



# Type 1 Diabetes

## Know the Facts

*A charity supporting and listening to people who live with diabetes*

HELPLINE: 01604 622837  
[www.iddtinternational.org](http://www.iddtinternational.org)

- The Trust offers support, understanding and information to people with diabetes and to those who care for them.
- We listen to the needs of people who live with diabetes and do our utmost to offer help and support.
- We raise awareness of important issues for people living with diabetes and lobby governments on issues that affect people's lives.
- We fund research into ways of improving the lives of people with diabetes.

## Introduction

Diabetes is a chronic disease which affects over 3 million people in the UK – only around 10% have Type 1 diabetes and remaining 90% have Type 2 diabetes. Type 1 diabetes is a life-long, largely self-managed condition, so it is important that those who have the condition and/or those who care for someone with it, have a good understanding of its management.

Diagnosis is not an easy time as we go through the process of learning to live with Type 1 diabetes. It can also be a difficult for families and parents of children diagnosed with the condition. There is a lot to learn at a time when perhaps we are not able to take in all the information that we are given. We hope that this booklet will be of help at diagnosis and in the years that follow.

## Facts about Type 1 diabetes

- Type 1 diabetes usually affects children and adults up to the age of forty, although people over 40 can be diagnosed with Type 1 diabetes. There are around 23,000 children aged 15 years or under with Type 1 diabetes. The number of children diagnosed under the age of 5 is markedly increasing.
- Type 1 diabetes is caused by the body's immune system attacking the insulin producing beta cells in the pancreas. The body no longer produces insulin and glucose levels rise. Treatment with insulin injections is always required for survival. It is usually diagnosed as an acute condition.
- There is no cure for Type 1 diabetes and the cause has not been established. It is thought that there may be several causes with a genetic link in some people. Research shows that a common virus may trigger the body's immune system to attack its own insulin-producing pancreatic cells.

***Note: It is important to avoid confusion between Type 1 and Type 2 diabetes***

As stated above, there are two main types of diabetes, Type 1 and Type 2 diabetes. In Type 2 diabetes, the pancreas often still produces insulin but either not enough or it is not used properly by the body. It usually affects people over 40, although with the increase in people being overweight and obese, it is now being seen in younger people and even in children. The misconception that 'diabetes' is simply a lifestyle condition minimises the public perception of the seriousness of both types of diabetes.

Type 1 and Type 2 diabetes are two very different conditions - they have different causes and affect different groups of people. All too often they are put together under the general umbrella of 'diabetes' and this blurring of the lines between Type 1 and Type 2 can cause unnecessary fears, confusion and misunderstandings that can be dangerous. Type 2 diabetes is a progressive condition and may ultimately be treated with insulin but it is still Type 2 diabetes and never becomes Type 1 diabetes.

**Symptoms of Type 1 diabetes**

Symptoms of Type 1 diabetes can develop quickly, or over days or weeks. The main symptoms are:

- feeling very thirsty,
- urinating frequently, particularly at night,
- feeling very tired,
- weight loss and loss of muscle bulk.

Other symptoms include:

- itchiness around the vagina or penis, or regular bouts of thrush,
- blurred vision that is caused by the lens of your eye changing shape,
- cramps,
- skin infections.

Vomiting or heavy, deep breathing can also occur at a later stage. This is a dangerous sign and requires immediate admission to hospital for treatment.

## Understanding Type 1 diabetes

To understand Type 1 diabetes and its treatment, we first have to learn how the body works in people without diabetes.

### Normal metabolism

Normally during food digestion the body breaks down the carbohydrates we eat into simple sugars, known as glucose. The glucose is absorbed into the blood and transported around the body by the blood vessel system to provide the energy needed for all our activities. As food is eaten, insulin is released into the blood stream and this allows glucose to enter the body's muscle, fat and liver cells.

### The pancreas

The pancreas is a gland behind the stomach. Beta cells in the pancreas produce the hormone insulin to help to control the levels of glucose in the blood.

### The liver

The liver also plays a part in maintaining normal blood glucose levels. When there is more glucose in the cells than your body needs for energy, it is removed from the blood and stored in the liver as glycogen. It can then be used when necessary, such as at times when you run low on glucose if you have missed a meal or taken extra, often unexpected, physical activity. In such situations the liver releases glucose into the bloodstream.

### What affects the amount of glucose in the blood?

The amount of glucose in the blood varies according to several factors, such as the food eaten, exercise, stress and infections. The relationship between insulin production, glucose and the liver makes sure that the blood glucose levels stay within normal limits. For people without diabetes, these are 4 to 7mmols/l.

### What happens in Type 1 diabetes

In people with Type 1 diabetes, the beta cells in the pancreas cannot

produce insulin. When carbohydrates are eaten, no insulin is produced and so the glucose levels in the blood rise higher and higher.

The body cannot cope with this, so the excess glucose is passed through the body into the urine. This means that people with untreated diabetes pass urine frequently to get rid of the excess glucose. In turn, this makes them thirsty because the body gets dehydrated. These are the classic signs of undiagnosed diabetes – thirst and peeing a lot. The body becomes short of energy as a result of the glucose being excreted and the person feels tired. The body starts to burn its own fats to provide the necessary energy so there is weight loss. Treatment is essential at this stage and it is often an acute emergency situation. Type 1 diabetes always requires treatment with insulin to control the blood glucose levels.

### **Why do blood glucose levels need to be controlled?**

If blood glucose levels are too high then this can lead to long-term complications. The risk of long-term complications is reduced by the treatment of diabetes with insulin and by lifestyle changes, diet and exercise, to reduce blood glucose levels.

The recommendations are that people with Type 1 diabetes should try to keep their blood glucose levels as near normal as possible, that is between 4 and 7mmols/l. However, it is well recognised that in Type 1 diabetes this increases the risk of severe hypoglycaemia (low blood glucose levels) threefold so good control is a balance between achieving blood sugars that are as near normal as possible while at the same time avoiding hypoglycaemia. Hypoglycaemia in people treated with insulin is caused by the blood glucose lowering effect of insulin itself and not by diabetes. For many people, hypoglycaemia and the avoidance of it, is one of their major daily concerns so it is important that blood sugar levels are kept as near normal as possible, while at the same time avoiding them going too low and causing hypoglycaemia.

## **The complications affect:**

### ***The eyes***

Diabetes can affect the blood vessels at the back of the eye (retinopathy) which can lead to visual impairment or blindness. Diabetes is the leading cause of blindness in the working population.

### ***The heart and vascular system***

Diabetes can affect the heart and the vascular system making people more susceptible to heart disease and stroke. It can also cause blood clots in the vessels in the legs which may result in amputation. Amputations are 50-80 times higher in people with diabetes than the general population.

### ***Kidneys***

Diabetes can affect the kidneys resulting in damage or kidney failure (nephropathy).

### ***Nerves***

Diabetes may cause nerve damage (neuropathy). The most common form of nerve damage is in the extremities leading to pain or loss of sensation in the feet and ulceration of the legs. Again, this can lead to amputation.

## **Low blood glucose levels [hypoglycaemia]**

Low blood glucose levels (hypoglycaemia) are experienced by most people with Type 1 diabetes and are often their biggest day to day fear. When this happens there is too much insulin present for the amount of food eaten and this situation needs treatment immediately with a sugary drink, sugary food or glucose tablets.

Hypoglycaemia [often referred to as a hypo] occurs for several reasons:

- The amount of insulin given was too great.
- A delayed or missed meal.
- Extra energy has been used by extra activity without eating extra food. The glucose in the blood has been used up and so it drops below normal.
- Fear, anxiety, excitement, stress and various emotions.

- Alcohol.
- For no apparent reason at all!

**Hypoglycaemia is caused by the treatment of diabetes and not by diabetes itself. People taking insulin are at risk of hypoglycaemia.**

### Hypo warning signs

Most people have warning signs of the blood glucose level dropping below normal, which often happens just before a meal or after unexpected exercise. They are usually aware of these themselves, although quite often carers and family members recognise the signs earlier. There are classic warning signs but these may vary from person to person or may vary at different times in the same person, but generally they are as follows:

- Feeling weak
- Trembling or shaking
- Pallor
- Blurring of vision
- Hunger
- Confusion
- Aggression/change in behaviour or mood.

### Treatment of hypos

- Quick-acting carbohydrate in the form of a sugary drink or sugary food. This can be seen as a time to eat the foods that are normally restricted eg cakes, chocolate etc.
- This should then be followed by some long-acting carbohydrate, such as a wholemeal bread sandwich or a bowl of cereals, to stop the glucose levels dropping again.
- If the hypo remains untreated then the blood sugars drop even further and this can lead to coma which, in some people, may be accompanied by a seizure.

### Loss of hypo warnings [also called hypoglycaemia unawareness]

Some people experience hypo unawareness or loss of hypo warnings.

**Total loss of warnings** is a condition where the warning symptoms of an impending hypo are not present and so when the blood glucose levels drop there are no warning signs that the person must eat. This makes the likelihood of severe hypos much greater. People with loss of warnings have to rely on the help of others.

**Partial loss of hypo warnings** is when warning symptoms are present sometimes but not at other times. In some ways this is more difficult than total loss of warnings because the person may not even be aware that they have some loss of warnings and so have unexpected and unheralded moderate or severe hypos. This is particularly dangerous when driving.

**Reduced warning symptoms** is where the early warning signs of hypoglycaemia are reduced or missing [sweating, trembling etc] and the blood glucose drops to the stage where the symptoms are less obvious [confusion, behavioural changes etc]. This means that the person often then requires the help of others to treat the hypo.

### **Causes of hypo unawareness**

- Long-term Type 1 diabetes can result in loss of warnings.
- Frequent hypoglycaemia itself can cause loss of warnings and therefore the risk of more hypos. This then becomes a vicious circle of hypos leading to loss of warnings and more hypos!
- Intensive therapy with multi-daily insulin injections and aiming for near normal blood glucose levels, has been shown to cause a threefold increase in the risk of severe hypoglycaemia. This increased hypoglycaemia can therefore increase the risk of loss of warnings.
- Neuropathy – damage to the autonomic nervous system is a complication of diabetes and this can cause loss of warning symptoms.
- Changing insulin species can cause a loss or change in warning symptoms.
- ‘Human’ and analogue insulins can cause loss of warnings of hypos and from the early 1990s, Patient Information Leaflets in ‘human’ insulin packs had to include this warning.

## The effects of loss of warnings

Information gathered from the experiences of people with diabetes and their carers suggests that loss of warnings may result in the following:

- A feeling of insecurity and loss of independence.
- Embarrassment.
- A fear of leaving the home.
- Being a danger to oneself and others.
- Aggressive or violent behaviour.
- Family conflict, breakdown of relationships.
- Loss of driving licence – it is illegal to drive with loss of warnings.
- Loss of job
- A deliberate raising of blood glucose levels to avoid such situations.

**There is a golden rule about hypos.** If you are unsure whether or not someone is hypo, then **FEED**. If this is a misjudgement and results in a high blood sugar, this will not be harmful but leaving a hypo untreated could result in the blood sugar dropping even further and eventually, coma. It is common for the person with diabetes to deny they are hypo and refuse food – ignore this!

## High blood glucose levels [hyperglycaemia]

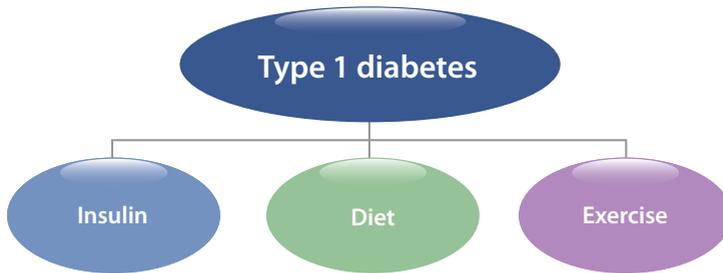
Blood glucose levels that are too high can occur for several reasons:

- If there is not enough insulin for the amount of carbohydrate eaten or if an injection is missed.
- If the amount of exercise is less than normal and so the glucose in the blood is not used up.
- When there is an illness, cold or 'flu. They often rise before an illness so high sugars can be a sign that a cold or illness is 'brewing'.
- Stress.
- Sometimes for no apparent reason at all!

High blood sugars can and do occur and the odd high is not unusual. The symptoms and signs of more prolonged high blood glucose levels are similar to those of the undiagnosed state, although not usually as severe

unless the highs are present for some days. If this is the case and blood sugar readings are high for a prolonged period, then medical advice is necessary. Many people with diabetes treated with insulin will increase their dose of insulin to deal with this situation, without consulting the doctor or nurse.

### Three important factors in the treatment of Type 1 diabetes



There are three important factors in the treatment of Type 1 - insulin, diet and exercise. There is an important relationship between all three as they all affect blood sugar levels and they all affect each other. The aim of treatment is to try to achieve blood glucose levels that are as near normal as possible or the target blood glucose set by you and your diabetes team.

### Insulins

#### Types of insulin [also known as species of insulin]

- For nearly 60 years all people with diabetes who required insulin treatment used animal insulin. Originally this was beef insulin but in the 1970s highly purified pork insulin also became available. All insulins are now highly purified.
- In 1982 genetically engineered, so-called 'human' insulin was introduced and about 85% of people using insulin were transferred to human insulin on the assumption, not evidence or proof, that it was better than animal insulin.
- In the late 1990s the first insulin analogue was introduced. Analogue insulins are made from 'human' insulin by genetically engineering it again.

So, in the UK, there is a choice of insulin analogues, human and animal insulins and all are available on an NHS prescription. Insulin analogues are now prescribed to more people than the other insulins although NICE guidelines state that they should only be used in certain situations. Insulin analogues are significantly more expensive than all other types of insulin.

**Action and duration times of insulins**

In Type 1 diabetes usually between 2 to 4 daily injections are given but even so, this does not mimic the body’s normal action of insulin being produced according to need (that is the amount of carbohydrate eaten). Therefore, the amount insulin, its peak of activity and the duration of its action have to be balanced with the amount of food eaten and the level of activity or energy required.

Rapid and short-acting insulins are designed to work quickly to deal with the rise in blood sugar levels at meal times.

Intermediate and long-acting insulins are designed to be absorbed gradually and work in the background all the time.

**Table 1 shows the different types of insulin according to their origin and length of action.**

insulin	Rapid	Short	Intermediate	Long
Analogue	Apidra Humalog NovoRapid			Lantus Levemir Tresiba
Animal		Hypurin Bovine Neutral Hypurin Porcine Neutral	Hypurin Bovine Isophane, Hypurin Porcine Isophane	Hypurin Bovine lente Hypurin Bovine PZI
Human		Actrapid, Humulin S, Insuman Rapid	Humulin I, Insuman basal, Insulatard	

Also available are pre-mixed insulins which are combinations of rapid-acting or short-acting insulins with an intermediate-acting insulin. These are usually used where only two injections a day are required.

**Table 2 is a rough guide to the activity curves of the different insulins and the insulins are listed in order of their development.**

<b>Insulin type</b>	<b>Onset</b>	<b>Peak [hours]</b>	<b>Effective duration [hours]</b>	<b>Maximum duration [hours]</b>
<b>ANIMAL</b>				
Regular [short]	0.5 - 2 hours	3 - 4	4- 6	6 - 8
NPH [intermediate]	4- 6 hours	8 - 14	16 - 20	20- 24
<b>'HUMAN'</b>				
Regular [short]	0.5 -1 hour	2 - 3	3 - 6	6 - 10
NPH [Intermediate]	2- 4 hours	4 - 10	10 - 16	14 - 18
<b>ANALOGUES</b>				
Rapid	Immediate	Immediate to about 1 hour	Tails off from peak over 3- 4 hours	About 4 hours
Lantus [long]	2 hours	None	24 hours	
Levemir [long]	2 hours	None	14 or more hours	
Tresiba [long]	N/K	None	24 hours	

**It is important to remember...**

- The above chart is only a rough guide and insulins act differently in different people.
- The speed of action of injected insulin varies at different injection sites. For example, if Hypurin Porcine Neutral is injected above the umbilicus [tummy button] its speed of action is much quicker, and similar to a rapid-acting analogue, than if it is injected below the tummy button.
- The depth of the injection also affects the speed of action and it is important to have the correct sized needle for the amount of fat at injection sites.

## Devices for injecting insulin

**Pen** – most people use this device for injection as it is convenient and discreet.

**Needle and syringe** – some people prefer this method of injecting or they may be using a type of insulin that is only made in vials and not cartridges for a pen.



**Innolet** – this is a hand held device with a large dial used to measure the required number of units of insulin. It makes an audible click when a unit is dialled so is particularly useful for people with visual impairment or dexterity problems. Unfortunately, it is only available with certain brands and types of insulin.

**Insulin pumps** - some children and adults with Type 1 diabetes use insulin pump therapy [continuous subcutaneous insulin infusion or CSII] instead of injections. This is where there is a continuous infusion of short/rapid-acting insulin delivered by a short cannula under the skin with boluses of insulin given to cover meals. It has distinct advantages and disadvantages and people who use a pump have to satisfy a strict set of criteria before they are prescribed one.



## Rotation of injection sites

In the days before insulins were highly purified [1970s], it was common for people with diabetes to develop lumps and dents at injection sites, one of the causes being repeated injections at the same places. This condition is called lipodystrophy which includes lipohypertrophy, the bumps, and lipoatrophy, the dents.

Lipodystrophy is a defect in the breaking down or building up of fat below the surface of the skin. The subcutaneous tissue which is the third layer of the skin into which insulin injections take place, contains fat and

connective tissue that houses larger blood vessels and nerves. The body pulls the injected insulin from the fatty tissue and this can result in a shrinking of the fatty tissue [atrophy] causing dents at the injection site.

With the arrival of purified insulins, in the 1970s there was a marked reduction in the numbers of people with lipoatrophy and it is now viewed as a rare complication of treatment with insulin analogues. However, it has been reported with most of the brands and types of analogue insulins in adults and children, so it does still occur.

One of the major problems with lipoatrophy is that if people continue to inject in these affected areas, it can lead to erratic insulin absorption which in turn leads to erratic blood glucose levels. There is no treatment if lipoatrophy does develop, so the best way is to prevent the problem from happening in the first place and this means rotating the injection sites and regular inspection of injection sites.

### **ANIMAL INSULIN SUPPLIES IN THE UK**

*Some people have adverse reactions to synthetic human and analogue insulins and have to use natural animal insulins.*

*Animal insulins are available on an NHS prescription in just the same way as other insulins. Even when suffering unaccountable symptoms and loss of warnings of hypoglycaemia, most people are not given the opportunity to try animal insulin.*

*All too often people are not informed of their availability or worse still, they are told by health professionals that they are no longer manufactured. This is not the case and pork and beef insulins are supplied on the NHS by Wockhardt UK.*

#### **Future availability:**

*In 2012 Wockhardt UK confirmed that they have no plans to discontinue beef and pork insulins. Wockhardt also export animal insulins for personal use to people in countries where they are no longer available.*

## Insulin Regimes

NHS policy is to provide patient-centred care, defined by National Institute for Health and Care Excellence [NICE] as treatment that takes into account patients' need and preferences. Type 1 diabetes is a condition that is largely self-managed, so it is especially important that you are involved in decisions so that you can make an informed choice of the insulin and regime to suit your needs, your lifestyle and your preferences. It is also a condition that affects the people around you, your family or friends and so it is important that they have the opportunity to be involved in your choices, if that is what you wish. The most commonly used regimes are as follows:

### **Short or rapid-acting insulin at meal times with intermediate or long-acting insulin (basal bolus regime)**

- Rapid-acting insulin starts to act almost immediately and was designed to lower post-meal blood sugars but short-acting insulin takes between 20 to 30 minutes to start acting. However, short-acting insulin has the advantage of lasting longer than the rapid-acting insulins and it is still active by the next meal time. It is worth noting that for people who eat a high fibre diet of slow-acting carbohydrate, rapid-acting insulin may be too rapid acting as it will work before the carbohydrate has got into the system and this could result in hypoglycaemia.
- Intermediate insulins provide the background [basal] insulin and last for around 12 hours and therefore are best given twice a day [before breakfast and the evening meal] to give 24 hour background insulin cover.
- The long-acting analogues, Lantus and Levemir differ in the duration of action. According to the manufacturers, the duration of action of Lantus is 24 hours and the duration of Levemir is 12-14 hours or more [the manufacturers advise that it should be used once or twice daily].

### **Pre-mixed insulins morning and evening.**

These insulins are usually used twice a day. As they are a combination of 30% short-acting or rapid-acting and 70% intermediate-acting insulin

given twice daily, they provide 24 hour basal insulin coverage. The drawback to pre-mixed insulins is less flexibility because the short/rapid-acting insulin cannot be adjusted independently of the longer-acting insulin.

**Note:** Variations on these standard regimes can be introduced to suit individual lifestyles or to try to obtain more even blood glucose levels where people feel able to manage more complex regimes. Here are some examples:

- Pre-mixed insulins can be used with the addition of long or intermediate-acting insulins.
- If rapid-acting analogue insulin is too short-acting so that blood sugars go up before the next meal, a short-acting insulin with a longer duration can be given at the same time.
- If Hypurin Porcine Neutral is the short-acting insulin normally used but this does not act quickly enough after meals, a small dose of a rapid-acting insulin analogue can also be given with the meal. This may only apply with certain mealtime injections eg before breakfast if blood sugars are high in the morning.
- Small doses of short-acting insulin [human or animal] or rapid-acting analogue insulin can be given at any time of day to bring down unexpected high blood sugars. Alternatively taking exercise [brisk walk or cycle ride] can reduce the high blood sugar which may be preferable to giving extra insulin.

## **Factors that may influence your choices of insulin and insulin regimes**

**Insulin** - you have the choice of animal, human or analogue insulins.

**Diet** - the type of diet eaten may affect your choice of insulin. Here are just some examples:

- You may prefer a low carbohydrate diet to reduce your daily intake of insulin and reduce the risks of severe hypos by only needing small doses of insulin.

- If you prefer a low carbohydrate diet it may mean that a lunchtime injection is not necessary eg if you eat salad with no carbohydrate.
- If meals are largely slow-acting carbohydrates, then animal or human insulin may be better than a rapid-acting analogue which acts too quickly and does not last long enough for the slow-acting carbohydrate.

**Practicalities, lifestyle and quality of life** - your lifestyle may be such that it influences your choice of insulin regime. Here are just some examples:

- If your job involves a lot of driving, you may consider that it is safer for you to run your blood sugars less tight than the target of near normal, so that you do not increase your risks of being hypo while driving.
- If you live alone, you may prefer to run your night time blood sugars a little higher to avoid the risk of a night hypo.
- If injecting at lunchtime is a problem, such as for children at school, then you may choose to use short-acting insulin and twice daily intermediate insulins that cover lunchtime carbohydrate eaten without the need for an injection.
- If you find multi-dose regimes difficult and confusing, you may find it easier to use a twice daily injection regime to give you a better quality of life.

### **Adverse reactions, safety and efficacy**

As with all new drugs, when new insulins are introduced to the market, it is important to be aware that they have only been used in trials involving a relatively small number of selected people, so they may not suit everyone. Adverse reactions may not show up until the new insulin is used in the wider diabetic population. In addition, the long-term safety and efficacy of new insulins are unknown, so you may prefer to stay with a previous insulin that has a history of safety and where any adverse reactions are known.

It is also important to remember that adverse reactions can show up immediately, within weeks or even years later. If you experience adverse reactions, or suspect an adverse reaction, you should report this to your doctor.

***You have a choice of treatment and so IDDT recommends that you discuss your choice and the risks and benefits with your doctor or diabetes team.***

## Diet

### Understanding Carbohydrates

Carbohydrates are sugars and starches – bread, potatoes, rice, pasta, cereals and sugar. They provide the energy our bodies need for all its various activities. Energy is also supplied by fats and proteins. In Type 1 diabetes the amount of carbohydrates eaten has to be matched with the insulin dose and so carbohydrates are central to the treatment of Type 1 diabetes

### The recommended diet

The recommended diet in the UK for people with diabetes is the standard high carbohydrate, low fat, plenty of fruit and vegetables, which is the ‘healthy diet’ recommended for the general population.

Prior to 1986, the recommended diet for people with both Type 1 and Type 2 diabetes was a restricted carbohydrate diet. In people with Type 1 diabetes, this involved matching the insulin dose to the amount of carbohydrates eaten and many people continued to follow this diet. There is now a trend to return to this diet and many people are taught to count the carbohydrates they eat and match this with the correct dose of insulin.

Some people also follow a low carbohydrate diet which results in lower doses of insulin being necessary and this in turn often results in less variable blood sugars and less weight gain. Despite a resistance to the low carb diet on the part of many healthcare professionals, there is now evidence that a low carbohydrate may well be beneficial. However, as well as the amount of carbohydrate eaten being important, the type of carbohydrate is also important.

## What happens to the carbohydrates in someone without diabetes?

- When we eat, beta cells in the pancreas produce insulin, a hormone which controls the glucose levels in the blood. The pancreas produces the right amount of insulin for the amount of carbohydrates we have eaten and this keeps the level of glucose in the blood within the normal range. [People WITHOUT diabetes have blood glucose levels within certain measurements – 4 to 7mmols/l.]
- The carbohydrates are converted into glucose which then goes into the blood and is carried around the body in the blood stream to provide energy wherever it is needed.
- If we have eaten more carbohydrates than we need for energy at a particular time, then the excess glucose is stored in the liver as glycogen. This is used for extra physical activity, or occasions when the blood glucose levels drop unexpectedly, such as times of fear.

## What happens to carbohydrates in people with Type 1 diabetes?

- In people with diabetes the cells in the pancreas cannot produce insulin. When carbohydrates are eaten, no insulin is produced and so the glucose levels in the blood rise higher and higher.
- The body cannot cope with this and so the excess glucose is passed through the body into the urine. This means that people with untreated diabetes pee a lot to get rid of the excess glucose. In turn, this makes them thirsty because the body gets dehydrated. These are the classic signs of undiagnosed diabetes – thirst and peeing.
- The body becomes short of energy as a result of the glucose being excreted and the person feels tired. The body starts to burn fats to provide the necessary energy and there is weight loss. Treatment is essential at this stage and it is often an acute emergency situation.

As the body does not produce its own insulin, the treatment of Type 1 diabetes is always with insulin. In the person without diabetes, insulin is produced in response to carbohydrates eaten but in people with Type 1 diabetes, the insulin is given in regular doses, so it has to be balanced with the amount of food eaten and the level of activity / exercise. Therefore counting the carbohydrates eaten is an important part of controlling blood glucose levels.

## The types of carbohydrate are important

**Fast-acting carbohydrates [sugary foods]**, such as cakes and biscuits, will raise blood sugars more quickly and higher in people with diabetes. It may be necessary to increase the dose of insulin. Sugary carbohydrates tend not to last as long in the body so blood sugars may drop before the next meal. They also tend to make blood glucose levels peak and trough.



Examples of 15g portions of fast-acting carbohydrate:

- 1 scoop or small block ice cream.
- 1 mini chocolate bar.
- 3 tsp sugar, jam or marmalade.
- Small packet of crisps



## **Slow-acting carbohydrate [unrefined carbohydrates]**

, such as cereals and bread, do not raise the blood sugars as quickly or as high after eating. They last longer and therefore tend to give more even blood glucose levels and the amount of insulin needed may be less.

Examples of 15g carbohydrate portions of slower-acting carbohydrate:

- 1 medium slice of bread or toast, preferably granary or wholemeal.
- 4 tablespoons of breakfast cereal or 2 tablespoons of muesli.
- Half a pitta bread or chapatti.
- 2 boiled or baked potatoes, each the size of a small egg.
- 1 tablespoon of cooked rice or pasta.

## **Fruit and vegetables**

All of us are advised to eat 5-9 portions of fruit and vegetables a day. These foods are mainly low in fat (apart from avocados and olives), are full of vitamins and minerals, fibre and antioxidants, which have an important protective effect on the body, which is particularly important for people with diabetes. However, it is worth remembering that fruits contain a form of sugar and therefore this needs to be taken into account when counting carbohydrates, eg 10 grapes contain 10 grams of carbohydrate but strawberries contain much less.



## **Fats**

Fats provide some of the energy our bodies need. The healthy eating guidelines recommend that we should eat less fat, especially saturated fat in order to reduce the risk of heart disease and to keep blood cholesterol levels down. This can best be achieved by eating a varied diet with plenty of fruit, vegetables, whole grain cereals, pasta, rice and potatoes. As people with diabetes have an increased risk of heart disease, it is particularly important to reduce the fats in the diet.

## **Alcohol and diabetes**

Alcohol lowers blood glucose levels and this can result in hypoglycaemia. The tendency to hypo after alcohol can be within 4-6 hours but blood glucose levels can remain low for 24-36 hours after significant alcohol consumption. The carbohydrates that the alcoholic drink may contain do not offset the blood sugar lowering effect of the alcohol, so these should not be counted as part of your carbohydrate consumption.

In addition to the risk of hypos, alcohol impairs your judgement and so if you have diabetes, this means that you may not realise that

you are having a hypo and so you will not treat it with sugary food. Furthermore, your friends may not realise that you are hypo and may simply assume that your 'odd' behaviour is because you are drunk. This is a dangerous situation and can result in a severe hypoglycaemic attack, unconsciousness, seizure and hospitalisation.

Having diabetes does not mean that you cannot or should not drink alcohol because this can affect your social life. However, it does mean that you should:

- Only drink in moderation, sensible advice whether you have diabetes or not.
- Learn by experience how alcohol affects you – everyone is different.
- Take the appropriate steps to prevent a hypo and if necessary lower your insulin dose at the meal prior to going out for a drink.
- The best time to drink is with a meal.
- If you are not having a meal with your alcohol, then it is a good idea to nibble carbohydrate [eg crisps] throughout the evening.
- Never drink alcohol before a meal.
- Have an extra bedtime snack before going to bed. Remember the alcohol could lower your blood glucose during the night while you are asleep, resulting in a night hypo. The alcohol may also make you sleep more soundly and so the hypo warnings may not wake you.

The InDependent Diabetes Trust (IDDT) has published a booklet, '*Diabetes – Everyday Eating*' which contains 28 days of meals for breakfast, lunch and dinner.

This can be obtained by contacting IDDT, Tel 01604 622837, email [enquiries@iddtinternational.org](mailto:enquiries@iddtinternational.org) or by writing to IDDT, PO Box 294, Northampton NN1 4XS

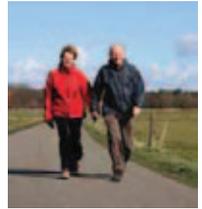
## Exercise

It is recommended that the general population takes exercise – at least 30 minutes brisk walking, 5 days a week. However, this particularly applies to people with diabetes because they are at greater risk of coronary heart disease and regular exercise reduces this risk.



### Exercise and Type 1 diabetes

- Physical activity can reduce the daily insulin intake.
- Physical activity appears to raise HDL [good] cholesterol levels but it does not affect LDL [bad] cholesterol levels.
- It lowers blood pressure or prevents it from developing.
- It helps to reach and maintain a healthy weight.



### Types of activity

**Aerobic activity** – this type of exercise benefits your heart. It is any activity that is rhythmic and repetitive eg walking, swimming, cycling or dancing, which increase the body's demand for oxygen so making the heart and lungs work harder and more efficiently.

**Isometric exercise** - this increases muscle tension without moving a joint eg pushing against a wall. Isometric exercise does not help the heart and circulation. It should be avoided by people with heart disease or high blood pressure because it can increase blood pressure and put the heart under stress.

### Exercise and the risk of hypoglycaemia [low blood glucose levels]

Keeping fit is recommended for people with diabetes, including those being treated with insulin. However, injected insulin cannot mimic the response of a healthy pancreas to exercise.

When treated with insulin, exercise can cause hypoglycaemia at the time, or up to 12 – 14 hours or even longer after exercise. This is because the body uses up any circulating glucose to try to replace the glycogen stores in the liver that were used up during exercise. In addition, exercise increases the sensitivity of the body tissues to insulin, especially the muscles.

## **It is important to eat sufficient carbohydrates before, during and after exercise to avoid hypoglycaemia by:**

- Eating a meal of slow-acting carbohydrates about an hour before exercising will keep your blood sugars steady during exercise. Examples: porridge, cereal or multi-grain bread.
- Eating fast-acting carbohydrate immediately after exercise will help to prevent hypoglycaemia and will help to re-stock the liver stores of glycogen which the body turns into glucose when needed. Examples: a piece of fruit, fruit juice or biscuits.
- Regular blood glucose monitoring is important when exercising to avoid both high and low blood sugars.

## **Sometimes blood glucose levels can be high after exercise**

We are all led to believe that exercise will lower blood glucose levels and it does, but there are times when exercise actually raises blood glucose levels. IDDT is often asked by people with Type 1 diabetes why this happens.

Exercise normally lowers blood glucose levels, often rapidly, because glucose is necessary for the extra energy needed quickly for exercise or physical activity. This is why exercise is a good way of reducing blood sugars that are a bit high instead of giving extra insulin which may have a knock on effect later.

However, while exercise does mostly lower blood glucose levels there are occasions when it can cause them to be high and the most common reasons are:

- blood glucose levels are too high when you start to exercise or
- if the exercise you are taking is strenuous.

Whenever blood glucose levels are too high, it always means that there is not enough insulin present to bring them down.

The muscles need energy for exercise and the quickest form of energy is glucose so the muscles temporarily increase their sensitivity and the same amount of insulin releases more glucose into the muscle cells so that they

can carry out the extra exercise. However, if there is not enough insulin in the muscles, they will not receive enough glucose from the blood, even if there is enough glucose in the blood. So the muscles send a signal that they need more energy and the body responds by releasing more glucose but as there is still not enough insulin in the muscles to convert the glucose into energy, the blood glucose levels rise. The muscles continue to send out the signals and more glucose is released, so the blood sugars continue to rise. So if blood sugars are high before exercising, exercise can cause them to rise even higher and the reason is not enough insulin. This is why you are advised not to exercise if your blood sugars are high.

### **Strenuous exercise**

Strenuous exercise can have the same effect and can raise blood glucose levels. This is for the same reasons – not enough insulin. During very strenuous exercise the muscles send their signal for more energy and the body responds by releasing more glucose which in turn raises the blood glucose levels.

Under normal conditions the body uses about 60% of its energy from fat and 40% from glucose. The harder you work, the less fat is used and the more glucose is used until you reach a state of anaerobic activity [weight lifting, fast sprinting] which uses 100% glucose. Although it is not what we expect, the harder you exercise the more insulin your body needs to deal with the increased amount of glucose being released for energy.

With this anaerobic exercise, up to 17 times more glucose is required but such large amounts of glucose are not available from the bloodstream and via the insulin transport mechanism, so it is taken directly from the glycogen stored in the muscle. Insulin is used for the glucose to get into muscle cells so that it can be stored as glycogen but insulin is not needed when glycogen derived glucose is burned in the muscle. Glucose made from muscle glycogen cannot get into the bloodstream and is burned by the muscle in which it was stored but when the glucose is derived from muscle, the glycogen in the liver also produces extra glucose that

goes directly into the blood stream and this is why strenuous exercise [anaerobic exercise] can cause the blood glucose levels to go up.

During strenuous exercise, glucose is the primary source of energy for the first 15 to 20 minutes of aerobic exercise and initially 70% comes from carbohydrates. After about 20 minutes, fat becomes the primary source of energy with 70% coming from fat. If the exercise then becomes anaerobic, glycogen reserves in the muscles are used and the muscles will use as much glucose as they need.

While high blood sugars after exercise are not what we expect, this somewhat complex explanation offers the reasons.

## Education



It has been estimated that on average most people only spend around 3 and a half hours a year with their diabetes health professionals, so both Type 1 and Type 2 diabetes are largely self-managed conditions. It is therefore important that people with diabetes receive education to help them to manage their condition.

The National Institute for Health and Care Excellence (NICE) Guidance (TA60) states that everyone with Type 1 diabetes and/or their carer is entitled to a structured education programme at the time of diagnosis, then on an ongoing basis as necessary. Most people with diabetes in England and Wales are offered education, at least at the time of their diagnosis. However, the length, content and style of educational options varies greatly between services; some of the educational programmes offered are unstructured and very few have been formally evaluated, and few individuals who deliver education have been formally trained for this purpose.

### The key points from the NICE guidance:

- Education should be provided by an appropriately trained multidisciplinary team to groups of people with diabetes, unless group work is considered unsuitable for an individual. Multidisciplinary teams providing education should include as a minimum, a diabetes specialist nurse (or a practice nurse with experience in diabetes) with knowledge of the principles of patient education and a dietitian.
- Sessions should be accessible to the broadest range of people, taking into account culture, ethnicity, disability and geographical issues, and could be held either in the community or at a local diabetes centre.
- Educational programmes should use a variety of techniques to promote active learning and adapted wherever possible to meet the different needs, personal choices and learning styles of people with diabetes, and should be integrated into routine diabetes care over the longer term.

To help people to live a long and healthy life with Type 1 diabetes, it is important that diabetes education is offered at diagnosis and in an ongoing way.

## Measurement of blood glucose levels

### Home blood glucose monitoring



Regular self monitoring of blood glucose levels is the way people with Type 1 diabetes control their diabetes. This way they know what is happening to their blood sugars and whether they need to make any adjustments to their food intake, physical activity or insulin dose. Blood glucose tests give accurate readings of the blood glucose level at that particular moment.

**Blood glucose testing helps to maintain blood glucose control by:**

- detecting high or low blood glucose levels
- monitoring trends or patterns in blood glucose levels
- helping to manage blood glucose levels during illness
- assessing the effects of different foods or changes in diet on blood glucose levels
- helping to manage blood glucose levels before, during and after physical activity.

Normal blood glucose levels in someone WITHOUT diabetes are between 4 and 7mmols/l. Most people with diabetes are encouraged to try to keep their blood glucose levels as near to normal as possible while avoiding them dropping too low. There are circumstances where this target is not always appropriate and recommended blood glucose levels may be higher, for example people who live alone, people who are at risk of hypoglycaemia and people who are elderly.

**Results may vary**

It is important to remember that insulin injections or the delivery of insulin via an insulin pump, is not the same as the way the pancreas normally works, so test results can vary and it is not always possible to find an explanation. However, there are some common possible causes of blood glucose levels being too high or too low.

- After a hypo when extra carbohydrate / sugary food or drink has been eaten, then the next test results may be high.
- After exercise or physical activity tests results may be high or low.
- Illness can affect results and infections often cause blood sugars to rise.
- Stress can cause erratic test results, many people have high blood sugars when stressed.
- The weather can also affect results – very hot and very cold weather often cause low blood sugars.

## What does home blood glucose monitoring involve?

A small drop of blood is needed and this is obtained by using a finger-pricking device. You should prick the side of the finger beside the fingernail, but not too close to the nail as this will be painful. Avoid using the forefinger and thumb and change the fingers at each test to avoid them becoming sore or the skin hardening. Gently squeeze your finger to obtain a droplet of blood, place this on the test strip and put the strip in the meter which then gives a reading of the blood glucose level in seconds.

### Recommended target blood glucose levels

Everyone with Type 1 diabetes should be treated as an individual and everyone is different so recommended targets are only a guide. You and your healthcare team should agree on the targets that are suitable for you.

- **Adults with Type 1 diabetes** should aim for 4 – 7 mmol/l before meals and no higher than 9mmol/l 2 hours after a meal.
- **Children under 16 with Type 1 diabetes** should aim for 4 – 8 mmol/l before meals and no higher than 10mmol/l 2 hours after a meal.
- **Pregnant women with Type 1 diabetes** should aim for 3.5 – 5.9 mmol/l before meals and no higher than 7.8mmol/l one hour after meals.

There are many different meters on the market and your diabetes healthcare team will discuss these with you, show you how to test accurately and to know what action, if any, to take as a result of the test result.

**Points to remember**

- Wash your hands in water, especially important if you have been hypo and your fingers could be sticky. Do not use wet wipes because they could contain glycerine which would alter the results.
- If you do not obtain much blood after pricking your finger, hold your hands down so that the blood can flow to your fingers.
- Make sure that your hands are warm as it is harder to draw blood if they are cold and it is more painful.
- It is important to record your blood glucose test results as this will show any trends or patterns in your blood glucose levels. These can be recorded in a hand written diary, stored in your blood glucose meter or using a computer programme. The method of recording is not important as long as you have a record to discuss with your healthcare team so that any adjustments to treatment can be made, although with a hand written diary, you can add comments alongside the results.

**Testing for ketones**

If you have Type 1 diabetes and your blood glucose levels rise to high (above 14mmol/l) and remain high, you may develop diabetic ketoacidosis (DKA). This is a dangerous and potentially life threatening condition when there is not enough insulin in the body to transport the glucose from the blood to the cells where it is needed for energy. A different source of energy has to be found so the body burns fats and during this process, ketones are produced. You can test for ketones in the blood or urine using ketone strips or you may have a meter that is able to test for ketones.

If you find ketones in your blood or urine, you should seek medical advice.

**Blood glucose testing by your healthcare team**

There is also a blood glucose test that will be carried out by your healthcare team and this is called the HbA1c test. It measures the average

blood glucose levels over the previous 8 weeks or so. For this test blood is taken from your arm and it either will have to be sent to a laboratory or some clinics have a machine that can give an instant result.

This test measures the amount of glucose being carried by the red blood cells in the blood. If blood glucose levels are too high, the excess glucose sticks to the red blood cells and the HbA1c test measures this to detect what has been happening to blood glucose levels over the previous 8 weeks or so.

**Note:** one of the problems with the HbA1c test is that it does not detect low blood glucose levels and therefore the results can be misleading. For instance, someone whose blood sugars frequently swing from high to low could appear to have a 'good' HbA1c because they are not high most of the time but as their blood sugars are erratic, they actually do not have the 'good' control implied by the HbA1c results.

### HbA1c Converter

HbA1cs used to be measured in percentages, and still are in some countries, but in the UK new measurements are now used and these are mmol/mol. The table below shows the conversion of percentage measurements to mmol/l.

HbA1c measurement (%)	HbA1c (IFCC) measurement mmol/mol
6	42
7	53
8	64
9	75
10	86
11	97
12	108
13	119

### Target HbA1c

Your healthcare team will discuss with you the HbA1c level that you

should be aiming for. In the UK the ideal target is 48mmol/mol (6.5%) but other countries have set their target levels at 53mmol/mol (7%). Whatever target is classed as standard, targets will vary according to each person's needs and again those who live alone, who are elderly or those who are at risk of severe hypoglycaemia may be asked to aim for higher targets, such as 58mmol/mol (7.5%).

### **Frequency of HbA1c tests**

Soon after diagnosis, you may be seen every 3 months for an HbA1c tests and then it may be 6 monthly or even annually. The problem with only having an annual test is that adjustments need to be made and 12 months is a long time before further tests are carried out.

### **Fructosamine Test**

There are certain conditions which involve abnormal red blood cells, such as anaemia, sickle cell anaemia or thalassaemia, and these mean that the HbA1c test is not accurate. In this case your doctor may carry out a fructosamine test. This measures glucose molecules attached to proteins in the blood and shows the average blood glucose levels over the previous 2 to 3 weeks. There is no standard reference range for the fructosamine test and you need to discuss your individual targets with your doctor.

## Regular reviews

To help you to look after your diabetes control and to check for possible complications, you will have regular reviews with your doctor and/or healthcare team. NICE recommends that that everyone with diabetes should receive nine key tests on an annual basis. These should be carried out at your annual review at your hospital or GP appointment.

These tests are:

- Weight measurement
- Blood pressure
- Smoking status
- HbA1c
- Urinary albumin
- Serum creatinine
- Cholesterol
- Eyes
- Feet





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