BC Diabetes Foundation

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Type 1 Diabetes

Type 1 diabetes (TID, previously known as Juvenile, insulin-dependent diabetes or insulin-dependent diabetes, IDDM) is a condition that, when untreated, is characterized by very high blood sugar (glucose) – often above 20.0 at the time of diagnosis (compared to a range of 4.0 to 6.0 for people without diabetes). High blood sugar is caused by a severe deficiency of insulin. Insulin is required to control blood sugar – it causes sugar to be stored in all the cells of the body. Insulin is produced in beta cells in of your pancreas in special units called "Islets of Langerhans".

Low insulin levels are caused by the immune system destroying these beta cells. The cause of this "auto-immunity" is unknown. At birth there are typically 10 billion beta cells, by the time T1D is diagnosed there are fewer than 1 billion remaining (<10%). Occasionally some of the beta cells come back to life for weeks or months (seldom > 6 months). This phenomenon is known as a diabetes "honeymoon."

A research study being conducted in Vancouver known as UST1D2 is investigating whether beta cell destruction can be stopped and the beta cells regenerated with a medication, ustekinumab ("Stelara") already in use for arthritis and colitis. Here is a 2 minute video clip suitable for potential subjects. To qualify subjects must be aged 18-35 and have had their diabetes for less than 80 days.

If blood sugar runs high for many years, irreversible damage to the eyes, kidneys, nerves and blood vessels may result. If blood sugar is kept close to normal throughout life, the chances of any such damage are very small. People with well-controlled diabetes have normal life expectancy and are able to live full lives – they can go scuba diving and fly commercial jet airplanes.

The key to living well with Type 1 diabetes is to find the optimal balance between insulin dose, diet and exercise, and your everyday life by frequent measurement of blood sugar. This requires knowledge and experience. Our team of physicians, diabetes case managers (foreign medical graduates) will support you on your journey. To register with BCDiabetes go to https://register.bcdiabetes.ca/.

Glucose Testing

Previously finger poke testing of blood glucose was the mainstay of glucose testing. This has now been largely replaced by continuous glucose monitor (CGM, see http://bit.ly/2OYPE2p) which measure the glucose in the body juice (interstitial fluid). All individuals with T1D should get a CGM - they are covered by BC Pharmacare with Special Authorization. Your doctor will apply on your behalf if you ask.

With respect to finger poke testing, the necessary hardware can be obtained from any pharmacy. All the blood glucose meters on the market are safe, accurate and reliable. You need to find the one that suits your needs best - in terms of size, speed, amount of blood required, whether the meter has a magazine for storing multiple strips and whether add-ons such as software for blood glucose analysis are features you desire.

Either CGM or frequent blood glucose testing is necessary to determine the correct dose of insulin, how your body responds to various foods, the effects of exercise or illness upon blood sugar and whether it is safe to drive and operate machinery. Factors that lower sugar are insulin and exercise. Factors that raise sugar are food, physical or psychological stress and illness.

The minimum requirement for blood glucose testing is to test upon waking, before going to bed and before each meal. Ideally you will also test after meals, at least some of the time. A good blood sugar when you wake up, before meals & bed and when you are asleep is 5-8 mmol/L (90-145 mg/dl). It is wise to test your blood at 2:00 or 3:00 AM every week or so to ensure you are not going low in your sleep. A good blood sugar two hours after a meal is 6-10 (110-180 mg/dl). To learn to control blood sugar by adjusting insulin and diet see “Insulin Therapy” below.

Every person diagnosed with T1D should be seen by a diabetes specialist or internist or at a Diabetes Centre

Apart from the blood glucose testing that you carry out yourself, another test called the “A1c” is recommended every 3 months - this is usually performed at your local laboratory (but also available as “point-of-care” machines in BCDiabetes offices and in the near future as home blotter kits that can be mailed into the local lab) The A1c is very helpful in assessing your long-term blood sugar control. The A1c is a guide to blood glucose control over the previous 3 months. A1c values in people who do not have diabetes are 4.0 - 6.0. In people with Type 1 diabetes who have been under treatment for 3 months or more a value 6.5-7.5 is regarded as “optimal” (providing they feel “in control” and haven’t had severe low sugars): a value of 7.5 - 8.5 is consider “sub-optimal” and values >8.5 as inadequate. The A1c number is not the same as the value you get from your blood glucose meter though there is a close relationship between the two. Another measurement sometimes used is eAG (estimated average glucose) - this is calculated from the A1c as follows: eAG = 1.6*A1c-2.6. eAG is the approximately the average of your blood sugar over the last 3 months if the sugar was measured every 5 minutes. It is a weighted average - sugars 2 months age exert much more effect on the eAG (or A1c) than sugars 2 weeks ago.

Every person with Type 1 diabetes should have his/her A1c measured every 3 months. If it has been to target for 12-24 months then it may be measured every 6 months is sufficient. An example of a requisition for A1c (and other tests that need to be done on an annual basis), good for 12 months and renewable thereafter (“standing order”) is attached to this document. Such standing orders are routinely available to BCDiabetes.ca registrants.

Hypoglycemia is low blood sugar. It is often called a “low” or a “reaction” or a “hypo”. Low blood sugar is any reading under 4.0 when you don’t feel normal, or any blood sugar less than 3.0 even if you feel normal, providing you have repeated the test and it is still < 3.0. Hypoglycemia is potentially very serious, as sugar is the fuel of the brain. Without adequate fuel, the brain works less well or may stop working completely. This may cause lack of concentration, decreased attention, confusion, seizures, coma or even death. Hypoglycemia is treated by eating small quantities of sugar or starchy food like bread or crackers or by drinking

sugary drinks like juice or regular pop (not diet pop which contains artificial sweetener, and no sugar). For a mild low, the dose of sugar/starch is 10 grams - you will learn how much this is - roughly one rounded teaspoon of sugar or half a cup of juice. Your body will usually tell you that you are having a hypo - you will feel shaky, sweaty or feel your heart pounding. If you ignore those symptoms (or if you have had diabetes for many years) your brain may start to malfunction as mentioned above. If you feel low, test your blood sugar and eat if you are indeed low. If you feel very low, eat before testing your sugar.

Hyperglycemia is high blood sugar. Values greater than 10 are often associated with increased urination and thirst. Increased urination is caused by sugar getting into your urine and dragging water out with it - thirst is a healthy response to the increased urine flow. If your sugar is persistently greater than 15, and you are taking your insulin and following your diet, it suggests that your body may be producing ketones. Ketones can be easily detected in your urine using test-strips (available at any pharmacy). If ketones are present and your sugar is high, you should drink copious quantities of water (not juice, milk or regular pop), and take small doses of rapid insulin (see below - say 10% of your total daily insulin dose) every 60 minutes until the sugar is below 10. If your sugar has not come down within 6 hours, go to the emergency room.

Insulin Therapy

Insulin needs to be present in your blood at all times – in small amounts when you are not eating (basal insulin) and in variable quantities at mealtimes ("prandial" insulin) depending on how much starchy food you eat. Insulin may be given intermittently by injection using a pen device or syringe, or either continuously or intermittently using an insulin pump. An insulin pump that communicates with a CGM through a smartphone loaded with an insulin adjustment app is called a closed loop device or Artificial Pancreas System (APS, see https://bit.ly/3lbeWKC). BCDiabetes recommends that every person with T1D consider using an APS. To start with shots of insulin, basal and rapid, see below, are recommended.

Technologies to allow insulin to be given by inhalation are available in the USA (not Canada) and are not recommended because dosing is complicated by colds.

Once on insulin therapy you need to learn to adjust your insulin to bring your sugar to target (see http://bit.ly/3aJ2XZ4).

Basal insulin

The job of basal insulin (sometimes called baseline or background insulin) is to stop the body from producing too much sugar when you are not eating. Your liver and muscles produce sugar to provide fuel for your body if you haven't been eating. Basal insulin can be given by shots or by an insulin pump. The discussion below pertains to shots – insulin pumps are excellent but expensive and unnecessary for most individuals.

Basal insulin is most simply given by a single daily shot. At time of writing, the best basal insulin on the Canadian market is insulin glargine, known as Lantus. Lantus is usually given in the morning, though any time of day is acceptable (but always at the same time of day). The dose is ideal when the sugar before breakfast is between 4.0 and 7.0. If the sugar is < 4.0, there is an increased risk of a hypo and the dose is considered excessive. If the sugar is > 7.0 before breakfast, the dose may be insufficient. Adjustments to doses should be made in 20% decrements (for sugar < 4.0) or 10% increments (for values > 7.0).

An alternative basal insulin to Lantus is insulin detemir, known as Levemir. An old-fashioned insulin known as NPH (or “cloudy” insulin) is also an effective basal insulin; it is given twice daily, usually before breakfast and at bedtime.

An example of a prescription for Lantus using a simple-to-use pen injection device is attached as part of this document. If necessary, the pharmacist will teach you how to use the pen device.

A further alternative for basal insulin administration is an insulin pump. Insulin pumps provide for a much higher level of control over basal insulin administration than do basal insulins such as Lantus or Levemir – insulin pumps allow the basal rate of insulin to be changed hour to hour. Insulin pumps are expensive ($7500), covered for patients 26 years of age or younger by most extended insurers, but not necessary for the vast majority of individuals with Type 1 diabetes. One of the additional benefits of insulin pumps is that they can be coupled to a “sensor” or CGM (continuous glucose monitor). A sensor is a device, also inserted into the skin, that measures the sugar in the body's water (the body's “juice,” otherwise known as interstitial fluid). The sugar measurement is not as accurate as blood sugar testing but is good for trend analysis. Sensors can also be used to set a low sugar or high sugar alarm. Sensors can be purchased as stand-alone devices (without a pump) for around $2000.

There are 3 insulin pumps on the Canadian market at the time of writing: the Animus Vibe, the Medtronic/Minimed Veo and the Omnipod. All cost around $7500. There is one stand-alone sensor (not packaged with an insulin pump), the Dexcom, which costs around $2000.

What is the starting dose of basal insulin? For Lantus, take your weight in kilograms and divide it by 5 – take this many units of Lantus once daily.

Meal-time insulin

The ideal insulin for meal-times is rapid acting insulin (“rapid”). There are three commonly prescribed rapid insulins: insulin lispro (branded as Humalog and Admelog), insulin aspart (branded as NovoRapid and Trurapi). These three insulins are essentially equivalent. The effect of rapid starts 10 minutes after injection, peaks 60-90 minutes after injection and is gone 4-6 hours after injection. There are two ultra-rapid insulins available: insulin aspart (“Fiasp”) and insulin lispro (“Lyumjev”).

Rapid or ultra-rapid insulin is usually taken immediately before the meal. For individuals who are not sure of their appetite or for those who may forget to eat after taking rapid, it can be taken immediately after your meal.

The way to determine the correct dose of rapid is to test your blood sugar after eating. A reasonable target 2 hours after a meal is 6 to 10. If the 2-hour post meal sugar is lower than target it implies too much rapid or too little starch (see carb-counting below); if the 2 hour post meal sugar is above target it implies too little rapid or too much starch. Either way, a correction can be made next time you eat. Insulin pumps may be used to give meal-time insulin. Such doses are called “boluses”.

So at what dose of rapid should you start? For the average size meal, most people require somewhere between 2 and 10 units (U) of rapid. For beginners, I would recommend you take no more than 2 U to start unless you are greater than 60 kg in weight. For those less than 60 kg in weight, start with 1U. For children under 12, start with 0.5 U. Through experiment and

observation, you can determine how much you need for any given meal, and further fine-tune the dose by using Carb counting (see below).

A prescription for Apidra using a simple-to-use pen is attached as part of this Careplan. If necessary, the pharmacist will teach you how to use the pen device.

Diet

After insulin, the most powerful treatment for diabetes is a low-carb diet. On a low carb diet insulin adjustment becomes much simpler. If you are eating carbs try to choose carbs with a glycemic index (GI) < 55.

Carb counting

Carbohydrate ("carb") counting is the process of making an intelligent guess as to how much starch or carbohydrate is contained in the meal you are about to eat. Carbs are usually estimated in units of grams (1 oz = 28 grams). The reason for counting carbs is that the ideal dose of mealtime rapid (rapid-acting) insulin is directly proportional to the carbs you are about to eat.

Check out BCDiabetes' 2020 youtube webinar on carb-counting.

First, learn the carb values for common starchy foods. These can be obtained from a number of resources. One place to start is www.bcchildrens.ca/Services/SpecializedPediatrics/EndocrinologyDiabetesUnit/ForFamilies/DiabetesHandouts.htm#nutrition [link].

Next, figure out how many grams of carbs it takes to neutralize the effect of one unit of rapid insulin. This value is often called the "carb ratio." People with Type 1 diabetes who are very sensitive to insulin may require as many as 20 grams of starch to neutralize one unit of rapid insulin (ie their "carb ratio" is 20 to 1 or 20:1). Most individuals with Type 1 diabetes has a carb ratio close to 10:1. Some individuals, particularly those with Type 2 diabetes or those who are overweight may have carb ratios of 5:1 or even 2:1.

When starting out with carb counting, it is safe practice to assume your carb ratio is 15:1 – we choose a high starting carb ratio because we don't want you to have a low sugar after your first dose! To find out your own carb ratio, you will have to do a series of simple experiments with your favorite starchy foods.

A small bagel has 30 grams of starch. If your carb ratio is 15 to 1 and you plan to eat a bagel, you will need 30/15 = 2 U of rapid insulin to neutralize the carbs in a single bagel. The ultimate test of whether you got the dose of insulin right (based on carb counting and your carb ratio) is whether the sugar two hours after a meal is in the 6-10 range (or 8-12 one hour after a meal). This also assumes that your blood sugar before the meal started out in the right range (say 5-8). So if you ate the bagel and your sugar was > 10 two hours after the meal it means you didn't take enough insulin and that your carb ratio is less than 15 to 1. Next time you eat the bagel you might want to try a carb ratio of 10 to 1 which would mean you would take 30/10 = 3 units of rapid acting insulin. On the other hand if your blood sugar after the bagel was <6 that implies you took too much insulin and your carb ratio is actually higher than you guessed. Note for American readers: to convert blood sugar values discussed in this article to American units multiply by 18.

Note, on average 25-30% more insulin is required at breakfast than for the same amount of starch taken later in the day. So an individual who has a carb ratio of 10:1 for lunch or dinner may need to use a carb ratio of 8:1 or 7:1 for breakfast.

Providing you are doing your carb counting correctly and your sugars after meals are good, your sugar values when you wake and before meals have much more to do with your dose of basal insulin (Lantus or Levemir). The dose of basal insulin is correct when your sugar when you wake and before meals is in the 5-8 range. If your pre-breakfast readings are consistently above 8 you probably need to increase your basal insulin dose. To be on the safe side you should check your sugar at 2:00 or 3:00 AM to make absolutely sure you are not low – some people have morning highs because they have asymptomatic 2:00 or 3:00 AM lows. If your pre-breakfast readings are consistently less than 5 you need to decrease your basal insulin dose.

Corrections You should always test before taking your mealtime insulin to see whether the previous dose of your basal insulin and/or mealtime insulin was correct. If your sugar is higher than your pre-meal target (usually in the range of 5-8), you may give yourself extra mealtime insulin, above and beyond what you would usually take for the carbs in the upcoming meal. This extra mealtime insulin is called a “correction” or “sliding-scale”. Usual corrections for people with a carb-ratio of 10 or 15:1 would be 1 extra unit for every 2 the sugar is above target. For people with a carb ratio <10:1, a correction of 1 for every 4 the sugar is above target. Thus if your before meal target is 5-8, and your carb ratio is 10:1 & your sugar before a meal is 12.0 you would take a correction of 2 units. Here is the detail for the calculation: sugar now = 12, upper range of target = 8; 12-8 = 4. 4 divided by 2 = 2. Therefore correction dose is 2 units of mealtime insulin.Usual corrections for people with a carb-ratio of 10:1 or 15:1 would be 1 extra unit for every 2 (using mMol/L) that the sugar is above target. For people with a carb ratio <10:1, a correction of 1 for every 4 that the sugar is above target.

As an example for an individual whose before meal target is 5-8 & whose carb ratio is 10:1, if blood sugar before meal is 12.4, this is 4.4 above target. 4.4 divided by 2 gives 2.2 units. Rounding down this would mean a correction dose of 2 units of rapid would be added to the dose to cover the meal (by carb counting).

Driving/Operating Machinery and Diabetes

If a severe low occurs while driving or operating machinery there is a risk of injury or death. It is therefore a personal, moral and civic responsibility to test before driving or operating machinery so that this never happens. A value > 5.0 is generally considered safe to drive or operate machinery. For airline pilots the value is >6.0 (and they must always fly with a copilot). An individual with Type 1 diabetes (and some with Type 2 diabetes) should never drive a car or operate dangerous machinery without knowing what their blood sugar is. A value < 5 means “do not drive”. Individuals with Type 1 diabetes should never go out of the house without snacks to treat a hypo; individuals on a drive should stop every hour to test. If stopping is not an option (such as on a freeway) then food should be consumed every hour even if no blood glucose test is done.

Intercurrent Illness and Insulin dose “sick day management”

During intercurrent illness (colds, flu or severe stress) insulin is less effective: thus higher doses of insulin are required. The simplest approach on sick days is to increase the dose of basal insulin by 20% (or more). If the sugar is > 15 and there is vomiting there is a real risk to life &

the individual should go to the nearest hospital immediately. If the sugar is > 15 but there is no nausea or vomiting then water or salty unsweetened fluids such as chicken soup or broth should be consumed and hourly doses of rapid insulin taken until the sugar is < 10. The hourly dose of rapid insulin should be 10% of the total daily insulin. For instance if usual insulin dose is Lantus 40 units and rapid 40 units daily then 10% = (40+40)/10 = 8 units taken every hour.