



# Understanding Your Diabetes

## Facts About Diabetes

**Diabetes is a chronic disease that affects around 2.2 million people in the UK, around 85 to 90% of whom have Type 2 diabetes. In the UK there are 20,000 children with Type 1 diabetes under the age of 15 years.**

**There are two forms of diabetes:**

### Type 1 diabetes

- This type accounts for about 10 to 15% of the total number of people with diabetes. It affects children and adults up to the age of forty. The number of children diagnosed under the age of 5 is markedly increasing. It is also referred to as insulin dependent diabetes or juvenile diabetes.
- 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.
- Around 20,000 people are treated with natural animal insulin and the remainder with synthetic 'human' or analogue insulins made by genetic engineering.
- There is no cure for Type 1 diabetes and cause has not been established. It is thought that there may be several causes with a genetic link in some people. Recent research shows that a common virus may trigger the body's immune system to attack its own insulin-producing pancreatic cells.

### Type 2 Diabetes

- Type 2 diabetes affects 85 to 90% of the total number of people with diabetes, nearly 2 million people and it is thought that there is an equal number of people undiagnosed. It occurs mainly in people over the age of 40. This type of diabetes is also referred to as non-insulin dependent diabetes.
- In Type 2 diabetes, the pancreas often still produces some insulin but either not enough or it is not used properly by the various organs in the body (so there can be too much insulin in the system).
- Type 2 diabetes can sometimes be treated with diet and exercise alone, sometimes with oral blood glucose lowering drugs and if this fails to reduce blood glucose levels sufficiently, then treatment with insulin is necessary. On average, people with Type 2 diabetes start to take insulin 7 years after diagnosis.
- Type 2 diabetes can remain undiagnosed for several years during which time the blood glucose levels are too high, causing damage and some of the complications of diabetes. People with Type 2 diabetes are often diagnosed as a result of having complications rather than because they suspect they have Type 2 diabetes.
- There is a tendency for Type 2 diabetes to run in families but a sedentary lifestyle and being overweight or obese are also causes.



### The term 'diabetes' blurs the lines and causes confusion

As we can see, 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' - in press articles, NHS information and even diabetes organisations' magazines are guilty of just referring to 'diabetes'. This blurring of the lines between Type 1 and Type 2 can cause unnecessary fears, confusion and misunderstandings which can be dangerous. The misconception that 'diabetes' is simply a result of lifestyle, minimises the public perception of the seriousness of both types of diabetes.

### Why blood glucose levels need to be controlled

If blood glucose levels are too high then this can lead to long-term complications. Type 1 and Type 2 diabetes are different diseases in cause, effect and treatment but the same long-term complications can arise in both types of the condition. The risk of complications is reduced by the treatment of diabetes and by lifestyle changes to reduce blood glucose levels. In the case of Type 2 diabetes, early diagnosis helps to reduce the risk of complications developing.

The recommendations are that people with both types of 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 threefold, so good control is a balance between achieving blood sugars that are as near normal as possible but at the same time avoiding hypoglycaemia. Hypoglycaemia in people treated with insulin is caused by the blood glucose lowering effect of insulin and not by diabetes itself. For many people, hypoglycaemia and the avoidance of it, is one of their major daily concerns.

### The complications affect:

#### The eyes

Diabetes can affect the blood vessels at the back of the eye (retinopathy) and this 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.



## Understanding Diabetes and its Treatment

To understand diabetes and its treatment, first we 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 e.g. if you have missed a meal. 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 – 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.

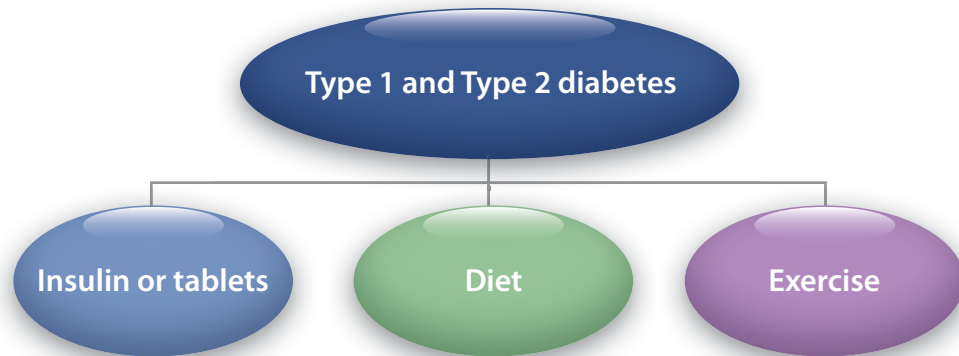
The body cannot cope with this and so the excess glucose is passed through the body into the urine. This means that people with untreated diabetes pass urine frequently to get rid of the excess glucose. In turn, this makes them thirsty because the body gets dehydrated. These are the classic signs of 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 and 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.

## What happens in Type 2 diabetes...

In Type 2 diabetes either the insulin-producing cells in the pancreas do not produce enough insulin or the insulin they produce is not used properly – this is called insulin resistance. The blood glucose levels gradually rise and this may be so gradual that it takes place over several years before diagnosis.

As the onset is gradual, the extreme symptoms that occur with Type 1 diabetes don't occur but they creep on gradually. Blood glucose levels may not rise sufficiently high for glucose to spill into the urine, so Type 2 diabetes can go undiagnosed, during which time it can be causing some of the complications.

## Three important factors in the treatment of Type 1 and Type 2 diabetes



Although Type 1 and Type 2 diabetes are very different conditions, the treatment of both types of diabetes has three factors in common – medication (insulin or tablets), diet and exercise. All three are important, they all affect blood sugar levels and they all affect each other. So in both Type 1 and Type 2 diabetes there is an important relationship between medication (insulin or tablets), diet and exercise and to achieve good diabetic control we have to try to balance all three. It is much easier to manage both types of diabetes if we understand about carbohydrates, about exercise and about insulin or tablets.

## Understanding Carbohydrates

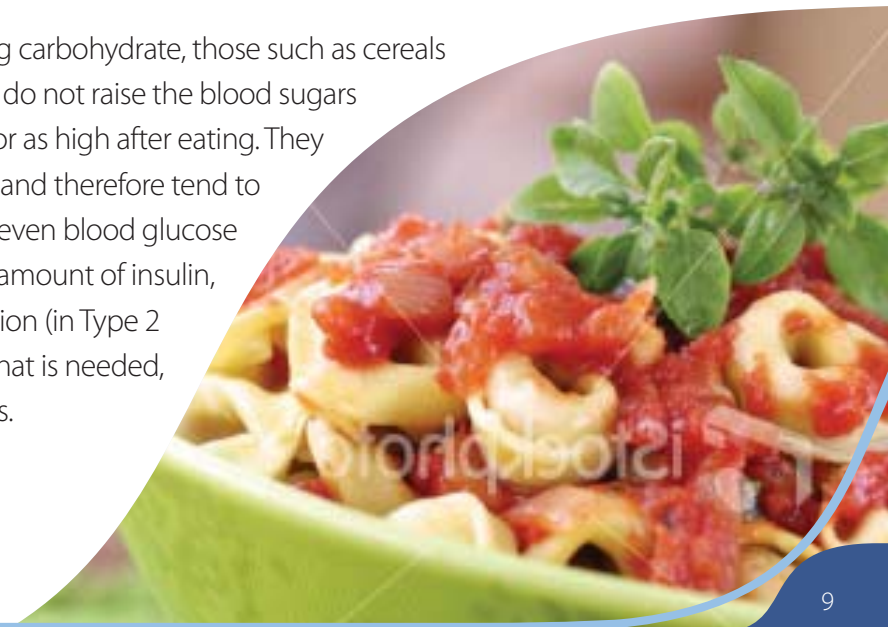
Carbohydrates are sugars and starches – bread, potatoes, rice, pasta, cereals and sugar. They provide the energy our bodies need for all their various activities.

## What happens to the carbohydrates we eat?

- 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.
- If we have eaten more carbohydrates than we need for energy at a particular time, then the excess glucose is stored in the liver. This is used for emergencies such as extra physical activity or occasions when the blood glucose levels drop unexpectedly, such as times of fear.

## The type of carbohydrate we eat is important in people with diabetes:

- Sugary foods, such as cakes and biscuits, will raise blood sugars more quickly and higher in people with diabetes and more injected insulin or medications may be necessary. Sugary carbohydrates tend not to last as long in the body so blood sugars may drop before the next meal. Sugary carbohydrates tend to make blood glucose levels peak and trough.
- Slow-acting carbohydrate, those 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. The amount of insulin, or medication (in Type 2 diabetes) that is needed, may be less.



## Understanding Exercise

Physical activity and diabetes - it is recommended that we all take exercise, at least 30 minutes brisk walking, 5 days a week.

### Facts about exercise

- People with diabetes are at greater risk of coronary heart disease and regular exercise reduces this risk.
- Physical activity can reduce the amount of medication needed or reduce the daily insulin intake.
- Moderate, rhythmic exercise seems to reduce the risk of people developing Type 2 diabetes in middle age.
- 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 e.g. 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 e.g. 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.

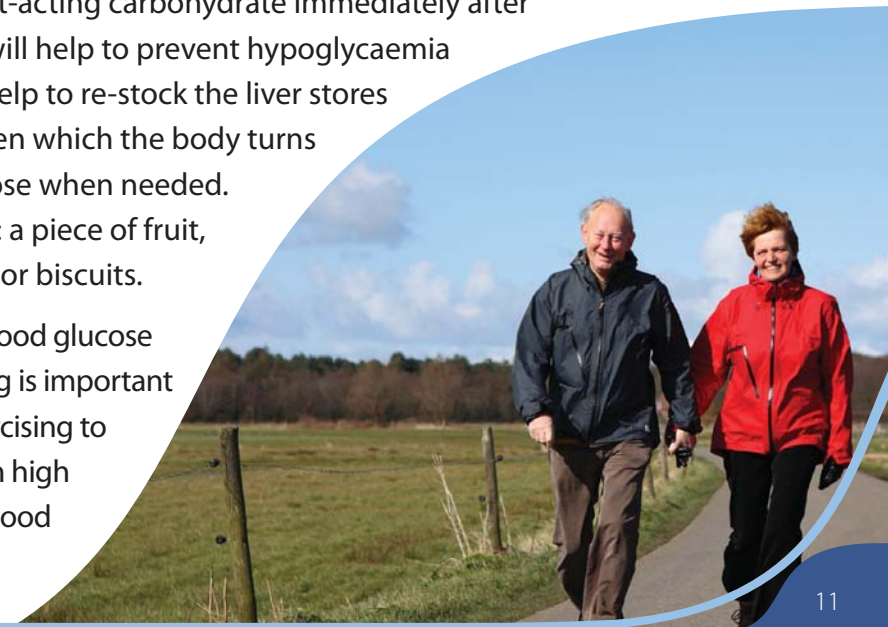
### Exercise and the risk of hypoglycaemia (low blood glucose levels)

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.

If you have diabetes which is treated with insulin, or with one of the Type 2 diabetes drugs that can cause hypoglycaemia, then exercise can cause hypoglycaemia. Hypoglycaemia can occur 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.



**Understanding carbohydrates and exercise is necessary in both types of diabetes, but the medications for Type 1 and Type 2 diabetes are different so we have to look at Type 1 and Type 2 diabetes separately.**

## Type 1 Diabetes – Insulins and Insulin Regimes

### 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 whether beef, pork or genetically modified human insulin (GM insulin).
- In 1982 genetically modified so-called 'human' insulin was introduced and about 85% of people using insulin were transferred to human insulin on the assumption, not proof, that it was better than animal insulin.
- In 1998 the first insulin analogue was introduced. Analogue insulins are made from 'human' insulin by genetically modifying it again.

So in the UK, there is a choice of analogue, animal and human insulins and all are available on an NHS prescription.

### Action and duration times of insulins

In Type 1 diabetes usually between 2 - 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 of 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 deal with the carbohydrates eaten at meal times.
- Intermediate and long-acting insulins work in the background all the time.

Table 1 shows the different insulins according to their origin and their length of action.

INSULIN	RAPID	SHORT	INTERMEDIATE	LONG
Analogue	Apidra Humalog NovoRapid			Lantus Levemir
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 of rapid-acting, or short-acting insulins with an intermediate-acting insulin. These are usually used when only two injections a day are required.

Table 2 shows the different pre-mixed insulins.

INSULIN	Pre-mixed
ANALOGUE	Humalog Mix 25 and Mix 50, NovoMix 30
ANIMAL	Hypurin Porcine 30/70
HUMAN	Humulin M3, Insuman Comb 15, 25 and 50, Mixtard 30

**Table 3** is a rough guide to the activity curves of the different insulins. It is important to remember that these times of peak activity and duration are general and will vary in different people.

**Table 3 lists the order of the development of the different insulin types.**

INSULIN TYPE	ONSET	PEAK (hours)	EFFECTIVE DURATION (hours)	MAXIMUM DURATION (hours)
<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 hours	10 - 16 hours	14 - 18 hours
<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	

Note: Long-acting beef insulins (Bovine lente and Bovine PZI) are available but they are not included in this Table as they are rarely used.

### Key facts about insulins and their actions:

- The manufacturers' profiles of the speed of onset, peak of action and duration of action are only a rough guide and may vary. 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.



## Insulin Regimes

### Standard insulin regimes include:

Short or rapid-acting insulin at meal times with intermediate or long-acting insulin.

- **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

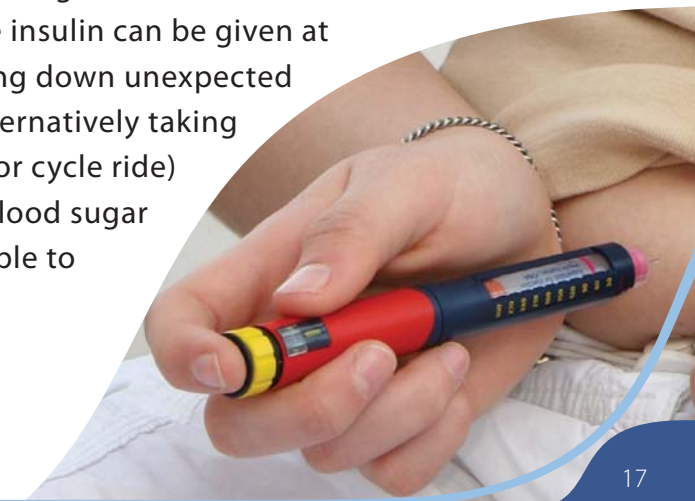
These insulins are usually used twice a day. As they are a combination of 30% short-acting and 70% intermediate-acting insulin given twice daily, they provide 24 hour basal insulin coverage. The drawback to pre-mixed insulins is less flexibility because the short/rapid-acting insulin cannot be adjusted independently of the longer-acting insulin.

### Long-acting insulins alone

These are sometimes used alone but usually for Type 2 diabetes either once or twice daily depending on the type of insulin being used.

*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 e.g. 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 (a brisk walk or cycle ride) can reduce the high blood sugar which may be preferable to giving extra insulin.



## Your Choices of Insulin and Insulin Regimes

NHS policy is to provide patient-centred care, defined by the National Institute for Health and Clinical Excellence (NICE) as treatment that takes into account patients' need and preferences. NICE goes on to say that 'good communication' is essential, supported by evidence-based information, to allow patients to reach informed decisions about their care. (NICE Guidelines for Type 2 Diabetes, May 2008)

Type 1 diabetes is a condition that is largely self-managed, so it is especially important that you are involved and can make an informed choice about the insulin and regimes to suit your needs, your lifestyle and your references. Type 1 diabetes is also a condition that affects the people around you, like your family or work colleagues and so it is important that they have the opportunity to be involved in your choices, if that is what you wish.

### Factors that may influence your choices

There is a choice of insulins - animal, human or analogue insulins.

#### Diet:

**The type of diet eaten may affect your choice of insulin. Here are 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 e.g. 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 may be such that it influences your choice of insulin regime. Here are 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-time 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 trialled in a relatively small number of people, so they may not suit everyone. Adverse reactions may occur in some people but 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 is unknown, so you may prefer to stay with a previous insulin that has a history of safety and where any adverse reactions are known.

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.

The International Diabetes Federation Position Statement, March 2005 states:

***"There is no overwhelming evidence to prefer one species of insulin over another and patients should not be changed from one species to another without reason."***

## Type 2 Diabetes Treatment

As we have established, essential parts of the treatment of Type 2 diabetes are diet and exercise and appropriate medications, when necessary, to try to achieve target blood glucose levels. NICE guidelines recommend that target blood glucose levels for Type 2 diabetes should be agreed with you, the patient but unlike Type 1 diabetes, NICE also recommends that pursuing highly intensive management to HbA1c levels of less than 6.5% should be avoided. (HbA1c is a measurement of average blood glucose levels over the past 6-8 weeks).

### Diet and exercise alone

Initially for some people, diet with exercise may produce the desired lowering of blood glucose levels. However this may not be appropriate for everyone and may not maintain blood glucose control so drugs have to be used.

### Type 2 drugs

There are a range of drugs to treat Type 2 diabetes all of which should be used with diet and exercise. There are three main drugs that are used to treat Type 2 diabetes when just diet and exercise are not sufficient.

#### ***NICE recommends that they are used as follows:***

- Metformin (Glucophage) – this increases insulin sensitivity. It does not increase insulin production and therefore does not cause hypoglycaemia (low blood sugars). It is particularly used in people who are overweight. Its main adverse effects are gastrointestinal problems. If metformin alone does not control blood glucose levels then another drug may be added from the range known as sulfonylureas.
- Sulfonylureas (Amaryl) – these drugs stimulate the production of insulin and therefore may cause hypoglycaemia.

- Glitazones (Avandia, Avandamet and Actos) can be added to treatment. These drugs work by reducing insulin resistance in fat tissue, muscles and the liver. Recent research has shown that they can cause fluid retention, heart and liver problems, increase the risk of osteoporosis and some doctors are no longer prescribing these drugs. It is advisable to discuss them with your doctor.

There are other drugs available which your doctor may discuss with you. A range of new drugs that have been recently approved but at the time of writing these are being considered by NICE.

### Addition of insulin

If the above tablets fail to control blood sugars sufficiently, then insulin may be required. NICE recommendations for insulin regimes in this situation are as follows:

- Begin with intermediate-acting insulin at bedtime or twice daily according to need.
- Alternatively, there are situations where a once-daily long-acting insulin analogue may be advisable: (i) if assistance with injections is needed, (ii) if there is significant and frequent hypoglycaemia or (iii) twice daily basal insulin plus oral medications would otherwise be needed.
- Consider twice daily pre-mixed human insulin, especially where the HbA1cs are greater than 9%. A once-daily regime with pre-mixed insulin may be an option.
- Consider pre-mixed insulin analogues rather than human pre-mixed analogues when: (i) immediate injection before a meal is preferred, (ii) hypoglycaemia is a problem or (iii) there are marked rises in blood glucose levels after a meal.

These are some basic insulin regimes for you and your doctor to discuss. However, structured education should also be offered to you and/or your family carer at the time of diagnosis to help you to learn to manage your diabetes.

***NICE recommends this education programme should include:***

- Continuing telephone support from an appropriately trained and experienced healthcare professional.
- Frequent self-monitoring.
- Dose titration to target (how to adjust insulin doses).
- Dietary understanding.
- Management of hypoglycaemia – how to avoid it and treat it.
- Management of acute changes in glucose control.

### Summary of the key NICE Guidance for Type 2 diabetes (May 2008) for implementation by health professionals

#### Patient Education

- Offer structured education to every person and/or their carer at and around the time of diagnosis – this can be in group sessions run by people who have been specially trained to do this.
- Provide individualised and ongoing nutritional advice from a healthcare professional with specific expertise and competencies in nutrition.

#### Setting a Target HbA1c

- Involve the person in decisions about their individual HbA1c target level, which may be above that of 6.5% set for people with Type 2 diabetes in general.

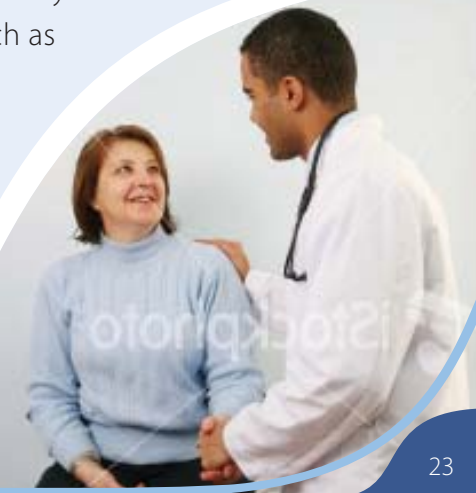
- Encourage the person to maintain their individual target unless the resulting side-effects (including hypoglycaemia), or their efforts to achieve this, impair their quality of life.
- Offer therapy (lifestyle and medication) to help achieve and maintain the HbA1c target level.
- Inform a person with higher HbA1c that any reduction in HbA1c towards the agreed target is advantageous to future health.
- Avoid pursuing highly intensive management to levels of less than 6.5%.

#### Self-Monitoring

- Offer self-monitoring of plasma glucose to a person newly diagnosed with Type 2 diabetes only as an integral part of his or her self-management education. Discuss its purpose and agree how it should be interpreted and acted upon.

#### Regular Reviews

Looking after diabetes, whether you have Type 1 or Type 2, means having regular reviews with your doctor and/or diabetes team to help you control your blood glucose levels and also to check for any diabetes complications. It may be that you will be prescribed other drugs to help you, such as for blood pressure or raised cholesterol levels. This is also your opportunity to discuss any concerns or questions you may have and this way you are working together to provide the best care of you and your diabetes.





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