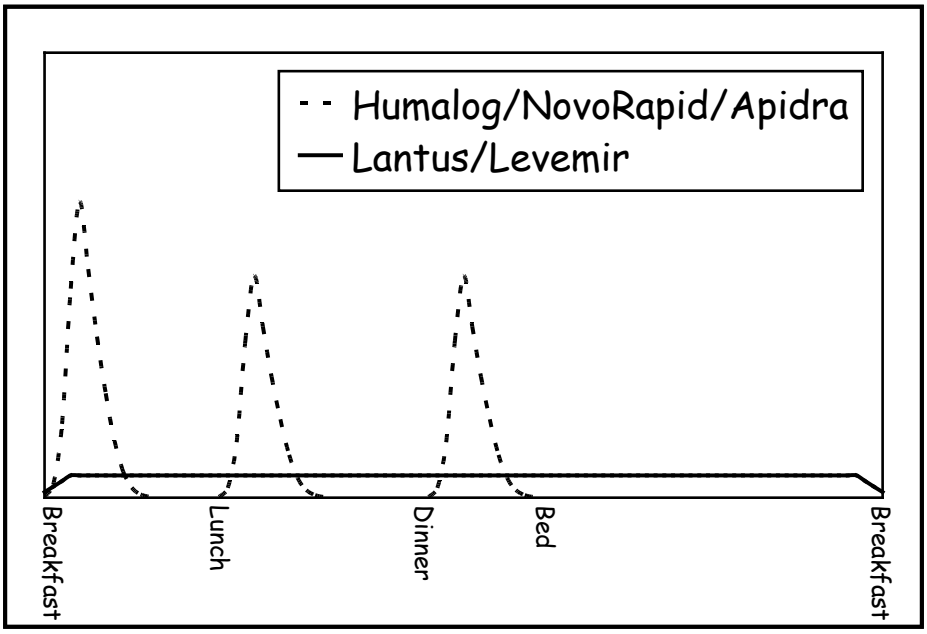


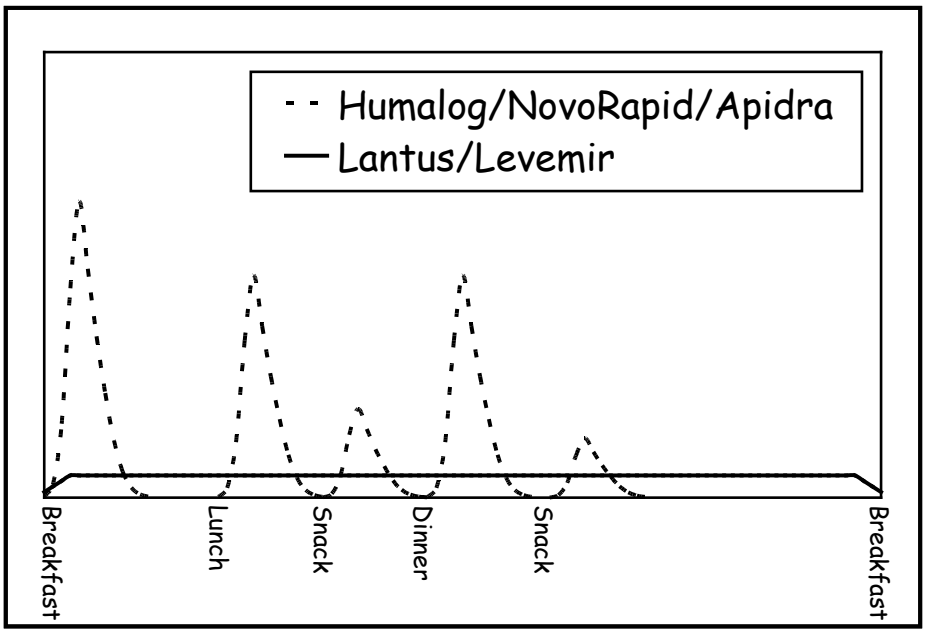
BC Children's Hospital © 2009 - BCCH1410

Basal-Bolus Insulin Action with Lantus or Levemir and Rapid-Acting Insulin

The following two pictures show the actions of Lantus or Levemir (basal) and rapid-acting insulins Humalog, NovoRapid or Apidra (bolus) working to provide basal–bolus insulin for 24 hours. Rapid-acting insulin is needed to cover carbohydrate-containing meals and may also be needed for snacks. Lantus or Levemir is needed even if no food is eaten.

Basal: Lantus or Levemir
Bolus: rapid-acting (Humalog, NovoRapid or Apidra)

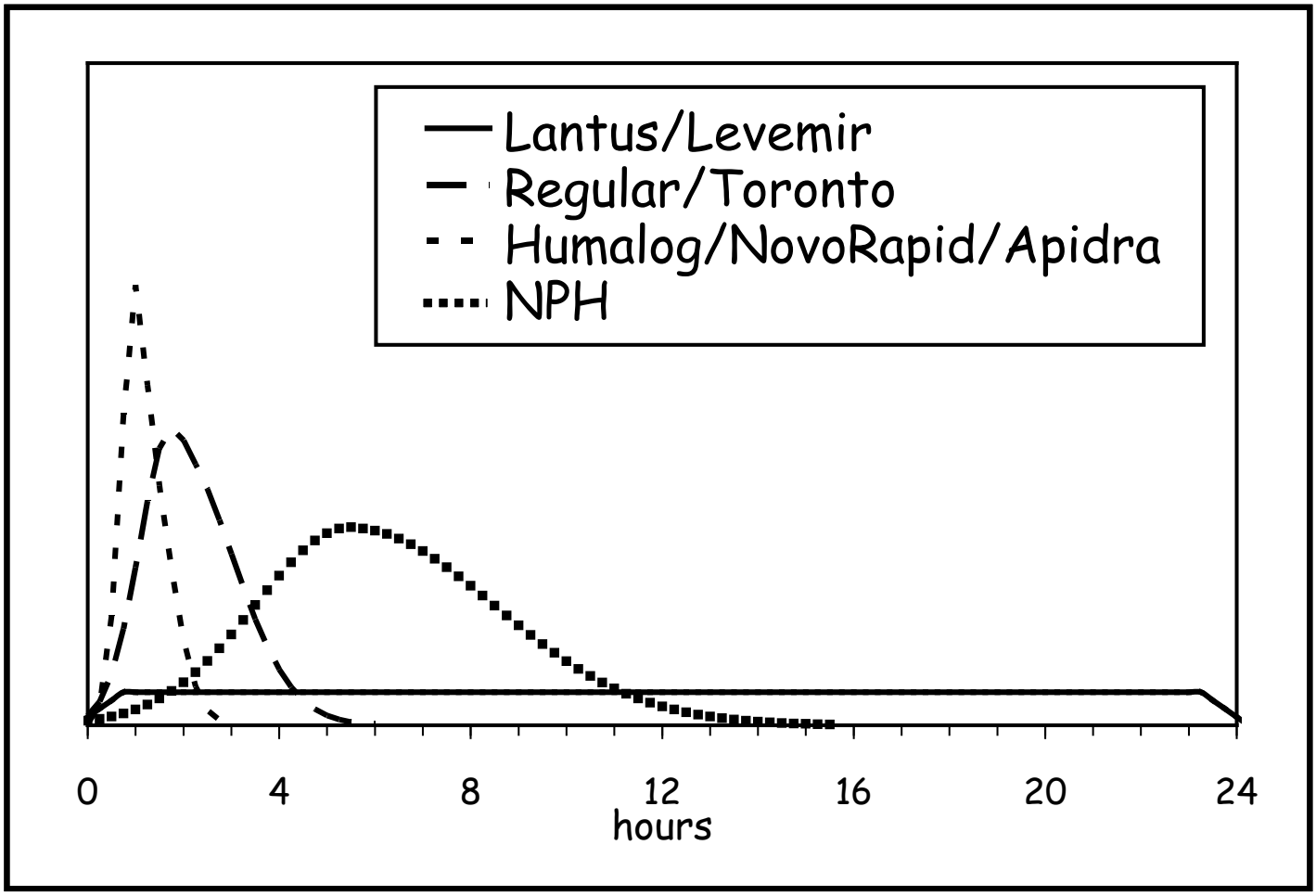




Lantus/Levemir and rapid-acting insulin with meals and snacks

BC Children's Hospital © 2009 - BCCH1410

Basic Insulin Action
Action Profiles of Common Insulins



INSULIN NAME	STARTS	STRONGEST	LASTS
Humalog/NovoRapid/Apidra	10 - 15 minutes	60 - 90 minutes	4 - 5 hours
Regular / Toronto	30 - 60 minutes	2 - 4 hours	5 - 8 hours
NPH	1 - 3 hours	5 - 8 hours	up to 18 hours
Lantus / Levemir	1 - 1½ hours	none	18 - 24 hours

BC Children's Hospital © 2009 - BCCH1410

What are a Correction Factor, Correction Bolus and Insulin Scale?

Either a Correction Factor or an Insulin Scale can be used in a basal–bolus plan to bring high blood sugars back into your target or goal range. Using a Correction Factor or Insulin Scale allows you to correct high blood sugars by giving additional rapid-acting insulin at meal times and other times.

Correction Factor:

A Correction Factor is an estimation of how much 1 unit of rapid-acting insulin will lower the blood sugar. *(Another term for the Correction Factor is the Insulin Sensitivity Factor, or ISF).* Correction Factors must be individually set for each person. For example, one person may find that 1 unit of rapid-acting insulin lowers their blood sugar by 2 mmol/L, while another person may find that 1 unit of rapid-acting insulin lowers their blood sugar by 3 mmol/L. Your diabetes team will estimate your Correction Factor for you or will teach you how to do this. Once you know your Correction Factor, you can calculate how much rapid-acting insulin is needed to bring a high blood sugar back into your target range. **The amount of rapid insulin that is given for a high blood sugar is referred to as a Correction Bolus or a Correction Dose.**

Correction Bolus:

The formula that is used to calculate a Correction Bolus (Correction Dose) is:

$$\text{Correction Bolus} = \frac{\text{Current Blood Sugar - Target Blood Sugar}}{\text{Correction Factor}}$$

Example: Current Blood Sugar = 15
Target Blood Sugar = 7
Correction Factor = 2

$$\text{Correction Bolus} = \frac{15 - 7}{2} = 4 \text{ units of rapid-acting insulin}$$

Practice Question:

Use the example below to practice figuring out how much rapid-acting insulin to give:

Example: Current Blood Sugar = 10.7
Target Blood Sugar = 8
Correction Factor = 5

What is the correction bolus?

$$\text{Correction Bolus} = \frac{\text{Current Blood Sugar (10.7) - Target Blood Sugar (8)}}{\text{Correction Factor (5)}} = 0.54$$

Answer:

Correction Bolus = ½ unit of rapid-acting insulin (rounded down to nearest half-unit).

Notes:

1. Only give a Correction Bolus if the amount needed is at least a ½ unit.
2. Correction Factors may change over time depending on your sensitivity to insulin. If you notice a pattern where your blood sugars do not come back into the goal range within 3–4 hours of giving a Correction Bolus, it may mean your Correction Factor needs to be changed.

BC Children's Hospital © 2009 - BCCH1410

Insulin Scale:

Some people find it easier to have their pre-meal bolus doses written on an **Insulin Scale** instead of calculating the dose each time they need rapid-acting insulin. An Insulin Scale provides a list of how much insulin to give before a meal. The amount of insulin listed on a scale includes a Correction Bolus (already calculated) and takes into account the pre-meal blood sugar level as well as the amount of carbohydrate that is usually eaten at that meal. Insulin Scales are sometimes called **Correction Scales**, **Variable Insulin Dose Scales** or **Sliding Scales** to emphasize that the dose of rapid-acting insulin is not always the same. When a blood sugar is higher or lower than the goal blood sugar, more or less rapid insulin is given according to the amount listed on the Insulin Scale. When using a scale, it is still important to THINK about the dose of insulin. Consider the amount of food and activity that you are planning, as these will also affect the amount of insulin needed. For example, if you are going to eat more than usual, you may need more insulin than the amount listed on your scale. Or, if you are going to be more active than usual, you may need less insulin than the amount listed on your scale. Your diabetes team can provide you with an insulin scale or show you how to set up your own scale.

Example: An example of an Insulin Scale for Alisa is shown below. In the example, a Correction Factor is built into the scale: the dose of rapid-acting insulin goes up by 1 unit for every 4 mmol/L that the blood sugar is above Alisa's goal range of 4–8 before meals. Alisa usually eats the same amount of carbohydrate (CHO) each day. Although her carbohydrate intake is the same, her dose of rapid-acting insulin varies according to her pre-meal blood sugar level.

Blood Sugar	Breakfast Rapid	Lunch Rapid	Dinner Rapid
Less than 4 (treat low!)	3	2	2
4-8	4	3	3
8-12	5	4	4
12-16	6	5	5
16-20	7	6	6
Above 20	8	7	7
NOTES: **Pre-meal BG goal: 4-8** **Correction Factor:** 1 unit lowers blood sugar by about 4 mmol/L **Check ketones if BG >15**	**Usual Meal CHO:** 55 grams **Insulin:CHO Ratio:** 1:15	**Usual Meal CHO:** 60 grams **Insulin:CHO Ratio:** 1:20	**Usual Meal CHO:** 60 grams **Insulin:CHO Ratio:** 1:20

BC Children's Hospital © 2009 - BCCH1410

CHECK YOUR UNDERSTANDING:

Using the Insulin Scale on **page 9**, and assuming "usual" meal sizes and activity levels:

1. How much rapid-acting would you give if the blood sugar before lunch is 14.7?

2. How much rapid-acting would you give if the blood sugar before dinner is 5.2?

3. If Alisa plans to eat an extra 15 grams of carbohydrate (CHO) at breakfast, should she take the amount of insulin shown on her scale?

Answers:

1. 5 units.
2. 3 units.
3. No. The amount of insulin on the scale is for the amount of CHO she usually eats. If she plans to eat more CHO than usual, she will need more insulin. Using her Insulin:CHO Ratio for breakfast, she will need an extra 1 unit of rapid insulin for an extra 15 grams of carbohydrate.

Another Example of an Insulin Scale:

Here is another example of what an Insulin Scale could look like. The scale below shows how correction doses can be used for blood sugars outside of the goal range. In this example the goal blood sugar range before meals is 4–6 mmol/L. The scale includes a standard insulin dose and uses a Correction Factor of 2 (already calculated). As shown on the scale, the insulin dose changes for every 2 mmol/L that the blood sugar is above or below the goal range.

Note: The amount of insulin listed on the scale does not take into account changes in carbohydrate or activity. If a different amount of carbohydrate is going to be eaten or activity levels will be different than usual, a different amount of insulin will be needed.

Blood Sugar	Breakfast Rapid	Lunch Rapid	Dinner Rapid
Less than 4 (treat low!)	-1	-1	-1
4-6	Standard dose	Standard dose	Standard dose
6-8	+1	+1	+1
8-10	+2	+2	+2
10-12	+3	+3	+3
12-14	+4	+4	+4
14-16	+5	+5	+5
16-18	+6	+6	+6
18-20	+7	+7	+7
Greater than 20	+8	+8	+8
	Usual Meal CHO: _____	**Usual Meal CHO:** _____	**Usual Meal CHO:** _____

Reminder: The doses listed on your Insulin Scale sometimes need to be adjusted.

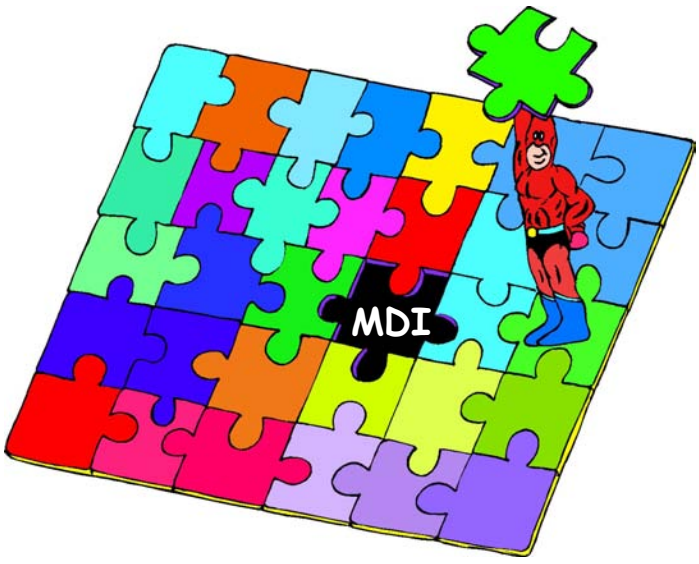
BC Children's Hospital © 2009 - BCCH1410

Fitting Basal-Bolus into Daily Life: Is MDI for You?

You may have already done some reading about a basal–bolus approach to diabetes management but still want a better idea of what it would involve in real life.

This handout provides three examples to give you a picture of what a basal–bolus insulin plan could look like in the life of a child or teen with diabetes. Mike is 16 years old, Jenny is 11 and Cammie is 2½. As you will see, each plan is individualized according to the interests and needs of the child and family. Reviewing these examples may help you decide if you are interested and ready to start on basal–bolus insulin too.

A checklist is also included in a separate handout to help you decide if you are interested and ready to switch to basal–bolus insulin therapy. (See our handout: *Are You Ready for Basal–Bolus Insulin?*). Your diabetes team can also give you information to help you make an informed decision about starting on a basal–bolus insulin plan.



BC Children's Hospital © 2009 - BCCH1410

EXAMPLE One: MIKE, 16 YEARS OLD

Mike switches from using insulin three times a day to a basal–bolus plan with Lantus once a day at bedtime and rapid insulin before each meal and snack. Mike knows he will need to do his blood sugar and insulin more frequently than before, but he thinks the lifestyle gains will definitely make it worthwhile. He is looking forward to more flexibility with food, better blood sugar control during and after physical activity, and of course — sleeping in as long as his parents will let him! Mike has been using insulin pens for both his NPH and rapid (Humalog) insulin for about a year. He likes pens and will continue using them.

Background Information:

Mike has had type 1 diabetes for 10 years. He is very active in sports and has recently started training with a competitive swim team. He has been having difficulty with his blood sugars since training, and he is frustrated that his meal times have been interfering a bit with his training schedule. He wants to improve his blood sugars so he will have plenty of energy when he is training. He also wants more flexibility with meal times and the amount he eats. Mike doesn't want to follow a set meal plan or schedule but he wants to keep his blood sugars in his target range as often as possible. Mike and his parents feel he will do better using an Insulin-to-Carbohydrate Ratio* and a Correction Factor* to calculate how much insulin to give for food or high blood sugars. For the past while, Mike's irregular snacks and eating times have been a source of stress between him and his parents. They all like the idea of learning to use basal–bolus insulin.

Sample Basal–Bolus Plan for Mike

Basal Insulin: Lantus 28 units at 10:30 pm (before bed)

Bolus insulin before meals: Humalog dose calculated by using his:

Insulin:Carbohydrate ratio of 1 unit of Humalog for every 10 grams of carbohydrate

PLUS

Correction Bolus for high blood sugar: 1 unit of Humalog for every 2 mmol/L over his target blood sugar of 7 mmol/L before meals

= TOTAL DOSE OF RAPID-ACTING INSULIN (HUMALOG) BEFORE MEALS

Notes:

1) Mike also gives boluses of rapid-acting insulin if he eats carbohydrate-containing snacks.
2) To prevent low blood sugars during the night, Mike uses a higher blood glucose target and less insulin for bedtime boluses.

*For more information about Insulin-to-Carbohydrate Ratios and Correction Factors, see our handout: *Rapid-Acting Insulin for Carbohydrate and High Blood Sugar*.

BC Children's Hospital © 2009 - BCCH1410

A Sample Day for Mike

7:30 am

- Wake up.
- Check and record blood sugar.
- Decide what to eat for breakfast.
- Give bolus of rapid (Humalog) insulin before breakfast. (Add together the Carbohydrate Bolus and, if needed, a Correction Bolus. Mike gives a Correction Bolus for blood sugars higher than his target of 7 mmol/L.)

10:00 am

- Decide on snack.
- Depending on the type and size of the snack, a bolus of rapid insulin might be needed. (Mike uses an Insulin:CHO Ratio to calculate the amount of Humalog to give for snacks that contain carbohydrate.)

12:00 Noon

- Check blood sugar.
- Decide what to eat for lunch.
- Give bolus of rapid insulin (Humalog) before lunch. (Add together the Carbohydrate Bolus and, if needed, a Correction Bolus.)

3:45 pm

Get ready for an hour and a half of intense swimming. Check blood sugar before getting in the water and decide on what snack is needed. Mike does not need a bolus for his afternoon snack on swim days. (However, on non-swim days he needs to bolus for his afternoon snacks which generally include lots of carbohydrate!) From previous experience swimming and doing lots of blood sugar checks, Mike knows what his blood sugar needs to be and how much he needs to eat for his blood sugar to be ok when he swims.

5:30 pm

Check blood sugar after swimming.

6:30 pm

- Check blood sugar before dinner
- Give bolus of Humalog before dinner. (Add together the carbohydrate bolus and if needed, a correction bolus.)

10:00 pm

Check blood sugar and decide on bedtime snack. Depending on his blood sugar and what he is going to eat, he may need some rapid-acting insulin. To prevent low blood sugars during the night, Mike has a different Insulin:Carbohydrate Ratio and a different Correction Factor to use at bedtime. He has a higher blood glucose target and gives less insulin for bedtime boluses, especially on active days.

10:30 pm

- Give Lantus before bed.

3:00 am

Wake up and check blood sugar. (This does not need to be done every night; however, Mike's training was very intense today and he wants to make sure he does not have a delayed low blood sugar.)

BC Children's Hospital © 2009 - BCCH1410

EXAMPLE Two: JENNY, 11 YEARS OLD

Jenny switches from using NPH and NovoRapid insulin twice a day to a basal-bolus plan with Levemir twice a day and NovoRapid before each meal. Before changing to a basal–bolus plan, Jenny and her parents met with her doctor and diabetes educator to make sure they had enough information about the pros and cons of basal–bolus insulin — and to make sure they had a plan that suited them well. They decide to switch to basal–bolus to help improve Jenny's blood sugars and to gain more flexibility with meal and snack times. They also like the idea of being able to sleep in longer than usual on weekends. They will continue using a meal plan to guide food choices but they also want to learn to use an Insulin:CHO Ratio for more flexibility with meal and snack sizes. They decide that an insulin pen and an insulin scale will make it is easier for Jenny to give her NovoRapid at school. Jenny and her parents already know how to use an insulin scale and want to keep using one as part of deciding how much insulin to give before breakfast, lunch, dinner and Jenny's bedtime snack.

Background Information:

Jenny has had type 1 diabetes for three years. She and her family have been using a meal plan and information from Beyond the Basics to make choices about her food. They feel a meal plan works well for them, and they have a good understanding of how much carbohydrate is in each food choice. They know how to include variety in Jenny's meals and snacks by trading different types and amounts of food according to the food choice system. Jenny eats quite consistently from day to day but there are times she would like to eat more or less than the amount included in her meal plan. They would also like to have more flexibility with meal times, especially at dinner time and on weekends.

After meeting with her diabetes team, Jenny and her parents make a plan for starting on basal–bolus insulin. They also see the dietitian at the clinic to review her meal plan and learn about any special considerations for snacks on a basal–bolus plan with Levemir. They will be in contact with the diabetes nurse regularly during the first couple of weeks to review Jenny's blood sugars and insulin doses. Once her baseline doses have been established, they will be given an Insulin:CHO Ratio to adjust her rapid insulin for changes in meal or snack sizes. They also sign up for a workshop to gain more knowledge and confidence for adjusting insulin on their own.

BC Children's Hospital © 2009 - BCCH1410

Jenny's Basal-Bolus Plan

Basal insulin: Levemir 6 units before breakfast and 6 units at bedtime

AND

Bolus insulin before meals: NovoRapid is given according to an Insulin Scale. Jenny's goal blood glucose range is 4-8 mmol/L. Her Insulin Scale includes a standard insulin dose for her usual carbohydrate at meals. It also includes a Correction Factor (already calculated) for blood sugars above goal range. If Jenny's blood sugar is lower than 4 before a meal, it must be treated immediately – her mealtime bolus will also be smaller than usual. Jenny's Correction Boluses at bedtime are smaller than during the day in order to prevent hypoglycemia during the night.

Blood Sugar	Breakfast Rapid	Lunch Rapid	Dinner Rapid	Bedtime Rapid
<4	2	2	3	-
4-8	3*	3*	4*	-*
8-10	3½	3½	4½	-
10-12	4	4	5	-
12-14	4½	4½	5½	-
14-16	5	5	6	2
16-18	5½	5½	6½	2½
18-20	6	6	7	3
>20	6½	6½	7½	3½

Jenny's standard dose for rapid insulin is shown with a *. This is the amount of rapid insulin she takes before each meal if her blood sugar is in the goal range and she is going to follow her usual meal plan and activity levels. If she is going to eat a different amount of carbohydrate than usual at meal time, her insulin dose will be increased or decreased by using her Insulin:CHO Ratio. She has a specific ratio for each meal. These were calculated with the help of the diabetes team after Jenny's standard insulin doses were set.

Notes:

1) Rapid-acting insulin may also be given if Jenny is going to eat extra snacks.
2) If Jenny is planning to do more exercise than usual after her meals, her dose of Rapid-acting insulin will be lower than the 'usual' amount noted on the scale.
3) Jenny only has a correction bolus at bedtime if her blood sugar is above 14 mmol/L. Her correction boluses at bedtime are about half the amount of those used during the day.

BC Children's Hospital © 2009 - BCCH1410

A Sample Day for Jenny

7:30 am

- Check blood sugar.
- Give Levemir with insulin pen.
- Use Insulin Scale to decide on amount of rapid-acting insulin to give for usual breakfast.
- Give NovoRapid with insulin pen.
- Eat breakfast and leave for school.

10:30 am

Break-time. As usual, Jenny does not eat a morning snack as she prefers to just have fun with her friends. Sometimes she eats a snack that contains very little carbohydrate and does not require a bolus of rapid-acting insulin.

12:00 Noon

- Check blood sugar.
- Plan to eat usual lunch which she brings from home.
- Use Insulin Scale to decide on amount of NovoRapid insulin to give before lunch.
- (Jenny has a copy of her Insulin Scale in her bag and one in her lunch kit as a back-up.)
- Give NovoRapid with insulin pen and eat lunch.

3:30 pm

Although Jenny sometimes eats an afternoon snack she doesn't want one today. She knows that for her usual afternoon snack which contains 15 grams of carbohydrate she needs to give 1 unit of NovoRapid insulin. Today, because she is not going to eat a snack, she doesn't need to take any NovoRapid insulin until dinner time.

6:00 pm

- Check blood sugar.
- Plan to eat more carbohydrate at supper tonight — her favorite dessert!
- Use Insulin Scale and Insulin:CHO Ratio to decide on insulin dose:
  *Insulin Scale PLUS additional rapid insulin for planned larger meal = total amount of rapid to give before dinner. Use Insulin:CHO Ratio to decide on amount of additional rapid insulin to give for the dessert. Jenny needs 1 unit of rapid for every 15 grams of carbohydrate. They estimate the dessert contains 30 grams of carbohydrate. She will eat this in addition to her usual supper. Using the Insulin: CHO Ratio they decide Jenny needs an additional 2 units of NovoRapid.

8:00 pm

Check blood sugar 2 hours after dinner tonight to see how well the insulin dose matched her food.

9:30 pm

- Check blood sugar before bed. It is 8.2, so no bedtime snack is needed. Jenny is happy about this as she is still full from dinner and dessert. (She knows she needs to eat a snack at bedtime if her blood sugar is less than 7 mmol/L.)
- Give Levemir before bed.

3:00 am

Check blood sugar. Jenny and her parents are glad this does not need to be done every night! But they know it needs to be done sometimes to make sure Jenny is getting the right amount of Levemir insulin and not getting too low while she is sleeping.

BC Children's Hospital © 2009 - BCCH1410

EXAMPLE Three: CAMMIE, 2½ years old

Cammie is 2½ years old. She has had diabetes since the age of 18 months. Her parents would like to be able to let Cammie sleep through nap times without having to worry about whether or not she has eaten a snack. They would also like to have more flexibility with her diabetes management so they can better respond to her variable appetite and food interests. They are used to giving Cammie insulin twice a day and do not mind the idea of giving her more frequent injections. They talk to the diabetes team and decide that a basal–bolus plan with Levemir and NovoRapid (rapid-acting) insulin would be a good choice for Cammie. They will use insulin pens for her NovoRapid and Levemir insulins. They choose the Pen Junior because it measures half-units which Cammie often needs. They will learn to calculate her NovoRapid insulin doses using a Correction Factor and an Insulin:CHO Ratio. They understand that her Levemir dose, her Correction Factor, and her Insulin:CHO Ratio will all need to change as Cammie grows. Instead of following a meal plan as they have in the past, they will focus on overall nutritional needs and will also learn how to count and estimate carbohydrates. They need to learn more about insulin dose adjustments and carbohydrate counting and are keen to do this.

Background Information:

Although they have some learning needs, Cammie's parents are already in a good position to make a switch to basal–bolus insulin. They are already used to checking her blood sugars every day before meals and they usually check during the night at least once a week. They have a good understanding of insulin dose adjustments for pattern management as they previously completed the *On-Line Insulin Dose Adjustment Education Program* for parents and have been making adjustments on their own for a few months. They now need to learn how to use a Correction Factor and Insulin:CHO Ratios to calculate doses of NovoRapid. They will discuss this with the diabetes nurse during their clinic visit. They will also complete the practice questions included in our handout *Guidelines for Basal–Bolus Insulin Dose Adjustments with Lantus or Levemir and Rapid-Acting Insulin*.

They have some understanding of carbohydrate counting from previous teaching they received on the Good Health Eating Guide and from our handout *Carbohydrate Counting*. However, they will discuss carb counting with the dietitian to ensure they understand it well enough to be flexible and reach Cammie's target blood sugars.

Sample Basal-Bolus Plan for Cammie

Basal insulin: Levemir 2 units at breakfast and 2 units at dinner (supper) time

Bolus insulin before meals: NovoRapid:

Insulin:Carbohydrate ratio: 1 unit of rapid per 40 grams of carbs (or ½ unit for 20 grams)

PLUS

Correction Bolus for high blood sugar: **Cammie is just 2½ years old and small amounts of insulin make a big difference to her blood sugar. When her blood sugars are above 12 mmol/L, her parents give her a Correction Dose of NovoRapid. They know that ½ a unit will lower Cammie's blood sugar by about 6 mmol/L.**

= TOTAL DOSE OF RAPID-ACTING INSULIN (NOVORAPID) BEFORE MEALS

BC Children's Hospital © 2009 - BCCH1410

A Sample Day for Cammie

8:00 am

- Wake up. Check and record blood sugar.
- Give Levemir insulin.
- Estimate how much carbohydrate Cammie will eat for breakfast.
- Give rapid insulin before breakfast. (Add together the Carbohydrate Bolus and the Correction Bolus for blood sugars greater than 12 mmol/L.)
- Note: If Cammie was a fussy eater her parents could give her rapid insulin after breakfast so they could better match the insulin dose with the amount of carbohydrate eaten.

10:00 am

Cammie has a small snack. It contains less than 10 grams of CHO so she does not need any insulin for it.

11:00 am

- Cammie is sleepy and fussy. She needs to have a nap.
- Check blood sugar to make sure she is not low before going to sleep.
- Settle Cammie for her nap.

12:00 noon

This is Cammie's usual lunch time. Cammie's basal dose of Levemir has been working well so her mother does not wake Cammie to eat lunch at her "usual" lunch time. When Cammie awakens she will be hungry and ready for lunch — her mother will check her blood sugar and give her bolus insulin at that time.

1:15 pm

- Cammie wakes up from her nap.
- Cammie's mother checks her blood sugar and gives Cammie her bolus insulin before lunch (Carbohydrate Bolus + Correction Bolus if needed.)

3:30 pm

Cammie is full of energy and playing with her surprise visitor – her 5-year-old cousin. Her mom checks her blood sugar and gives her a small snack.

5:30 pm

- Check blood sugar before dinner.
- Give Levemir insulin.
- Give bolus of NovoRapid insulin before dinner. (Carbohydrate Bolus + Correction Bolus if needed.)

7:30 pm

Check blood sugar and get Cammie ready for bed. If her blood sugar is less than 7 mmol/L at bedtime, Cammie's parents make sure she has a snack that contains carbohydrate and protein.

11:00 pm

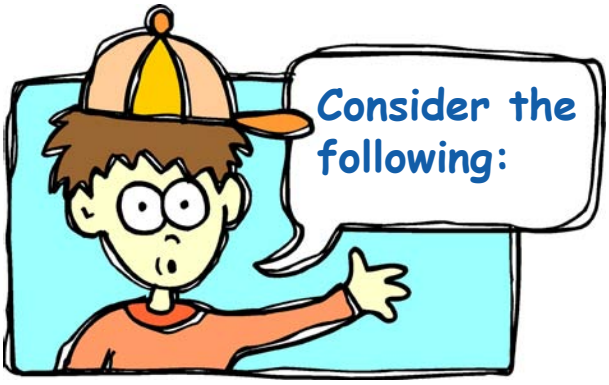
Cammie's parents are tired after a busy day. They expect to have a good sleep tonight and do not plan to get up to check Cammie's blood sugar during the night. They have recently done some blood sugar checks at about 3 o'clock in the morning and are confident that Cammie's blood sugars will be ok on her current dose of Levemir insulin.

BC Children's Hospital © 2009 - BCCH1410

Are You Ready for Basal-Bolus Insulin?

There are many advantages to using basal–bolus insulin in diabetes management.

Are you ready to start?



Pros:

What do you see as the main advantages (pros) of basal–bolus insulin?

Cons:

What do you see as the main disadvantages (cons) of basal–bolus insulin?

And:

- ❒ Do you want to improve your blood sugars and have a more flexible lifestyle?
- ❒ Are both you and your parents interested?
- ❒ Are you already in the habit of checking blood sugars at least 4 times a day and do you keep records?
- ❒ Do you make adjustments to insulin based on patterns in blood glucose?
- ❒ Do you want to learn more about insulin dose adjustment to improve blood sugars and gain flexibility?
- ❒ Do you follow a meal plan and/or count carbohydrates?
- ❒ Have you thought about how insulin will be given at school?
- ❒ Have you considered the cost of Lantus or Levemir insulin compared to NPH?
- ❒ Are you willing to maintain regular contact with your diabetes team, especially during the first few weeks after you start on basal–bolus insulin?
- ❒ In your opinion, do the pros of basal–bolus insulin outweigh the cons?

If you answer YES to most of the questions on this page, this could be a good time to start on a basal–bolus plan. Talk to your diabetes team and continue with your reading about basal–bolus insulin.

If you do <u>not</u> answer YES to most of the questions on this page, you may not yet be ready to start basal–bolus insulin. However, if you are interested in basal–bolus insulin, there are things you can do to get ready. Discuss this with your diabetes education team and make a plan.

BC Children's Hospital © 2009 - BCCH1410

Getting the Most Benefit from Basal-Bolus Insulin

In order to get the most benefit from your new basal–bolus insulin plan, you will need to:

- ❒ Give insulin several times each day.
- ❒ Check your blood sugar before each meal and at bedtime.
- ❒ Match your rapid-acting insulin doses with the food you eat.
- ❒ Check your blood sugar two hours after eating often enough to know if your insulin dose and food are well matched.
- ❒ Do some blood sugar checks at about 3:00 am.
- ❒ Record your blood sugars and other important information.
- ❒ Use information from blood sugar checks to make decisions about adjustments for insulin, activity and/or food.
- ❒ Stay in touch with your diabetes team, especially during your first couple of weeks on basal–bolus insulin.
- ❒ Work with your diabetes team to develop your knowledge, confidence and skills for using basal–bolus therapy.

✓ Checklist for Learning:

- ❒ Learn insulin dose adjustments for pattern management.
- ❒ Work with a dietitian to develop the knowledge you need for healthy eating and maintaining a healthy body weight.
- ❒ Learn carbohydrate counting. If you do not know how to carbohydrate count but you want more flexibility with your food, you will need to learn. Plan to see a dietitian or attend a carbohydrate counting workshop. You can also read our *Carbohydrate Counting* handout.
- ❒ Learn how to use an Insulin:Carbohydrate Ratio when you are making insulin dose adjustments for changes in food.
- ❒ Learn how to match insulin doses to changes in food and/or activity.
- ❒ Learn how to use a Correction Factor or an Insulin Scale to respond to blood sugars outside of the goal range.
- ❒ Review your blood sugar records to see how well your insulin doses, Insulin:CHO Ratios, and Correction Factors are working.

Learn as much as possible **before** starting on your basal–bolus insulin plan.

BC Children's Hospital © 2009 - BCCH1410

Guidelines for Basal-Bolus Insulin Dose Adjustments with Lantus or Levemir and Rapid-Acting Insulin

Adjusting insulin for a basal-bolus insulin plan includes:

1. adjusting basal insulins (Lantus or Levemir) and/or bolus insulins (Humalog or NovoRapid) based on **patterns** in blood sugars
2. adjusting rapid-acting insulin to quickly bring down high blood sugars by using a **Correction Factor** or an **Insulin Scale**
3. adjusting rapid-acting insulin to match food by using an **Insulin:CHO Ratio** (CHO=carbohydrate)
4. adjusting insulins for physical activity or other events

Your diabetes doctor and nurse will work with you initially to help establish the baseline doses for your Lantus or Levemir and rapid insulins. However, it is also important to learn to adjust insulin yourself. Talk to your diabetes nurse educator or attend a workshop to learn more about adjusting insulin.

The following information provides some general guidelines for adjusting insulin based on patterns in blood sugars. There are also several examples of how to calculate the amount of rapid-acting insulin to give for high blood sugar or carbohydrate-containing food. Several questions are included so you can practice figuring out insulin doses on your own. The guidelines and examples included in this handout are not meant to replace other education sessions or the advice of your doctor.

Note:** In this handout the term ***rapid insulin refers to rapid-acting insulin. There are three types of rapid-acting insulin available in Canada: NovoRapid, Humalog and Apidra.

BC Children's Hospital © 2009 - BCCH1410

Insulin Dose Adjustments Guidelines for Pattern Management

Pattern management involves adjusting insulin doses based on patterns in blood glucose. A pattern is a consistent trend where the blood sugar is either too high or too low at the same time of day, or in the same situation for several days in a row. For example, if the blood sugar is fine each day before dinner but it is too high for three days in a row before the bedtime snack, you can say there is a pattern of high blood sugar before bed. To change this pattern, it is important to think about which insulin is having the greatest effect at the time the blood sugar is too high (e.g. before the bedtime snack.)

The following guidelines briefly highlight points to consider when making insulin dose adjustments based on patterns in blood glucose. For a more detailed description of insulin dose adjustments, see our handout *Guidelines for Insulin Adjustment*.

General Guidelines:

- Know your blood sugar goals
- If blood sugars are not in target (goal) range, consider reasons
- Look for ***patterns*** (trends in blood sugars over about 3 days)
- Decide which insulin needs to be adjusted
- Adjust for low blood sugars first
- When blood sugars are outside of the goal range at more than one time of day, fix the first "problem" first. (For example, if the blood sugar is high before lunch and before dinner, start by adjusting insulin to lower the blood sugars before lunch.)
- If all sugars are high, begin with improving the blood sugar before breakfast
- Change 1 insulin at a time
- Always assess the effect of dose changes
- Call your diabetes health professional when you need help

Questions to ask yourself when you are making adjustments for patterns:

- When is your blood sugar outside of the goal range?
- Is your blood sugar too high or too low at this time?
- Which insulin has the greatest effect on the blood sugar at this time?
- Does the insulin need to be changed, or would it be more suitable to make changes to your diet or activity?
- Does the dose need to be increased or decreased?

REMINDER: Insulin doses change over time. If you see patterns of high or low blood sugars, you also need to consider if your basal insulin needs to be changed and/or if your Correction Factor, Insulin Scale or Insulin:CHO Ratios need to be changed.

BC Children's Hospital © 2009 - BCCH1410

Know Which Insulin Has the Greatest Effect on Each Blood Sugar

In order to adjust insulin doses, you need to know which insulin has the greatest effect on each blood sugar.

NOTE: The following chart shows which insulin has the greatest effect on each blood sugar for a person who takes **Lantus or Levemir ONCE A DAY in the evening** (at bedtime or at dinner) and rapid insulin (NovoRapid, Humalog or Apidra) before meals.

INSULIN	AFFECTS	BLOOD SUGAR
• **Evening Basal** (Lantus or Levemir)	»	• **Overnight** • **Before Breakfast**
• **Breakfast Rapid** (NovoRapid, Humalog or Apidra)	»	• **2 hours after breakfast** • **Before Lunch**
• **Lunch Rapid** (NovoRapid, Humalog or Apidra)	»	• **2 hours after lunch** • **Before dinner**
• **Dinner Rapid** (NovoRapid, Humalog or Apidra)	»	• **2 hours after dinner** • **Before bed**

NOTE: It is common for Levemir to be given two times a day (morning and evening). The morning Levemir has its greatest effect on the blood sugar before dinner. See the following BONUS QUESTIONS for more information about using Levemir two times a day.

Check your understanding

Answer the questions on the next pages to check your understanding of insulin action.

BC Children's Hospital © 2009 - BCCH1410

CHECK YOUR UNDERSTANDING:

The following questions include examples of blood sugar records for a person who takes **Lantus or Levemir ONCE A DAY in the evening (at dinnertime or at bedtime)** and **rapid-acting insulin before breakfast, lunch and dinner**. This person does not usually snack between meals.

QUESTIONS:

1. Which insulin has the greatest effect on the blood sugar before dinner?

2. Which insulin has the greatest effect on the blood sugar before breakfast?

3. Look at the following blood sugar record and decide which insulin needs to be changed. In this example, you can assume the amounts of activity and food are similar each day.

DATE	BLOOD SUGAR						
	Before Breakfast	After Breakfast	Before Lunch	After Lunch	Before Dinner	After Dinner	Before Bed
MONDAY	6.3	9.3	5.2		5.1		13.6
TUESDAY	8.2		6.9		4.9	13.9	12.5
WEDNESDAY	5.7		4.8		6.0		13.1

4. Look at the following blood sugar record and decide which insulin needs to be changed. In this example, you can assume the amounts of activity and food are similar each day.

DATE	BLOOD SUGAR						
	Before Breakfast	After Breakfast	Before Lunch	After Lunch	Before Dinner	After Dinner	Before Bed
MONDAY	3.3	12.7	6.2		6.1		7.3
TUESDAY	3.8	10.1	6.9		4.9	9.2	6.5
WEDNESDAY							

BC Children's Hospital © 2009 - BCCH1410

5. Look at the following blood sugar record and decide which insulin needs to be changed. In this example, you can assume the amounts of activity and food are similar each day.

DATE	BLOOD SUGAR						
	Before Breakfast	After Breakfast	Before Lunch	After Lunch	Before Dinner	After Dinner	Before Bed
MONDAY	6.1		16.2		10.9		6.1
TUESDAY	5.8	18.1	14.9		8.1	9.2	4.5
WEDNESDAY	4.9	13.7	12.8		7.0		7.2

6. Look at the following blood sugar record and decide which insulin needs to be changed. In this example, you can assume the amounts of activity and food are similar each day, except for Tuesday morning when there was more exercise than usual.

DATE	BLOOD SUGAR						
	Before Breakfast	After Breakfast	Before Lunch	After Lunch	Before Dinner	After Dinner	Before Bed
MONDAY	6.1	10.3	6.5	14.0	12.8	9.2	5.8
TUESDAY	5.8		2.7		14.7		6.5
WEDNESDAY	4.9		5.8	13.4	13.2		4.2

ANSWERS:

1. The rapid insulin given at lunch has the greatest effect on the blood sugar before dinner.
2. The evening Lantus or Levemir has the greatest effect on the blood sugar before breakfast.
3. The rapid insulin at dinnertime needs to be changed. (More insulin is needed. There is a pattern of high blood sugars before bed.)
4. The evening Levemir or Lantus needs to be changed. (Less insulin is needed. The blood sugar before breakfast has been low for two days in a row.)
5. The rapid insulin before breakfast needs to be changed. (More insulin is needed. There is a pattern of high blood sugars after breakfast and before lunch.)
6. The rapid insulin before lunch needs to be changed. (More insulin is needed. There is a pattern of high blood sugars before dinner.)

BC Children's Hospital © 2009 - BCCH1410

BONUS QUESTIONS:

When and why is basal insulin given two times a day?

Levemir is a basal insulin that is given one or two times a day depending on the amount that is given and how long it lasts. For some people, Levemir lasts up to 24 hours and can be given once a day in the evening. For other people, Levemir does not last 24 hours and needs to be given twice a day – once in the morning and once in the evening at dinner or bedtime.

Tip: One way to tell if Levemir is needed in the morning is to look at the blood sugars after lunch and before dinner. If the blood sugars are always ok two hours after lunch and high before dinner it may mean that a morning dose of Levemir is needed.

Answer the following bonus questions to learn more about using Levemir insulin TWO TIMES a day.

1. Is rapid insulin still needed if Levemir is given two times a day (once in the morning and once in the evening)?

2. Tina is on Levemir insulin once a day at bedtime. She also gives NovoRapid before breakfast, lunch and dinner. Most days she does not eat an afternoon snack, but when she does she gives NovoRapid to cover the carbohydrate in her snack. Review Tina's blood sugar record and answer the following question:

Does Tina need Levemir in the morning as well as the evening? Why?

DATE	BLOOD SUGAR							
	Before Breakfast	After Breakfast	Before Lunch	After Lunch	Before Dinner	After Dinner	Before Bed	During Night
May 4	5.2		6.4	8.0	12.1		7.2	
Insulin →	*NovoRapid 3*		*NovoRapid 5*		*NovoRapid 7*		*Levemir 16*	
May 5	6.0	8.2	4.9	6.8	11.8		6.5	
Insulin →	*NovoRapid 3*		*NovoRapid 5*		*NovoRapid 6*		*Levemir 16*	
May 6	5.3		5.8	7.1	12.9		6.3	
Insulin →	*NovoRapid 3*		*NovoRapid 5*		*NovoRapid 7*		*Levemir 16*	
May 7	4.6	9.1	8.5	8.2	13.3		8.2	
Insulin →	*NovoRapid 3*		*NovoRapid 6*		*NovoRapid 7*		*Levemir 16*	

BC Children's Hospital © 2009 - BCCH1410

3. Review the following blood sugar record. Which insulin needs to be adjusted and why?

DATE	BLOOD SUGAR							
	Before Breakfast	After Breakfast	Before Lunch	After Lunch	Before Dinner	After Dinner	Before Bed	During Night
June 8	12.7		7.9	8.2	5.9		6.9	12.3
Inuslin →	*NovoRapid 6 Levemir 8*		*NovoRapid 4*		*NovoRapid 7*		*Levemir 8*	
June 9	13.2		8.7	10.1	7.3		8.0	
Insulin →	*NovoRapid 6 Levemir 8*		*NovoRapid 4*		*NovoRapid 8*		*Levemir 8*	
June 10	11.9		6.3	7.2	4.9		5.9	
Insulin →	*NovoRapid 5 Levemir 8*		*NovoRapid 4*		*NovoRapid 6*		*Levemir 8*	
June 11	12.5		5.9		6.0			
Insulin →	*NovoRapid 6 Levemir 8*		*NovoRapid 3*		*NovoRapid 8*		*Levemir 8*	

ANSWERS:

1. Yes. Rapid insulin is still needed for meals and some snacks that contain carbohydrate. Remember, basal-bolus insulin plans include two types of insulin: basal insulin such as Levemir and bolus insulin such as NovoRapid. Basal insulin is the long acting background insulin that is needed 24 hours a day. It helps keep blood sugars in a healthy range between meals and during the night when no food is eaten. Rapid insulin is needed to cover sugar that comes from food and drinks.

2. Yes. Tina needs Levemir in the morning before breakfast. Her blood sugar is ok after lunch but it is high every day before dinner even though she does not eat an afternoon snack. This means her NovoRapid insulin is working well to cover her lunch but her evening Levemir is not lasting long enough to help with the blood sugars in the late afternoon. Adding a morning dose of Levemir should help with her blood sugar before dinner. She will still need Levemir in the evening to help with the blood sugars overnight and before breakfast.

3. The evening Levemir needs to be increased to lower the blood sugar before breakfast.

BC Children's Hospital © 2009 - BCCH1410

Rapid-Acting Insulin for Carbohydrate and High Blood Sugar

Rapid-acting insulin that is given to cover carbohydrate is called a **Carbohydrate Bolus** (or a ***Carb Bolus*** or ***Meal Bolus***). Rapid-acting insulin that is given for a high blood sugar is called a **Correction Bolus** or a ***Correction Dose***. Carbohydrate Boluses and Correction Boluses are calculated separately, but they may be given at the same time. For example, if the blood sugar is high before breakfast, a Correction Bolus would be given in addition to a Carbohydrate Bolus.

Carbohydrate (CHO) Boluses for Meals and Snacks:

- An **Insulin:CHO Ratio** can be used to decide on the amount of rapid-acting insulin to give for carbohydrate-containing meals or snacks. An Insulin:CHO Ratio estimates the amount of insulin that is needed to cover a specific amount of carbohydrate. For example a ratio of 1:15 means that 1 unit of rapid-acting insulin is needed for every 15 grams of carbohydrate. Some people need a different ratio for specific meals and snacks. For example, it is common to need more rapid insulin to cover carbohydrate eaten at breakfast than at lunch. It is also quite common to use a smaller amount of rapid insulin for bedtime snacks.

The formula for calculating how much rapid-acting insulin to give for carbohydrate (CHO) is:

$$\frac{\text{Total Amount of CHO to be Eaten}}{\text{Amount of CHO Covered by 1 Unit (the Insulin:CHO Ratio)}}$$

I can do this!

Example 1:

Total carbohydrate to be eaten at breakfast = 48 grams
Insulin:CHO Ratio = 1:15 (1 unit of rapid-acting insulin for every 15 grams of carbohydrate)

$$\frac{\textbf{48 grams}}{\textbf{15 grams}} = \textbf{3.2 units (round down to 3 units)}$$

Example 2:

Total carbohydrate to be eaten at dinner = 70 grams
Insulin:CHO Ratio = 1:10 (1 unit of rapid-acting insulin for every 10 grams of carbohydrate)

$$\frac{\textbf{70 grams}}{\textbf{10 grams}} = \textbf{7 units}$$

Note: Fine-tuning your Insulin:CHO ratio can be done after your basal insulin dose is set and when you are correctly counting carbohydrates. You can find out how well an Insulin:CHO ratio is working by checking your blood sugars 2 hours after eating.

BC Children's Hospital © 2009 - BCCH1410

Correction Boluses for High Blood Sugars:

Correction Formula:

The formula for calculating Correction Boluses for high blood sugar is:

$$\text{Correction Bolus} = \frac{\text{Current Blood Sugar - Target Blood Sugar}}{\text{Correction Factor}}$$

Example:

Current blood sugar = 12

Target blood sugar = 6

Correction Factor = 2

$$\frac{12-6}{2} = 3 \text{ units}$$

Another way to think about how much rapid insulin to give in this example is to add 1 unit of insulin for every 2 mmol/L that the blood sugar is above the target blood sugar of 6.

Guidelines and Cautions for using Correction Boluses:

- Check blood sugar 2-3 hours after giving a Correction Bolus to see how well it has worked.
- Do NOT give a Correction Bolus if blood sugar is less than your target blood sugar.
- Do NOT correct if it has been less than 2 hours since your last Correction Bolus.
- If a Correction Bolus is given between meals, the dose may need to be lower than usual.
- You may need a larger Correction Bolus than usual if you also have ketones. If you are sick and have ketones, follow the guidelines for sick-day management. Please see our handout *Managing Sick Days and Preventing Ketoacidosis*.
- Always THINK before you give a Correction Bolus. Consider the food and activity that you are planning as these will also affect the blood sugar.

Note: For more information on Correction Boluses see our handout *What Are a Correction Factor, Correction Bolus, and Insulin Scale*?

BC Children's Hospital © 2009 - BCCH1410

Combining Carbohydrate Boluses and Correction Boluses:

Sometimes both a Carbohydrate Bolus and a Correction Bolus are needed at the same time. To decide on the total amount of rapid-acting insulin to give, use your:

1. **Insulin:CHO Ratio to decide on a Carbohydrate Bolus**

   and your

2. **Correction Formula to decide on a Correction Bolus.**

Carbohydrate Bolus + Correction Bolus = Total Dose of rapid insulin before meal

Example:

Insulin:CHO Ratio = 1:15 (1 unit for every 15 grams of CHO)
Total carbohydrate to be eaten at breakfast = 30 grams

Carbohydrate Bolus = $\frac{\textbf{30 grams}}{\textbf{15 grams}}$ = 2 units rapid insulin

AND

Pre-meal blood sugar = 14
Target blood sugar = 7
Correction Factor = 2

Correction Bolus = $\frac{\textbf{(14-7)}}{\textbf{2}} = \frac{\textbf{7}}{\textbf{2}}$ = 3½ units rapid insulin

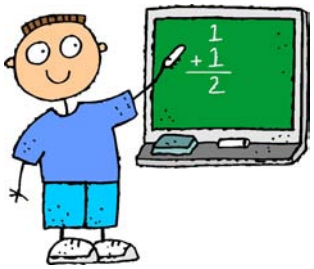
Therefore, you need IN TOTAL:

2 units (for CHO) + 3½ units (to correct for high blood sugar) = total dose of 5½ units of rapid-acting insulin before eating.

Note: It is important to consider the amount of insulin you are using as basal insulin and the amount you are using as bolus insulin. The basal insulin dose (Lantus or Levemir) usually makes up about half (50%) of the total daily insulin dose. Bolus doses of rapid-acting insulin make up the other half (50%) of the total daily insulin dose. Some people need a bit more or less basal insulin but it is usually in the range of 40–60% of the total daily insulin dose. If you find that you frequently need to give Correction Boluses, it may be a sign that your basal insulin dose needs to be changed or it could mean that your Correction Factor or Insulin:CHO ratios need to be changed.

BC Children's Hospital © 2009 - BCCH1410

Practice Insulin Dose Calculations for Boluses of Rapid-Acting Insulin



Here are some examples for you to practice calculating how much rapid insulin to give for high blood sugars or food. Remember:

1. Calculate a Correction Bolus if the blood sugar is **above** the target or goal range
2. Calculate a Carbohydrate Bolus as needed for planned carbohydrate intake
3. Also consider other factors such as planned exercise or the presence of ketones.

Example 1:

Target Blood Sugar = 8. **(Give a Correction Bolus if blood sugar is above target.)**

Insulin:CHO Ratio = 1:30

Correction Factor = 4

Current Blood sugar = 14.2

Planned Carbohydrate Intake = 40 grams

How much insulin would you give?

Example 2:

Target Blood Sugar = 8. **(Give a Correction Bolus if blood sugar is above target.)**

Insulin:CHO Ratio = 1:20

Correction Factor = 3

Current Blood sugar = 5.3

Planned Carbohydrate intake = 45 grams

How much insulin would you give?

Example 3:

Target Blood Sugar = 7.

Insulin:CHO Ratio = 1:10

Correction Factor = 2

Current Blood sugar = 19.6

No Ketones

Planned Carbohydrate Intake = None

How much insulin would you give?

Example 4:

Target Blood Sugar = 8.

Insulin:CHO Ratio = 1:40

Correction Factor = 14

Current Blood sugar = 12.9

No ketones

Planned Carbohydrate intake = 20 grams

How much insulin would you give?

BC Children's Hospital © 2009 - BCCH1410

Example 5:

Target Blood Sugar = 6 (Give a Correction Bolus if blood sugar above target.)

Insulin:CHO Ratio = 1:15

Correction Factor = 3

Current Blood Sugar = 4.3

Planned Carbohydrate Intake = 62 grams

How much insulin would you give?

Example 6:

Goal Blood Sugar Range: 4 to 8 (Give a Correction Bolus if blood sugar above goal range (above 8)).

Insulin:CHO Ratio = 1:30

Correction Factor = 3.5

Current Blood Sugar = 7.3

Planned Carbohydrate Intake = 15 grams

How much insulin would you give?

Example 7:

Goal Blood Sugar Range = 4 to 7

Insulin:CHO Ratio = 1:10

Correction Factor = 3

Current Blood Sugar before breakfast = 6.9

Planned Carbohydrate Intake = 50grams

Planned Activity: 1 hour strenuous activity after breakfast.

How much insulin would you give?

BC Children's Hospital © 2009 - BCCH1410

Answers to Practice Insulin Dose Calculations

Example 1:

Correction Bolus: $\frac{(14.2-8)}{4} = \frac{6.2}{4}$ = 1.55 units (round down to 1.5 units)

Carb Bolus: $\frac{40}{30}$ = 1.3 units (round down to 1 unit) **Answer: 1.5 + 1 = 2.5 units (2½ units)**

Example 2:

Correction Bolus: No Correction Bolus is needed, because the blood sugar is not above the target.

Carb Bolus: $\frac{45}{20}$ = 2.25 units (round down to 2 units) **Answer: 0 + 2 = 2 units**

Example 3:

Correction Bolus: $\frac{(19.6-7)}{2} = \frac{12.6}{2}$ = 6.3 units (round down to 6 units)

Carb Bolus: No Carb Bolus is needed, because no carbohydrate is going to be eaten.

Answer: 6 + 0 = 6 units

Example 4:

Correction Bolus: $\frac{(12.9-8)}{14} = \frac{4.9}{14}$ = 0.35 unit (The Correction Dose is less than ½ unit and is too small to measure with an insulin pen or syringe. Do not give a Correction Bolus)

Carb Bolus: $\frac{20}{40}$ = 0.5 (½ unit) **Answer: 0 + 0.5 = 0.5 unit (½ unit)**

Example 5:

Correction Bolus: No Correction Bolus is needed, because the blood sugar is not above the target.

Carb Bolus: $\frac{62}{15}$ = 4.13 units (round down to 4 units) **Answer: 0 + 4 = 4 units**

Example 6:

Correction Bolus: No Correction Bolus is needed, because the blood sugar is in the goal range.

Carb Bolus: $\frac{15}{30}$ = 0.5 (½ unit) **Answer: 0 + ½ = ½ unit**

BC Children's Hospital © 2009 - BCCH1410

Example 7:

Correction Bolus: No Correction Bolus is needed, because the blood sugar is in the goal range.

Carb Bolus: $\frac{\mathbf{50}}{\mathbf{10}}$ = 5 units

BUT: this needs to be further reduced because intense exercise will take place after breakfast. If this is the first time trying a period of intense activity, it would be appropriate to reduce the Carb Bolus by 50% to prevent hypoglycemia. A blood sugar check should be done after the activity is complete and again before lunch to assess how well the dose of rapid-acting insulin matched the planned food and activity level. Through a process of "trial and evaluation" it is possible to determine how much to reduce the dose of rapid-acting insulin for planned physical activity.

Answer: Given the planned activity, 2½ units will be given instead of the amount that would usually be given for 50 grams of carbohydrate.

BC Children's Hospital © 2009 - BCCH1410

Congratulations and Next Steps




CONGRATULATIONS

on reviewing the information and completing the practice exercises for basal–bolus insulin with MDI.

If you are ready to start on basal–bolus insulin, the next step is to meet with your diabetes doctor or nurse to:

- Pick a date to start your basal–bolus insulin plan.
- Decide on starting doses for your basal and bolus insulins.
- Make a specific plan for each insulin that you need to give on your ***switch-over*** or ***start*** day.
- Make a plan to follow up with your diabetes team who can help you fine-tune your basal-bolus insulin plan.

When you meet with your diabetes educator or doctor they may give you the following additional handouts:

- a basal–bolus record sheet to keep track of your blood sugars, insulin, and carbohydrate (see our handout *Multiple Daily Injection Log*)
- a Start Day handout with specific insulin doses to be used on the day you switch to a basal–bolus plan
- a handout that includes your estimated Insulin:CHO Ratios, Correction Factor, your initial dose of basal insulin and some instructions for the first 1–2 weeks on your new insulin plan
- a *Bolus Calculator* spreadsheet
- an Insulin Scale if you will be using one (see our handout *Insulin Sliding Scale for MDI*)




BC Children's Hospital © 2009 - BCCH1410