



# **Managing your diabetes with insulin pump therapy**

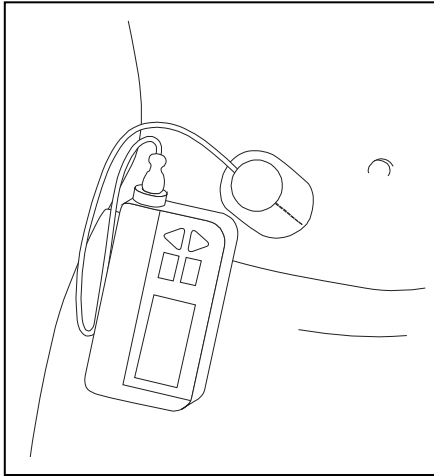


**A guidebook from the Pediatric Diabetes Team  
at McMaster Children's Hospital**

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## Learning about insulin pump therapy

### How does an insulin pump work?



- The pump is a small battery-powered device worn outside your body.
- Inside the pump is a reservoir that holds rapid acting insulin. The pump moves insulin from the reservoir through the infusion set (a thin tube leading to a straw-like cannula) placed under your skin.
- You set the pump to continually deliver a small amount of insulin, during the day and night. When you eat, you give extra insulin to match the carbohydrates in your meals and snacks.

### What is basal insulin?

Basal insulin is a small amount of rapid-acting insulin delivered continuously, 24 hours a day. Basal insulin keeps your blood glucose in the target range between meals and while you sleep. It is also called background insulin.

Your diabetes team will help you program your pump to deliver a certain amount of basal insulin each hour. This is called the **basal rate**.

You will learn to adjust the basal rate to meet your needs. For example:



Reducing the basal rate when you are physically active, so that your blood glucose does not get too low.



Increasing the rate when you are sick or have an infection, so that your blood glucose does not get too high.

## What is bolus insulin?

A bolus is a larger amount of insulin, given over a short time.

There are two reasons to give a bolus dose:

- When you eat, you program your pump to deliver a bolus of insulin that matches the amount of carbohydrate in your meal or snack.
- If your blood glucose is too high, you may need to give yourself a 'correction bolus' to lower your blood glucose.

## What happens overnight?



Your insulin pump will continue working while you sleep. When you go to bed, put your pump beside you, or under your pillow.

Your diabetes team will work with you to set an overnight basal rate that will help reduce low or high blood glucose in the morning.

## What should I do at school?

Tell your teachers and school staff that you are using an insulin pump. Give them instructions so they know what to do if there are any problems. Update your diabetes management plan.

Leave some pump supplies at the school, including:

- an infusion set
- alcohol wipes
- an insulin syringe or pen (in case your infusion set isn't working)
- batteries
- the phone number of your parent(s) or guardian

## Goals for insulin pump therapy

### 1. Blood glucose and A1C levels are in the target range for your age

Age	A1C	Blood glucose (before meals)
Less than 5 years	8 % or less	6 to 10 mmol/L
5 to 12 years	7.5 % or less	4 to 10 mmol/L
Older than 12 years	7 % or less	4 to 7 mmol/L

### 2. Less hypoglycemia

- Reactions may happen more often at first. Over time, hypoglycemia is less likely to occur with pump therapy.
- Severe hypoglycemic reactions are often prevented.

### 3. Less hyperglycemia

- Blood glucose control is improved because insulin can be matched to the intake of food and production of glucose by the liver.

### 4. No ketones

- Check for ketones when your blood glucose is greater than 13 mmol/L without a good reason or after a correction is given.

### 5. Feeling well and having lots of energy

### 6. Less chance of having complications of diabetes



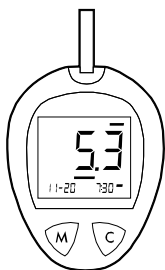
**A consistent routine makes it easier to manage your diabetes. Insulin pump therapy gives you flexibility when there are changes in your daily routine.**

## At pump start

When you first start using your pump you will:

- check your blood glucose often
- follow your carbohydrate targets carefully
- keep very detailed records
- talk with members of your health care team often

## How often do I check my blood glucose?



**At first, you need to check and record your blood glucose often, up to 10 times a day:**

- ✓ before each meal and snack
- ✓ 2 hours after each meal and snack
- ✓ at bedtime
- ✓ at midnight
- ✓ at 3 AM

**Carefully monitoring your blood glucose is the key to successful insulin pump therapy.**

The more you know about your blood glucose levels.



The more you can do to keep your blood glucose levels in the target range.



Leads to better health and fewer health problems later in life.

For the first 2 weeks, you can expect to call your nurse (or your contact person on the health care team) each weekday (Monday to Friday) with your blood glucose results.

- Your nurse or contact person will help you learn how to adjust your insulin.
- If you are unsure why a change is being made, please ask!



## What do I need to keep track of?

### Keeping detailed records makes pump therapy more effective

You will need to keep track of:



- ✓ all blood glucose results, so you can detect patterns
- ✓ basal insulin and all bolus doses
- ✓ amounts of food and carbohydrate
- ✓ all episodes of hypoglycemia
- ✓ ketone results when your blood glucose is greater than 13.0 mmol/L
- ✓ any extra activity
- ✓ any illness
- ✓ other things that might affect your blood glucose levels (such as stressful events or getting your period)
- ✓ when the infusion set is disconnected (this means you are not receiving insulin)
- ✓ site changes

## Pump basics

Only rapid acting insulin is used in an insulin pump.

Rapid acting insulin makes up your:

1. Basal insulin – the background insulin requirements, **and**
2. Bolus insulin – the insulin to cover carbohydrates.

## Your Total Daily Dose (TDD)

Your TDD is the total amount of insulin that you take in a given day. Calculate your TDD by adding up your total daily basal and your total daily bolus doses of insulin.

Total daily basal insulin	+	Total daily bolus insulin	=	Total daily dose of insulin
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Your TDD remains fairly steady from day to day. There will be small changes related to your activity and carbohydrate intake. Over time, it may change as your weight, lifestyle or metabolism changes.

**Basal insulin:** 40% to 60% of your TDD is usually given as basal insulin

**Bolus insulin:** 40% to 60% of your TDD is usually given as bolus insulin

## Your Insulin Sensitivity Factor (ISF)

Your ISF is the amount your blood glucose will drop by giving one unit of insulin without food. You and your doctor will determine your ISF.

If your blood glucose is high, use your ISF to calculate how much insulin will bring it down to your target range. This 'correction bolus' is given through your pump. If you are not sure whether your pump site is working, give yourself the correction bolus with a syringe or insulin pen.



**For good blood glucose control:**



Review your records regularly.

Look for patterns in your blood glucose results:

- Are there times in the day or night when you are high or low?
- How does your blood glucose respond to food, activity and illness?

Adjust your basal and/or bolus insulin as needed.

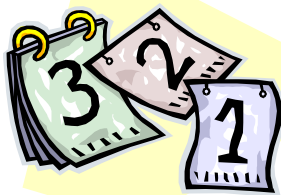
**Always try to be proactive (prevent problems)  
instead of reactive (correct problems).**

## Taking care of your pump

**Regularly check:**

- ☐ The supply of insulin in the pump reservoir. Always fill the reservoir with insulin at room temperature.
- ☐ The battery level. Replace batteries right away when they are low.
- ☐ The skin around the needle. Watch for signs of infection (redness and swelling).
- ☐ The tubing. It should be clear with no air bubbles, not kinked and connected to the pump and cannula.
- ☐ The cannula. It should be firmly in place.

## Rotating sites



**Change the infusion set every 2 or 3 days and move it to a new site.**

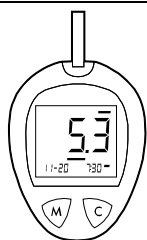
**Rotating sites helps to make sure that insulin will be absorbed properly.**

Your abdomen and buttocks are the preferred sites for your pump. In these areas, insulin is absorbed quickly and evenly, leading to better blood glucose control.

Preferred sites:	Sites to avoid:
<ul style="list-style-type: none"><li>✓ abdomen</li><li>✓ buttocks</li></ul>	<ul style="list-style-type: none"><li>✗ around the waistline or underwear lines</li><li>✗ within a 2-inch circle around the belly button</li><li>✗ any place where clothing will rub</li></ul>

To make sure the infusion set is placed and working properly, plan site changes:

- ✓ early in the day on weekends, or
- ✓ after school weekdays



**Test your blood glucose 2 hours after all site changes.**

If irritation occurs, change the infusion set right away.

For more information, refer to your pump manual.

# Hypoglycemia

## Preventing hypoglycemia

1. Eat meals and snacks on time and stick to your meal plan.
2. Review your log book regularly to look for patterns in your blood glucose – either above or below your target range.
3. If there is a pattern of low blood glucose for 2 days that cannot be explained by activity or diet, reduce your basal rate or bolus insulin following the guidelines from your diabetes team.
4. Plan extra activity carefully. You will need to adjust your insulin and/or have extra food at the time of the activity.
5. Check your blood glucose at midnight and 3 am to watch for hypoglycemia overnight.

## Recognizing mild hypoglycemia

1. Whenever possible, check your blood glucose when you feel low.
2. Make sure your family, friends, teachers and coaches know what to watch for (signs of hypoglycemia) and what to do.
3. Wear a medic alert bracelet or necklace at all times.



**Check your blood glucose  
when you feel low.**

## Treating mild hypoglycemia

1 tablespoon = 15 ml  
 ½ cup = 125 ml  
 1 oz = 30 grams

### Step 1

- Stop what you are doing.
- Use the chart to choose the type of carbohydrate and how much to take, based on your weight.

		Under 33 lb (under 15 kg)	33 to 66 lb (15 to 30 kg)	Over 66 lb (over 30 kg)
Amount of carbohydrate		5 gm	10 gm	15 gm
Type of carbohydrate	4 gm glucose tablets	1	2 or 3	4
	3 gm dextrose tablets	2	3	5
	Juice or Regular pop	1 ½ oz (45 ml)	3 oz (90 ml)	6 oz (180 ml or ¾ cup)

### Step 2

- Sit down and rest for 10 to 15 minutes. Then recheck your blood glucose level.
- If your blood glucose is still less than 4 mmol/L, repeat Step 1.



If you have hypoglycemia **just before a meal or snack**, treat it as described in Steps 1 and 2 and then have your regularly planned meal or snack and insulin bolus.

If your **next meal or snack is more than an hour away**, also have a snack with a starch and protein such as:

- ☐ ½ cup (125 ml) of milk and 2 plain cookies
- ☐ ½ cup (125 ml) of milk with ½ cup (125 ml) cereal
- ☐ 6 crackers with 1 oz (30 g) of cheese
- ☐ 1 slice of bread with 1 tbsp (15 ml) peanut butter or 1 oz (30 g) of cheese.

**If you are not able to test your blood glucose, treat your symptoms right away.**

## Managing persistent hypoglycemia

Persistent hypoglycemia is when you have several low blood glucose levels in a row during the day, despite treating them correctly.

Set a temporary basal rate that is reduced by 70% to 90% for 2 hours.

## Treating severe hypoglycemia

**These instructions are for  
parents or others to follow if  
you have severe hypoglycemia**

1. Turn your child on his/her side.
2. Check your child's blood glucose.
  - If your child has low blood glucose and is unable to swallow safely, is having a seizure or has passed out, give glucagon.
3. Prepare the glucagon.
4. Give the glucagon.
  - Choose the injection site (buttocks, upper and outer thigh, or the fatty part of the back of the upper arm).
  - Pinch up the skin and insert the needle straight in at 90° (the same way as giving insulin).
  - Push the plunger in to give the glucagon.
    - ☐ If your child is **less** than 5 years old or weighs **less** than 20kg (44 lbs), **give ½ of the glucagon** (0.5 ml = 500 mcg).  
If you give more than ½, there is no danger from overdose.
    - ☐ If your child is **more** than 5 years old or weighs **more** than 20 kg (44 lbs), **give all of the glucagon** (1 ml = 1000 mcg).
  - Remove the needle from the skin.
5. Call 911 to get medical help.
6. Suspend pump.



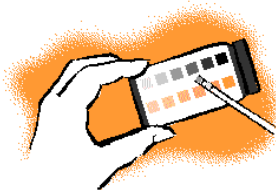
**Call 911 and stay with your child.  
Keep your child on his or her side.**

# Hyperglycemia

## Preventing hyperglycemia

1. Check your blood glucose before each meal and at bedtime.
2. Do not disconnect or suspend your pump for more than 1½ to 2 hours. Interrupting the flow of insulin can cause your blood glucose to quickly rise.
3. Check the infusion site often during the day. Make sure the tubing doesn't get disconnected or kinked. Check that your pump has a basal rate for 24 hours.

### When your blood glucose is high:



- Check for ketones.
- Make sure your pump and infusion set are working properly.

## Managing hyperglycemia

1. If your blood glucose is above your target give a correction bolus right away, based on your Insulin Sensitivity Factor (ISF).
2. Check your blood glucose again in 2 hours.
3. If there is no improvement, give insulin using a pen or syringe and change your infusion set.
4. Check blood glucose again in 2 hours to make sure the blood glucose is coming back down.

**You may need to give an extra bolus (correction bolus) as often as every 4 hours, when your blood glucose is greater than 13 mmol/L with or without ketones.**

## Adjusting insulin

During the first two weeks with your pump, your nurse (or contact person on the health care team) will help you learn to adjust your insulin. When you are ready to manage on your own, follow these step-by-step instructions to adjust your insulin during the day and night, when blood glucose levels are not in the target range. Starting at Step 1, do each step for 3 days in a row to look for a pattern in your blood glucose levels. It may take up to 2 weeks to do all 5 steps for a full evaluation.

**BG = Blood glucose**

Time period and directions	When to check blood glucose	Evaluating your results
<b>Step 1</b>  <b>Overnight:</b> <ul style="list-style-type: none"> <li>• Eat an early dinner (don't forget your bolus!)</li> <li>• Eat no carbs afterwards</li> <li>• Begin evaluation at bedtime</li> </ul>	<ul style="list-style-type: none"> <li>• Bedtime</li> <li>• Midnight</li> <li>• 3 am</li> <li>• Upon waking</li> </ul>	<p>After 3 days of testing:</p> <ul style="list-style-type: none"> <li>• Basal rates are correct if BG does not increase or decrease more than 2 to 3 mmol/L during evaluation.</li> </ul> <p><b>If BG increases:</b></p> <ul style="list-style-type: none"> <li>• Your basal rate needs to be increased 2 to 3 hours before the rise in BG.</li> </ul> <p><b>If BG decreases:</b></p> <ul style="list-style-type: none"> <li>• Your basal rate needs to be decreased 2 to 3 hours before the drop in BG.</li> </ul>

**When your morning BG is in your target range, you can go to step 2.**



### **For all basal rate changes:**

If BG increases or decreases more than 2 to 3 mmol/L, adjust your basal rate 2 to 3 hours before the BG rise or fall.

Time period and directions	When to check blood glucose	Evaluating your results
<b>Step 2</b>  <b>Breakfast time:</b> <ul style="list-style-type: none"> <li>Check your BG on waking</li> <li>Begin evaluation if BG is in target range for your age</li> <li>Count carbohydrates and bolus <u>before</u> meal</li> <li>No carbohydrates between breakfast and lunch</li> </ul>	<ul style="list-style-type: none"> <li>2 hours after finishing breakfast</li> </ul>	<b>Adjusting bolus</b>  After 3 days of testing: <ul style="list-style-type: none"> <li>If BG within 2 to 3 mmol/L do not adjust bolus.</li> <li>If BG increases or decreases more than 2 to 3 mmol/L, adjust bolus (ratio).</li> </ul>
	<ul style="list-style-type: none"> <li>Before lunch</li> </ul>	<b>Adjusting basal</b>  After 3 days of testing: <ul style="list-style-type: none"> <li>If BG increases or decreases more than 2 to 3 mmol/L, adjust basal rate.</li> </ul>
<b>If BG in target range, go to Step 3</b>		
<b>Step 3</b>  <b>Lunch Time</b> <ul style="list-style-type: none"> <li>Repeat Step 2 between lunch and supper</li> </ul>		
<b>If BG in target range, go to Step 4</b>		
<b>Step 4</b>  <b>Supper Time</b> <ul style="list-style-type: none"> <li>Repeat Step 2 between supper and bedtime</li> </ul>		
<b>If BG in target range, go to Step 5</b>		
<b>Step 5</b>  <b>Bedtime</b> <ul style="list-style-type: none"> <li>Have snack</li> <li>Apply ratio</li> </ul>	<ul style="list-style-type: none"> <li>Check BG 2 hours after</li> </ul>	After 3 days of testing: <ul style="list-style-type: none"> <li>If BG within 2 to 3 mmol/L bolus do not adjust bolus.</li> <li>If BG increases or decreases more than 2 to 3 mmol/L adjust bolus.</li> </ul>



## Your plan for physical activity

Each person reacts differently to activity. You need to review your records carefully to discover how exercise and other physical activities affect your blood glucose. This is the only way to determine what is best for you.

**Check your blood glucose before, during and after activity.**

### With pump on:

- Try to wear your pump during physical activity.
- Check your blood glucose before, during and after activity.
- Depending on your blood glucose results, you may need 15 grams of carbohydrate for every 30 minutes of activity. You do not need insulin for this carbohydrate.
- Another option is using temporary basal rates during and after activity.

### Without pump

- For some activities you may need to disconnect or remove your pump.
- The maximum time you can be off the pump is 1½ to 2 hours.
- Check your blood glucose before, during and after activity.
- Refer to your pump manual for more detailed instructions.

#### Take care



Hyperglycemia after activity may be followed hours later by hypoglycemia.

To find out if this is happening, test your blood glucose:

- before activity,
- during activity,
- right after activity, and
- 4 to 8 hours after the activity.

Check your blood glucose often, until you know the effect of different activities on your blood glucose.

## Your plan for sick days

### Prevent DKA



- ✓ Check your blood glucose early and often during an illness
- ✓ Give extra insulin if needed to stop the production of ketones



1. **Do not remove your insulin pump**
2. **Check your blood glucose and ketones often**
  - Every 2 to 4 hours during the day and night
3. **Change your infusion set right away when:**
  - Your blood glucose is greater than 13 mmol/L two times in a row, or
  - You have nausea with a high blood glucose.

Always assume that your pump may not be delivering insulin.  
Be prepared to give insulin using a pen or syringe.

4. **Make sure you are taking in enough sugar**

You must always have enough sugar going in to allow insulin to be given safely. Giving insulin without a source of sugar can make your blood glucose dangerously low.

There are three ways to get sugar into your body:

- Your normal diet
- Liquids that contain sugar such as fruit juices, Gatorade®, regular pop, popsicles or jello
- Intravenous glucose (I.V. dextrose) given in the hospital

5. **Try to drink extra water**

- Drinking water can help clear ketones and prevent dehydration.

## 6. Take your usual insulin PLUS a bolus if needed.

You must always have insulin. If you are taking in enough sugar, keep your insulin pump going at the usual rate. Do not remove your insulin pump.

Be prepared to adjust your insulin. You may need more insulin, because insulin may not work as effectively during an illness. The chart below tells you what to do.

You may need to give an extra bolus as often as every 4 hours when your blood glucose is greater than 13 mmol/L, with or without ketones.

Blood Glucose	Ketones		Action
	Urine	Blood	
Greater than 13 mmol/L	Negative or trace	Less than 1 mmol/L	<ul style="list-style-type: none"> <li>Use your correction factor.</li> </ul>
Less than 13 mmol/L	Negative or trace	Less than 1 mmol/L	<ul style="list-style-type: none"> <li>Give the usual insulin at the usual time.</li> <li>Drink fluids that contain sugar if you can't eat your usual foods.</li> </ul>
Greater than 13 mmol/L	Small to large	More than 0.9 mmol/L	<ul style="list-style-type: none"> <li>Give the usual insulin at the usual time, <b>plus</b> 10-20% of your Total Daily Dose (TDD).</li> </ul>
Less than 10 mmol/L	Small to large	More than 0.9 mmol/L	<ul style="list-style-type: none"> <li>Give the usual insulin at the usual time.</li> <li>Drink fluids that contain sugar to raise your blood glucose above 10 mmol/L, so that you can give 10% (only) of your TDD to correct the ketones.</li> <li><b>Note</b> – If you give 10% of your TDD as extra insulin with a normal blood sugar, you can get hypoglycemia.</li> </ul>
Do not give more than 10 extra units of insulin at one time.			
<b>Go to the Emergency Department:</b> <ul style="list-style-type: none"> <li>If you cannot drink or you vomit 2 times in 4 hours, or</li> <li>Ketones are still present after giving extra insulin 2 times in a row</li> </ul>			

## What to do if your pump stops working

or you want to take a “Pump Holiday”

### If your pump stops working:



- Check for problem with pump, tubing, site, delivery. If there is a problem call Customer Service at your pump company to get a replacement pump.
- Always keep a written record of your most current basal rates, daily basal total, correction factor.
- Obtain Lantus<sup>®</sup> from your pharmacy if a pump will not be available in 12 hours. A prescription is **not required** for insulin.

### Going without your pump – for less than 12 hours

#### As soon as possible:

- Give an initial dose of rapid acting insulin (Humalog<sup>®</sup>, NovoRapid<sup>®</sup> or Apidra<sup>®</sup>) using an insulin pen or needle and syringe.
- Correct any high blood glucose or ketones that may be present using the guidelines on page 17.

#### Then continue to:

- Check your blood glucose every 2 hours.
- Count carbohydrates for all meals and snacks.
- Use your insulin-to-carb ratio to determine how much insulin you need.
- Give rapid acting insulin every 3 to 4 hours by pen or needle and syringe. Try to co-ordinate this with a meal.
- Use your correction factor (insulin sensitivity factor) to correct a high blood glucose.

**Give rapid acting insulin every 3 to 4 hours to prevent DKA.**

## Going without your pump – for more than 12 hours

### Basal insulin

- Get Lantus<sup>®</sup> from your pharmacy. Lantus is a 24-hour basal insulin. It will replace the background insulin your pump was giving you.
- Determine your **daily total basal rate**. Your pump may display this.

Example: Determine total daily basal insulin				
Your basal rates are:	12 am to 4 am (4 hours)	0.5 units per hour	=	2 units
	4 am to 8 am (4 hours)	1.5 units per hour	=	6 units
	8 am to 12 am (16 hours)	1.0 units per hour	=	16 units
Total daily basal insulin:				24 units

- Give your daily total basal insulin (Lantus) by pen or needle and syringe. Lantus can be given at any time of the day. Most people take Lantus with breakfast or at bedtime.

### Bolus insulin

- Continue to count carbohydrates for all meals and snacks.
- Use your usual insulin-to-carb ratio to determine the amount of rapid acting insulin you will need.
- Give rapid acting insulin by pen or needle and syringe.
- Make corrections as needed using your correction factor.
- Check your blood glucose at least every 4 hours, including 3 am.

## **When you have a replacement pump**

- You will need to wait 24 hours after the last dose of Lantus before switching back to the pump.
- Start back on your pump at your previous rates.
- Check your blood glucose in 2 hours. Then check it at least every 4 hours until your blood glucose is stable.

## **If you are planning a pump holiday**

- Check your blood glucose at the usual times – before breakfast, lunch, supper and bedtime snack.
- Check your blood glucose at 3 am for at least 2 to 3 nights.
- If you need to make adjustments, refer to the handout “Adjusting Rapid Acting and Lantus Insulin”.

## **For more information**

Your diabetes team will work closely with you. Each member of the team will help you learn to use your pump and adjust your insulin as needed.

It may take several months for you to feel confident using your pump.



If you have questions or concerns, please call your diabetes nurse or contact person.

For questions about your pump, refer to your pump manual or contact the pump company directly.

