

## TYPE 1 DIABETES 101

### Introduction

You have Type 1 diabetes or insulin-dependent diabetes mellitus. This condition, when untreated, is characterized by very high blood sugar (glucose) – often above 20 at the time of diagnosis (normal is 4.0-6.0 for people without diabetes). Your blood sugar was high because there was a severe insulin deficiency in your blood. Insulin is required to control blood sugar – it causes sugar to be stored in all the cells of the body. Insulin is usually produced in the  $\beta$  cells of your pancreas. Your insulin level was low because your  $\beta$  cells were destroyed by auto-immunity – this means your own body's immune system has destroyed the cells. The trigger for auto-immunity is unknown but it may be related to viral infections and/or exposure to various antigens in the environment. By the time your diabetes became obvious fewer than 5% of your  $\beta$  cells were still functional.

The problem with diabetes is that if blood sugar is allowed to be significantly above normal 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, not only will you have very good quality of life but your life expectancy should be no different than people who do not have diabetes.

The key to living well with diabetes is to take insulin as prescribed (and to learn to adjust your doses), to test your blood frequently & to regulate your diet & exercise. With the help of your diabetes team of physician, nurse and dietitian you will acquire these skills over a period of weeks and months. It will be a slow process of gradual adaptation; it will be tough but ultimately will bring tremendous rewards.

### Blood Glucose Testing

Frequent blood glucose testing is necessary to determine the correct dose of insulin, how well you are following your diet, the effects of exercise or illness upon blood sugar and whether it is safe to drive and operate machinery. A blood glucose meter is necessary for you to know what your sugar is. 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. 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.

Your physician will assess your long-term blood sugar control using a test called the HbA1c usually known as the "A1c". The A1c is a guide to blood glucose control over the previous 10-12 weeks. Values in people who do not have diabetes are 4.2 - 6.0. In people with Type 1 diabetes who have been under treatment for 3 months or more a value < 7.0 is regarded as optimal, a value of 7.0 - 8.0 is regarded as moderate, and values >8.0 are regarded 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 test for determining long-term blood glucose control is fructosamine – it applies to the previous 2-3 weeks.

**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 < 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 you should test your blood sugar and eat if you are indeed low. If you feel very low you should eat before testing your sugar.

**Hyperglycemia** is high blood sugar. Values  $>10$  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  $>15$  & 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 with 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 2 hours until the sugar is normal - if the sugar is not coming down within 6 hours you should 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 after meals (prandial insulin) depending on how much starchy food you eat. Insulin is given by injection with a pen device or syringe. Technologies to allow insulin to be given by inhaler are currently being investigated.

**Basal insulin** The job of basal insulin (baseline/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 when you are in the fasting state. Basal insulin can be given by shots or by 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 of insulin glargine "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 correct when the sugar before meals, bed and overnight is 5-8. If the sugar is  $<5$  the dose is excessive and if  $>8$  the dose is inadequate. Adjustments to doses should be made in 10% decrements (for sugar  $<5$ ) or 10% increments (for values  $>8$ ). An alternative basal insulin to Lantus is insulin detemir "Levemir" - however this insulin generally needs to be taken twice daily.

An alternative to a single daily shot of Lantus or two shots of Levemir is two shots of intermediate-acting insulin. There are many different types of intermediate-acting insulin - Novolin N or Humulin N (known as "NPH" insulins), Novolin L or Humulin L (known as "Lente" insulins) or Novolin U or Humulin U (known as "ultralente" insulins). Intermediate-acting insulins are best given 12 hours apart with the second dose at your usual bedtime and the first dose 12 hours earlier. The dose of intermediate-acting insulin, like the dose of Lantus/Levemir, is adjusted according to the blood sugar before meals, particularly breakfast after fasting overnight (or a longer fast if you are resting, up to 24 hours!).

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. If you are taking Levemir, take your weight in kilograms and divide it by 10 - take this dose every 12 hours. If you are using intermediate-acting insulin, divide your weight in kilos by 10 and take that dose twice daily. Thus if you weigh 60 kg, the starting dose of Lantus would be 12 U once daily or Novolin N 6 U twice daily.

**Meal-time insulin** The ideal insulin for meal-times is ultra-short acting insulin ("ultra-short"). There are two brands of ultra-short, "Humalog" (insulin lispro) & "NovoRapid" (insulin aspart). These two insulins are essentially equivalent. The effect of ultra-short starts 10 minutes after injection, peaks 60-90 minutes after injection and is gone after 4 hours. Ultra-short is usually taken immediately before the meal. If there is a chance you might forget to eat after taking your ultra-short or if you are not sure how much starch you might eat, you may take it immediately after your meal.

The way to determine the correct dose of ultra-short is to test your blood sugar after you eat. A reasonable target 2 hours after a meal is 6-10. If your sugar is lower than the target you either took too much ultra-short or too little starch (see carb-counting below) and if it is higher you either took too little ultra-short or too much starch. Either way, you will know how to correct it next time.

So at what dose of ultra-short should you start? For the average size meal most people require somewhere between 2 and 10 units of ultra-short. For beginners I would recommend you take no more than 2U to start unless you are >60 kg in weight. If you are <60 kg start with 1U. For children under 12 start with 0.5 U. By a series of experiments you can determine how much you need for any given meal.

Carb-counting The most important variable is to learn how much starch (or carbohydrate) your body requires to neutralize 1 unit of ultra-short. You need to learn to estimate the amount of starch in the meal you are about to eat. This is called “carb-counting” or “carbo-counting”. This requires hundreds of little experiments to see exactly how much ultra-short is required to neutralize a certain amount of starch. You need to learn the carb or starch contents of common foods. To become more familiar with this concept you should attend a carb-counting class at your local diabetes centre. On my website [www.drTomelliott.com](http://www.drTomelliott.com) in the link “Patient Handouts” is a pdf file “Carbohydrate counting” which is an almost exact replica of the materials used at the Vancouver General Hospital carb-counting class.

In general however, lean and fit individuals may require up to 15 grams of carbohydrate to neutralize 1 U of ultra-short while non-lean, and less fit individuals (and fit teenagers) may require as little as 5 grams of carbohydrate per unit of ultra-short. This value of 15 to 1 (or 5 to 1) is known as a “carb ratio”.

Corrections You should always test before taking your ultra-short to see whether the previous dose of your basal 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 ultra-short insulin, above and beyond what you would usually take for the carbs in the upcoming meal. This extra ultra-short 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, your carb ratio is 10:1 & your sugar before a meal is 12.0 you would take 2 a correction of 2 units.

### **Driving/Operating Machinery and Diabetes**

If you have a severe low while you are driving or operating machinery there is a risk of injury or death to you or others. It is therefore your personal responsibility that this never happens. You should never drive a car without knowing what your blood sugar was within the previous hour. If you have had a low in the previous 12 hours you should test immediately before driving. You should not drive with a blood sugar under 4.5 (or under 5 if you have reduced signals for low blood sugar, known as “hypoglycemia unawareness”). You should never go out of the house without snacks to treat a low. If you are driving long distances you should stop every hour to test your blood sugar. If you have a motor vehicle accident with a low blood sugar it is likely that the Superintendent of Motor Vehicles will temporarily rescind your driver's licence. This will necessitate re-certifying through the Diabetes Centre and may cause you to lose your job.

### **Intercurrent Illness and Insulin**

During intercurrent illness (colds, flu etc) your body will be less sensitive to insulin and you will therefore require more. The simplest approach is to increase your basal (long-acting) insulin doses by 20% (or more) and to take correction doses of ultra-short insulin every 2 to 4 hours as well as your usual meal-time insulin.

### **Diabetes and Research**

There is active research in Type 1 diabetes being carried out at the the University of British Columbia – you may be eligible for a number of studies. There is no obligation to participate in these studies as they are separate from the clinical relationship you have with me or your diabetes physician.

To facilitate research and education in the diabetes area (and other areas of endocrinology including thyroid, pituitary, women's health, menopause and osteoporosis, cholesterol and lipid abnormalities) a charity of which Dr. Elliott is the president, the BC Endocrine Research Foundation was established in 1997. The Foundation is always looking for assistance be it either in time as a potential volunteer or financial support. You may discuss this with me at anytime.