ENDOCRINOLOGY & DIABETES UNIT
Diabetes Clinic: 604-875-2868
Toll-free Phone: 1-888-300-3088, x2868
Fax: 604-875-3231
http://endodiab.bcchildrens.ca

INSULIN PUMP THERAPY: OVERVIEW

Overview

People with type 1 diabetes require insulin to survive. Insulin is considered life-sustaining therapy. It can be delivered by pen or syringe, or by an insulin pump. Multiple daily injections (MDI) deliver insulin through either a pen or syringe and matches your insulin needs to the food eaten. It also provides flexibility in timing of meals. Similarly, insulin can be delivered through an insulin pump. People using MDI can often see the same results in blood glucose and A1C as someone using an insulin pump. A pump may help with some bolus delivery options or lifestyle challenges, and can be especially helpful for very small insulin adjustments.

Using a pump can bring on some challenges, and may not be for everyone. The goal of this overview is to help you decide if pump therapy is right for you. Success in diabetes management is not all based on the method of insulin delivery, but rather the amount of work that is put into daily diabetes care.

As mentioned above, diabetes is managed with different skills and tools. An insulin pump is a tool to help you manage your diabetes much like a glucose meter or insulin pen. Other skills that help in the day to day management are counting carbohydrates, checking glucose levels, giving insulin or correcting above target glucose levels. These skills are still required when you switch to insulin pump therapy.

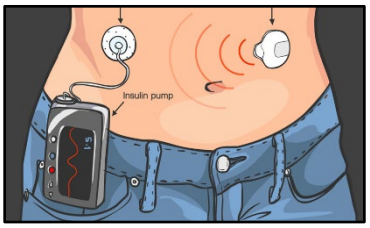
Important Self-Management Practice:

- Check blood glucose before meals and at bedtime
- Record keeping
  - Record blood glucose, food, exercise (can also be entered into CGM apps)
  - Review your records weekly to look for patterns of high or low glucose
  - Adjust your insulin, (carb ratios and corrections) based off those reviews
- Match Insulin to food intake
  - Carbohydrate counting
  - Correction factors
  - Food composition
- Healthy lifestyle
  - Balanced eating
  - Activity/exercise
  - Taking all insulin
- Regular follow up with your health care team
  - Growth and development
  - Review of diabetes treatment options
  - Regular screening for diabetes complications
  - Do an A1C every 3 months

Whether you are on a pump or MDI, attention to the above practice may help improve overall glucose management.

What Is an Insulin Pump?

An insulin pump is a small, battery-powered, mini-computer insulin delivery device. It can be tubed or tubeless. For both types of pump, insulin is delivered under the skin through a small, soft Teflon cannula (tube). Both types of pump have a reservoir filled with rapid-acting insulin (Humalog®, NovoRapid® or Apidra®). Both the infusion sets for tubed pumps and the tubeless pumps must be changed every 2–3 days.



Tubed pumps are about the size of a deck of cards and are worn clipped to a belt or waistband, or in a pouch or pocket, and they are attached to the infusion tubing and cannula. The cannula is introduced under the skin using a small needle, which is then discarded. Tubed pumps can be disconnected from the infusion set only for **short** periods for swimming, bathing and occasionally for exercise.

A **tubeless** pump ("pod") is worn attached directly to the skin, the cannula projecting from the underside of the pod. The cannula is inserted under the skin with an introducer needle, which then retracts into the pod. Tubeless pumps are operated wirelessly with a small electronic device ("PDM"). Once inserted, a tubeless pump cannot be removed until its useable life is finished.

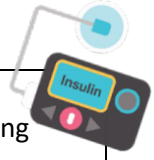
The insulin pump is **not** automatic, and it is not considered an "artificial pancreas". It must be programmed to give insulin when needed. The "official" term for insulin pump therapy is continuous subcutaneous insulin infusion (CSII). Insulin pump therapy and multiple daily injections (MDI) are called intensive diabetes management because it is possible to keep blood sugars in a tighter range. Blood sugars must be checked at least 6 times a day for pump therapy to be safe and effective.

The insulin pump itself does not monitor blood sugar! Real-time continuous glucose monitoring (CGM) is available and can work with some insulin pumps. This is with a transmitter and a sensor, inserted separately from the pump site. CGM measures sugar found under the skin (in the "interstitial fluid"), not blood sugar. A couple newer pumps can stop insulin delivery based on sensor glucose readings. These are called "hybrid closed-loop" systems.

Comparing MDI versus an Insulin Pump

MDI

- Long-acting basal insulin and rapid-acting insulin are used
- 1–2 doses of basal insulin every 24 hours
- A bolus of rapid-acting insulin is given for carbohydrates and to bring down high blood sugars
- Once injected, basal insulin can't be turned off or adjusted
- Not attached to a device



Insulin Pump

- Only rapid-acting insulin is used
- Continuous infusion of rapid-acting insulin.
- Rapid-acting insulin is given for carbohydrates and to bring down high blood sugars
- Temporary basal rates can be set to increase or decrease the basal insulin
- The pump can only be disconnected for short periods of time

Differences between MDI and Pump Doses

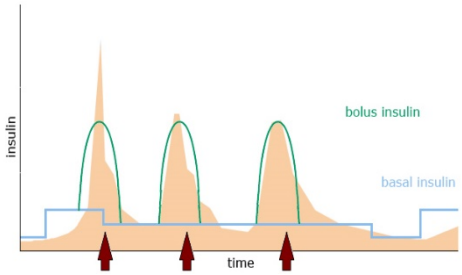
MDI

- Requires calculations for both food and corrections
- Doses are usually rounded up or down to make 0.5 unit dose adjustments
- Some younger children do not require insulin to cover their snacks

Insulin Pump

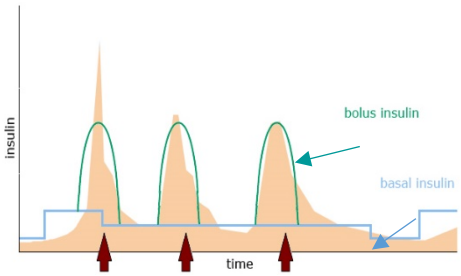
- Requires a bolus for both meals and snacks (may also include a correction)
- Can deliver much smaller doses of insulin and in small increments (3.2 units versus 3 units)
- Accurate carbohydrate counting is important
- Considers when last insulin dose given
- Calculates any insulin still working from previous dose to prevent insulin stacking
- Can deliver bolus in different ways (now versus over an extended period of time)

How Does It Work?



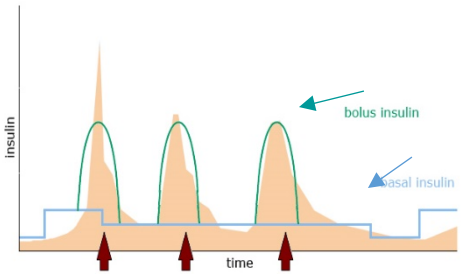
- An insulin pump tries to imitate what normally happens in the body.
- It uses only rapid-acting insulin that is programmed to match individual insulin needs.
- It can provide more flexibility and improved blood glucose.
- The pump will only do what the user has programmed.
- Newer pumps used in combination with a sensor may have some options to stop background insulin delivery to help prevent low glucose levels

Basal Insulin:



- A small amount of background insulin delivered 24 hours a day.
- The basal rate keeps the glucose levels in the target range between meals and overnight.
- The pump can be programmed to deliver different basal rates throughout the 24 hour period, based on individual needs.
- Usually about 40% of daily insulin needs.
- Replaces basal insulin (Levemir®, Basaglar®, Tresiba® or Toujeo®.

Bolus insulin:



- A larger amount of insulin delivered over a short period of time.
- Can be given as needed, however it can't be pre-programmed.
- A **pre-meal** bolus is given based on the grams of carbohydrates to be eaten.
- A **correction** bolus is an extra amount of insulin given when the blood glucose is above target.
- It should bring the blood glucose back to target within 3–4 hours.

How Does the Pump Calculate the Insulin Dose?

Pumps calculate the bolus insulin amount based on the:

- Current blood sugar
- Target blood sugar
- Correction factor (ISF)
- Time insulin is expected to last (active insulin/insulin on board)
- Grams of carbohydrate

Pumps only work when the blood sugar and carbohydrates are entered into the pump.

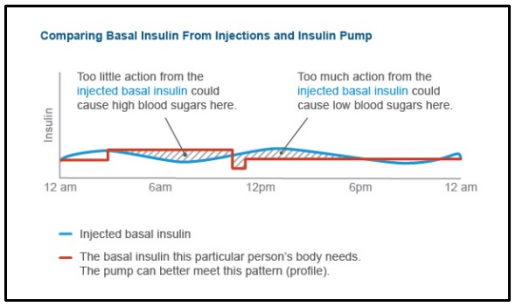
Basal Rates:

The amount of background insulin that is required in a 24 hour day. It is:

- Programmed into the pump based on individual needs
- Usually about 35–40% of your total daily insulin requirements
- Entered in as units per hour (U/hour) instead of units
- Can be broken down into hourly rates
- Precise amounts of insulin given in increments as small as 0.025 unit

For example: Basal insulin requirements are 12 units per day

Basal Injection(s)



Pump Basal Rates	
12 am	0.35 units/hour
3 am	0.50 units/hour
7 am	0.55 units/hour
8 pm	0.45 units/hour

Temporary Basal Rates

All insulin pumps allow you to set increased or decreased temporary basal rates for a set amount of time. A temporary basal rate should be set when the standard basal rate may be too high or too low.

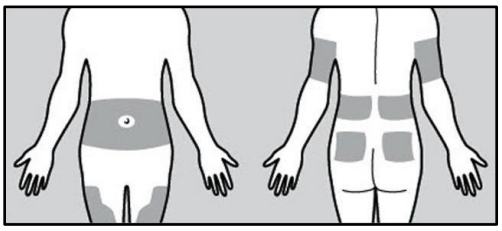
Short-term adjustments can be made for:

- Changes in activity level
- Illness
- Travel
- Trying out new basal rates
- After a low blood sugar
- After an evening meal with large amounts of protein and fat

Benefits and Challenges of Pump Therapy

Benefits	Challenges
▪ Precise dosing – matched to your personal insulin needs to keep blood glucose as close to normal most of the time (growth spurts, overnight lows) ▪ Flexibility – timing of meals, sleeping in, travel, exercise or illness ▪ More predictable absorption ▪ More meal insulin delivery options ▪ Fewer and less severe lows ▪ Improved glucose control ▪ Improved quality of life	▪ Risk of ketoacidosis (DKA) – only rapid-acting insulin is used. Extra care to be taken to prevent and manage high blood sugars ▪ Infection at insertions site – infusion sites as well as site rotation should be done every 2–3 days ▪ Hypoglycemia – some people experience more lows as the blood sugars come into target range ▪ Weight gain and sub-optimal nutrition – improved control can lead to weight gain, esp. with increased snacking ▪ Body image concerns/psychological adjustment – some people don't like being attached to a device all the time. Can impact choice of clothing ▪ Steep learning curve – there is a lot of preparation and required reading while learning to use a pump. Regular review and adjustments are required and take a lot of time and effort

Site Rotation:



Site rotation for insulin pumps is just as important as it is for injections.
Insulin is most consistently absorbed in the abdomen.
Sites for pump placement include:

- abdomen
- upper bum
- back of arms
- fleshy part of thighs

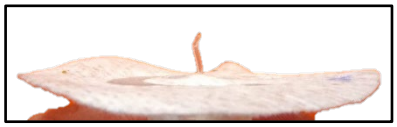
Illness Management

Insulin pumps only use rapid-acting insulin. There isn't a 'deposit' of long-acting insulin waiting to work. If you are not receiving insulin from the pump, soon there won't be any insulin in the body. Blood sugars will rise very quickly, and your body will start to make ketones. **This is a sign your body needs insulin!** A serious condition called diabetic ketoacidosis (DKA) can develop in 2–8 hours. This can happen even if the blood sugars were in a target range prior to when the pump stops delivering insulin. Always carry a pen or syringe with rapid-acting insulin with you in case of a pump problem

High Blood Sugars and Ketones

Insulin delivery can be impacted by:

- site leakage, kinks or disconnection
- infusion site pulled out or infected
- interruption of insulin delivery
- pump malfunction



Extra precautions for pump users. Check:

- the infusion site at least twice a day
- blood glucose levels at least 6 times/day
- for ketones if blood glucose is >15 mmol/L
- nausea or vomiting can be signs of ketones
- blood glucose 2 hours after a correction bolus or site change

Important Pump Features to Think About

Things to consider:

- Physical size of the pump
- Reservoir size
- Basal and bolus increments
- Number of basal rate segments
- CGM integration
- Can it be disconnected?
- Tubing or no tubing
- Waterproof or water resistant
- Software upgrades

A pump does **not**:

- Automatically give bolus insulin
- Think for you
- Program itself
- Count carbohydrates
- Take away the need for blood glucose checks
- prevent high or low blood sugars
- adjust insulin for food, illness or activity

Ongoing Pump Maintenance:

Daily:

- Check blood sugars and enter them into the pump
- Count carbohydrates to be eaten and enter them into the pump
- Decide if the suggested food and correction doses are okay based on activity
- Program temporary basal rates as needed
- Press the buttons to deliver meal and correction dose
- Respond to any pump alarms
- Problem-solve any unexplained high or low blood sugars
- Check for ketones when blood glucose above 15 mmol/L and decide if an insulin injection with syringe/pen is needed
- Examine insertion site for redness or leakage
- Inspect connection and tubing to make sure intact and not leaking
- Carry back up supplies at all times (battery, insulin and injection device, infusion set)
- Always carry fast-acting sugar
- Have a backup plan in case of pump malfunction

Regular Maintenance:

Every 2–3 days:

- Fill the reservoir with insulin
- Change the cannula or as needed

Weekly:

- Upload pump
- Review blood sugars and adjust pump settings as needed
- Program new rates into the insulin pump

Monthly:

- Check:
  - Basal rates
  - 3-AM glucose at least once a month if waking up above target
  - 2 hours after meal glucose for all meals at least once a month
- Review ISF, ICR and Total Daily Dose (TDD)
- Order Supplies

Checking basal rates requires missing or delaying meals and snacks for a set amount of time or eating a set meal plan for a short time. It also requires closer attention to glucose levels. It is important to fine-tune the basal rate so that the morning blood sugar is in range, so you don't have to 'catch up" all day.

Basal rate checks should be done in time segments:

- overnight (bedtime to breakfast)
- breakfast to lunch
- lunch to dinner
- dinner to bedtime

How Much do Pumps Cost in BC?

Coverage is dependent on your PharmaCare plan and any associated deductible and family maximum. If you are covered under Plan C (B.C. Income Assistance), Plan F (Children in the At Home Program), or Plan W (First Nations Health Benefits), PharmaCare covers 100% of the cost. If you are covered under the Fair PharmaCare plan, PharmaCare covers 70% of costs above your deductible and 100% of costs above your family maximum. Tandem pumps are currently not covered by Pharmacare. Many extended health plans will also cover up to 80% of the cost of a pump.

PharmaCare introduced a 2-tier system in 2018

- Tier 1 – Omnipod and Ypsomed
  - Omnipod provides PDM at no cost – pods based on deductible
  - Ypsomed offers a starter kit for $800, which can apply to deductible
- Tier 2 – Medtronic (630G and recently 770G)
  - Doctor needs to list reasons why a tier 1 pump is not an option
  - Cost is then based on family deductible
- Tandem t:slim x2 with Basal-IQ and Control-IQ is NOT currently approved by BC Pharmacare

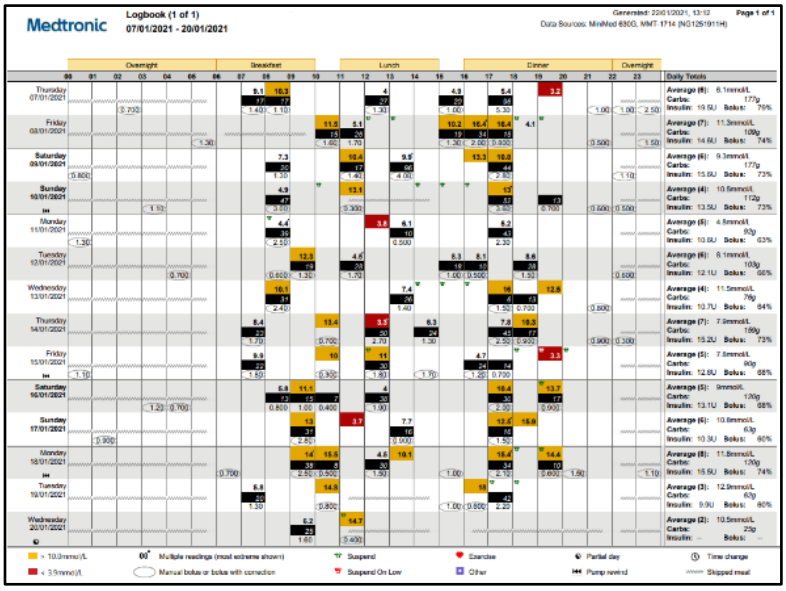
Pump supplies (infusion sets, reservoirs and tubeless pods) cost about $300–500 per month, depending on the insulin dose and frequency of site/pod changes, and these are also covered by BC Fair PharmaCare and extended health plans.

Pump Company Contacts (in alphabetical order):

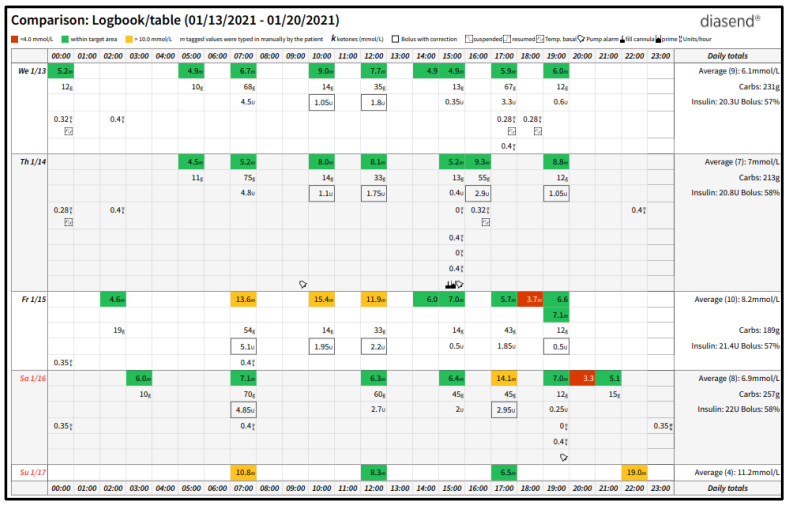
- **Insulet:** https://www.omnipod.com/en-ca/home or Canada toll-free number: 1-855-763-4636
  OmniPod® Insulin Management System
  Contact: Andrew Muirhead (amuirhead@insulet.ca), phone 604-754-6195
  Online product training program: https://www.omnipod.com/en-ca/DASH_video
- **Medtronic Diabetes:** www.medtronicdiabetes.ca or Canada toll-free number 1-800-284-4416
  MiniMed® 770G insulin pump with SmartGuard™ technology
  Contact: Brenda Heaney (brenda.heaney@medtronic.com), phone 604-312-7101
  Online product training courses: Virtual demo pump | Medtronic Diabetes Canada
- **Tandem Diabetes:** https://www.tandemdiabetes.com/ or Canada toll-free 1-833-509-3598
  t:slim X2™ insulin Pump with Basal-IQ and Control-IQ technology with Dexcom G6®
  Contact: Teri Currie (tcurrie@tandemdiabetes.com), phone 778-995-1268
  Demo apps: t:simulator app available from the Apple Store and from Android Play
- **Ypsomed:** www.ypsomed-diabetescare.com/en-CA/ or Canada toll-free 1-833-695-5959
  YpsoPump® insulin pump with Ypsomed App
  Contact: Sarah Brykajlo (sarah.brykajlo@ypsomed.com), phone 604-805-6384
  Handling videos: www.ypsomed-diabetescare.com/en-CA/services/handling-videos.html

Sample Pump Reports:

Medtronic CareLink™



Diasend® – Omnipod® and Tandem

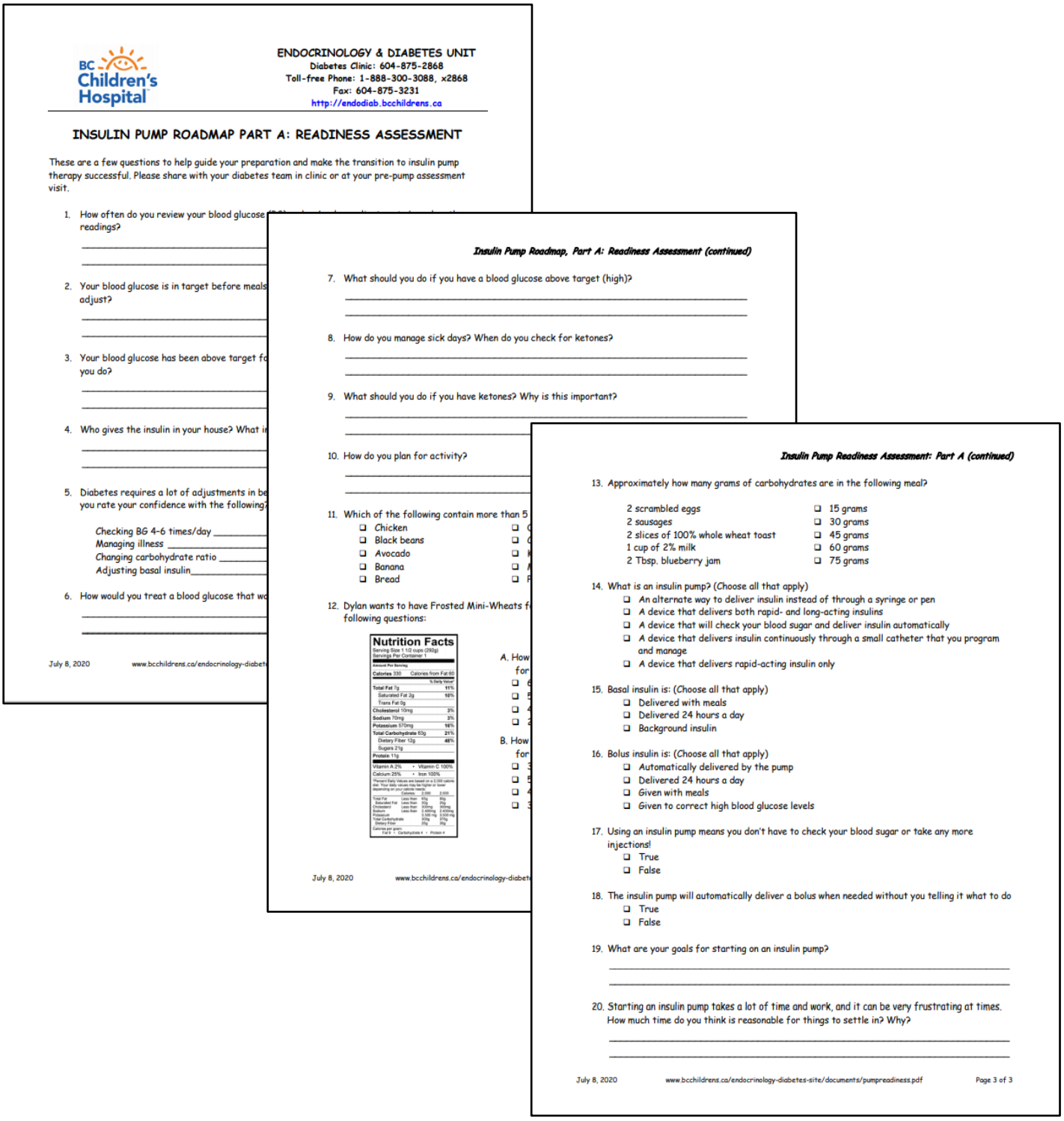


Books on Insulin Pumps (suggested reading):

These books are available for purchase online at www.amazon.ca or www.chapters.indigo.ca.

- *Pumping Insulin: Everything You Need for Success With an Insulin Pump (6th ed.)* (www.diabetesnet.com/pumping-insulin) by John Walsh and Ruth Roberts, Torrey Pines Press, ©2016.
- *The Calorie King® Calorie, Fat & Carbohydrate Counter* (www.calorieking.com) by Allan Borushek, ©2021. iOS and Android apps also available.

Readiness Assessment:



BC Children's Hospital

ENDOCRINOLOGY & DIABETES UNIT
Diabetes Clinic: 604-875-2868
Toll-free Phone: 1-888-300-3088, x2868
Fax: 604-875-3231
http://endodiab.bcchildrens.ca

INSULIN PUMP ROADMAP PART A: READINESS ASSESSMENT

These are a few questions to help guide your preparation and make the transition to insulin pump therapy successful. Please share with your diabetes team in clinic or at your pre-pump assessment visit.

1. How often do you review your blood glucose readings?
2. Your blood glucose is in target before meals adjust?
3. Your blood glucose has been above target fo you do?
4. Who gives the insulin in your house? What i
5. Diabetes requires a lot of adjustments in be you rate your confidence with the following?
   Checking BG 4-6 times/day
   Managing illness
   Changing carbohydrate ratio
   Adjusting basal insulin
6. How would you treat a blood glucose that wo

July 8, 2020 www.bcchildrens.ca/endocrinology-diabet

Insulin Pump Roadmap, Part A: Readiness Assessment (continued)

7. What should you do if you have a blood glucose above target (high)?
8. How do you manage sick days? When do you check for ketones?
9. What should you do if you have ketones? Why is this important?
10. How do you plan for activity?
11. Which of the following contain more than 5
    - ❑ Chicken
    - ❑ Black beans
    - ❑ Avocado
    - ❑ Banana
    - ❑ Bread
12. Dylan wants to have Frosted Mini-Wheats f following questions:

Nutrition Facts
Serving Size 1 1/2 cups (292g)
Servings Per Container 1
Amount Per Serving
Calories 330 Calories from Fat 60
% Daily Value*
Total Fat 7g 11%
Saturated Fat 2g 10%
Trans Fat 0g
Cholesterol 10mg 3%
Sodium 70mg 3%
Potassium 570mg 16%
Total Carbohydrate 63g 21%
Dietary Fiber 12g 48%
Sugars 21g
Protein 11g
Vitamin A 2% • Vitamin C 100%
Calcium 25% • Iron 100%

A. How for
B. How for

July 8, 2020 www.bcchildrens.ca/endocrinology-diabet

Insulin Pump Readiness Assessment: Part A (continued)

13. Approximately how many grams of carbohydrates are in the following meal?

2 scrambled eggs	❑ 15 grams
2 sausages	❑ 30 grams
2 slices of 100% whole wheat toast	❑ 45 grams
1 cup of 2% milk	❑ 60 grams
2 Tbsp. blueberry jam	❑ 75 grams

14. What is an insulin pump? (Choose all that apply)
    - ❑ An alternate way to deliver insulin instead of through a syringe or pen
    - ❑ A device that delivers both rapid- and long-acting insulins
    - ❑ A device that will check your blood sugar and deliver insulin automatically
    - ❑ A device that delivers insulin continuously through a small catheter that you program and manage
    - ❑ A device that delivers rapid-acting insulin only
15. Basal insulin is: (Choose all that apply)
    - ❑ Delivered with meals
    - ❑ Delivered 24 hours a day
    - ❑ Background insulin
16. Bolus insulin is: (Choose all that apply)
    - ❑ Automatically delivered by the pump
    - ❑ Delivered 24 hours a day
    - ❑ Given with meals
    - ❑ Given to correct high blood glucose levels
17. Using an insulin pump means you don't have to check your blood sugar or take any more injections!
    - ❑ True
    - ❑ False
18. The insulin pump will automatically deliver a bolus when needed without you telling it what to do
    - ❑ True
    - ❑ False
19. What are your goals for starting on an insulin pump?
20. Starting an insulin pump takes a lot of time and work, and it can be very frustrating at times. How much time do you think is reasonable for things to settle in? Why?

July 8, 2020 www.bcchildrens.ca/endocrinology-diabetes-site/documents/pumpreadiness.pdf Page 3 of 3

A Day in the Life of Wearing an Insulin Pump:

7:30 AM – Breakfast

- Wake up
- Check BG
- Decide what to eat for breakfast 10–15 minutes prior to eating
- Add up what is to be eaten and enter BG and amount of carbs into the pump
- Confirm the dose and press the buttons

Things to consider:

- Will I be exercising this morning, or unusual activity (i.e., going to the mall, raking leaves, snowball fights, jumping on trampoline)?
- Is my site intact, any problems?
- Do I have enough insulin in my reservoir to last for the day?
- Is my battery okay to last the day?

10:00 AM – Recess

- Check BG
- Add up what is to be eaten and enter BG and amount of carbs into the pump
- Confirm the dose and press the buttons

11:45 AM – Lunch

- Check BG
- Add up what is to be eaten and enter BG and amount of carbs into the pump.
- Confirm the dose and press the buttons

3:30 AM – Basketball Practice

- Check BG
- Add up what is to be eaten and enters BG and amount of carbs into the pump
- Consider how long practice will be. Do I need to give insulin?
- Consider setting a decreased temporary basal rate for the next few hours
- Confirms the dose and presses the buttons
- Check BG halfway through practice
- BG High/Low? Make treatment decisions appropriately

5:30 pm – Dinner

- Check BG after basketball practice and before dinner. Think about how activity before dinner may affect dinner dose of insulin
- Decide if any activity after dinner
- Are we eating out? Do we have a plan?
- Add up what is to be eaten and enter BG and amount of carbs into the pump
- Confirm the dose and press the buttons

9:00 PM – Bedtime

- Check BG before bed
- Think about how basketball may affect BG's overnight, is a small snack or temp basal needed?
- Decides if any activity after dinner
- Add up what is to be eaten and enter BG and amount of carbs into the pump
- Confirm the dose and press buttons

Things to consider:

- Is the site okay?
- Is there enough insulin for the night?
- Is the battery okay for the night?
- Consider setting a reduced temporary basal rate based on BG and risk of overnight low
- Set alarm to check at 3 am

3:00 AM

- Check BG
- Is my BG higher or lower?
- Treat accordingly

Are You Ready to Pump?

- You and your family have mastered the basics of diabetes care, and you have demonstrated an understanding of how to match insulin to food and exercise. Your family life has adjusted to the diagnosis of diabetes. For most families, this takes several months.
- You have been using basal–bolus insulin therapy (MDI) for at least 3–6 months.
- You have been checking blood sugars **at least** 4 times a day **and** recording the results in a logbook or uploading the results weekly **OR** you are using a CGM and checking with meter when appropriate. You are also entering all carbs and insulin doses.
- You and your parents **analyze** your blood sugars regularly (minimum every 2 weeks) and can independently make insulin adjustments when needed.
- You want to improve blood sugars and have a more flexible lifestyle.
- Child **and** both parents are interested. This includes younger children.
- You have a computer (or access to one) to upload the pump and analyze reports.
- You have read the handout on *Insulin Pump Therapy #1: The Basics*, available on our website, and completed the *Pump Readiness Assessment*.
- Once on the pump, you are prepared to check glucose readings 9–10 times a day including night checks at midnight and 3:00 AM for the first few weeks, then a minimum of 6 times per day with monthly night checks. This can be done with fingersticks or a CGM.
- You and your family have realistic expectations about what an insulin pump can and cannot do and the time commitment involved in getting started.
- You can already count carbohydrates accurately. See handout *Carbohydrate Counting*. You will have to have worked through our entire *Carb Counting Quiz* handout before starting the pump. You can also take a look at online carb counting module.
- You rotate injection sites and use your abdomen regularly. You do not use EMLA for injections.
- For teens, you allow your parents to be involved and participate in your diabetes care.
- For younger children, daycare personnel may not be able to operate the pump. This needs to be discussed directly with the school and/or daycare. A parent must be available at all times in case of problems.
- You and your family are prepared to attend 2–3 pump readiness and education sessions and do all of the required home reading/preparation and follow-up.
- Your family is registered with BC Fair Pharmacare

Pump Readiness Workshops:

BCCH has developed a pump readiness workshop (currently offered via Zoom) for families interested in pump therapy, or those who need a refresher on how different foods impact blood sugar. This workshop is different from the basal–bolus workshop. Topics covered include:

- Steps for Successful Pumping
- MDI vs Pump Comparison
- Pump Overview and Maintenance
- Illness and Ketones
- Things to Consider
- Carb Counting
- Food Composition and Effects on BG
- Pump Process – What Comes Next

What Comes Next?

- Discuss with your diabetes team
- Complete pump readiness assessment (can include link here)
- Attend pump workshop
- Independently look at pump options
- Once decided, let diabetes team know to submit Special Authority form
- Name will be added to training waitlist. Training wait may be up to 3 months
- Once approved, Special Authority will be sent to you. This approval is required to order pump
- Most successful pump starts are done during times of stable routines (not during sports camps, winter or spring break, vacations)
- Clinic will contact you to set up training, once you have training date:
    - You will have pre-pump homework to complete
    - Discuss change of therapy with school