

Patient information from the BMJ Group

Diabetes, type 2

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Diabetes, type 2

Diabetes is a long-term condition. And it can lead to serious health problems. But making changes to your lifestyle and taking medicines can help you live a long and healthy life.

This information is for people with type 2 diabetes, which usually starts in adulthood. For more information about type 1 diabetes, which usually starts in childhood, see [Type 1 diabetes](#) .

We've brought together the best research about type 2 diabetes and weighed up the evidence about how to treat it. You can use our information to talk to your doctor and decide which treatments are best for you.

What is type 2 diabetes?

If you have diabetes, you have too much glucose in your blood. Glucose is a kind of sugar that your body uses for energy. If it builds up in your blood, it can make you ill.

Diabetes doesn't go away. And if you don't treat it, you can get serious health problems. If you change the way you live, take medicines and keep a close watch on your condition, you can keep your glucose levels under control. You should be able to live a long and healthy life.

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Diabetes is a long-term condition, but with the right treatment you can live a long and active life.

Key points for people with diabetes

- Diabetes is a serious condition. But with the right treatment you should be able to stay healthy.
- If you have diabetes you have too much glucose in your blood.
- There are two main types of diabetes: **type 1** and **type 2**. This information is for people with type 2 diabetes. See also [Type 1 diabetes](#) .
- Many people with diabetes don't know they have it. You may not have any symptoms, or you may think the symptoms you do have aren't important. If you have symptoms such as feeling very thirsty, hungry or tired, having blurry vision or needing to urinate a lot, don't ignore them.
- Over time, having too much glucose in your blood can damage your blood vessels. This can lead to problems in your heart, eyes, **kidneys** , and other parts of your body.
- If you keep your blood glucose level as close to normal as possible you may be able to avoid some of these health problems.
- It's not easy to keep your blood glucose under control. And if you don't feel ill, you may not want to think about your glucose level. But keeping it under control is an important part of staying healthy.

What's a normal glucose level?

You always need to have some glucose in your blood. It comes from food and it gives your body energy. Every cell in your body needs glucose to work properly.

Normally, the amount of glucose in your blood is carefully controlled by a chemical called **insulin**. Insulin is a hormone made by your **pancreas**, a **gland** that sits behind your stomach. Insulin helps move glucose from your blood into your body's cells. Your cells use the glucose as energy. Insulin keeps your blood levels of glucose steady.

Doctors measure your glucose levels in millimoles. The amount of glucose in your blood should be between 4 millimoles per litre of blood (mmol/L for short) and 10 mmol/L. ^[1]

Your doctor may talk about your blood glucose level using just the number. For example, your doctor may say, "Your blood glucose is 10." Normally, your blood glucose level goes up and down throughout the day. Before you eat breakfast, for example, it should be between 4 mmol/L and 7 mmol/L. An hour or two after you eat, it may rise to 10 mmol/L.

To learn more, see [What is glucose?](#) and [How does my body control my blood glucose level?](#)

Types of diabetes

There are two main types of diabetes: type 1 and type 2.

- Type 1 diabetes usually starts in adolescence.
- Type 2 comes on gradually, usually when you're 40 or over.
- There's also a condition called impaired glucose tolerance. This isn't diabetes, but it does increase your chances of getting diabetes.
- Some women get a kind of diabetes while they're pregnant. This is called gestational diabetes.

For more information about other types of diabetes, see [Type 1 diabetes](#) and [Other types of diabetes and high blood glucose](#).

Type 2 diabetes

Most people who have diabetes get type 2 diabetes. More than three-quarters of people with diabetes have this type. ^[2]

Type 2 diabetes usually starts later in life and is more common in people who are very overweight (**obese**). But it's getting more common in children. This is because more children are overweight today than in the past.

Type 2 diabetes used to be called non-insulin-dependent diabetes mellitus (or NIDDM for short) because people who have type 2 diabetes often don't need to take insulin. It's

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sometimes called adult-onset diabetes because it tends to start in people over 40 years old.

What happens in type 2 diabetes?

If you have diabetes, your body can't control how much glucose is in your blood. Instead of the glucose being gradually used up as fuel by your cells, it builds up in your bloodstream. You'll hear the word **hyperglycaemia** a lot. It means having too much glucose in your blood. See [What are the symptoms of type 2 diabetes?](#) to find out how this affects you.

You need insulin to keep your glucose level under control. In diabetes, your glucose level can get too high for different reasons.

- Your body may not be making enough insulin. It might make only a little or none at all.
- Your body may be making insulin but the insulin isn't working properly. Scientists think that your cells don't behave as they should when insulin reaches them. Doctors call this insulin resistance.
- One of insulin's jobs is to tell cells in your **liver** how to use glucose. If there's any extra glucose in your blood, it should be stored in your liver. But if you have type 2 diabetes, your liver cells don't get the right messages. So instead of storing the glucose, your liver pumps more glucose into your blood.

If you have diabetes, a blood test taken first thing in the morning before you have eaten will show a glucose level of more than 7 mmol/L. But it can be much higher, rising to as much as 30 mmol/L or more.

Diabetes: why me?

Certain things can increase your chances of getting a disease. Doctors call these things risk factors. Having a risk factor for diabetes doesn't mean you will get the disease for certain. It just means you are more likely to get diabetes than someone who doesn't have that risk factor.

Some risk factors for type 2 diabetes are:

- Having a relative with type 2 diabetes: You're more likely to get type 2 diabetes if someone in your family has it. Your **genes** play a role. If both of your parents have type 2 diabetes, you have a 1 in 2 chance of getting it. ^[3] (To find out more about what these numbers mean, see Understanding risks.)
- Being obese: Some people believe that eating too much sugar causes diabetes. They think this extra sugar wears out your **pancreas**. This isn't true. What is important is your weight. ^[2] Obesity is the main risk factor for type 2 diabetes.

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- Lack of exercise: About 80 percent of people with type 2 diabetes are overweight and don't take enough exercise. If you're at risk of getting type 2 diabetes, you can reduce your risk if you exercise. For example, if you're overweight and you lose about 5 percent of your body weight, and you also take regular, moderate exercise (such as a brisk walk for 30 minutes, five days a week), your chance of getting diabetes is reduced by one-half. ^[4]
- Your ethnic origin: People of South Asian, African, African-Caribbean, and Middle Eastern descent are more likely to get type 2 diabetes than other people in the UK. ^[2] We're not certain why this is.
- Factors related to pregnancy: If you are a woman, you are more likely to get type 2 diabetes if you have had diabetes during pregnancy (gestational diabetes). For more information, see [Other types of diabetes and high blood glucose](#) . You are also more likely to get type 2 diabetes if you have given birth to a baby weighing more than 4 kilograms (9 pounds).
- Having a condition called the metabolic syndrome: This isn't a disease. It's a group of features that are linked to your body's metabolism. People with metabolic syndrome are much more likely to get type 2 diabetes. ^[5] To read more, see [The metabolic syndrome](#) .

What are the symptoms of type 2 diabetes?

If you have diabetes, your body isn't able to control how much glucose (sugar) is in your blood. When the level of glucose in your blood goes too high, doctors call this hyperglycaemia. It causes most of the symptoms of diabetes.

There are two main types of diabetes. In type 1 diabetes, you will probably get symptoms quite suddenly, over a few days or weeks. In type 2 diabetes, your symptoms can appear over several years, but many people don't have any symptoms. This information is for people with type 2 diabetes. We also have information on [Type 1 diabetes](#) .

Common symptoms

Some of the common symptoms of diabetes are listed below. ^[11]

- Needing to urinate more often: Your body tries to get rid of the extra glucose in your blood by flushing it out in your urine. You may need to go to the toilet more often, especially at night. This is an early symptom of diabetes.
- Feeling very thirsty: You may feel thirsty more and more often. You may even wake up during the night feeling thirsty. One reason for this is because you urinate more. Losing all that fluid leaves you dried out. Feeling thirsty is also one of the first symptoms of diabetes.

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- Feeling very hungry or tired: Glucose can't get into your cells, so your cells don't get the fuel they need to work properly. Your brain senses that you need more fuel, and it makes you feel hungry so that you'll eat more. At the same time, you get tired because your cells aren't getting the glucose they need. The energy supply is there, but you can't use it.

Symptoms that happen as type 2 diabetes gets worse

If it's not diagnosed, type 2 diabetes gets worse. You may get:

- Blurred vision
- Yeast infections in the folds of your skin
- Wounds or sores that don't heal well.

If you're a woman, you may also get vaginal thrush more often.

You can get another problem called nonketotic hyperosmolar state. You're more likely to get this if you're older and get another problem such as an infection.^[11]

To read more, see [What is nonketotic hyperosmolar state?](#)

Once you're being treated for type 2 diabetes, you should stop getting symptoms.

How do doctors diagnose diabetes?

If you have diabetes, it's important to get it diagnosed.

Sometimes diabetes causes symptoms early on, such as feeling very hungry or thirsty. Don't ignore them! It's important to diagnose diabetes so that you can start treatment and stay as healthy as possible. For more, see [What are the symptoms of type 2 diabetes?](#)

But you might not have any symptoms early on. Many people are diagnosed as part of routine screening by their GP. For others, the diagnosis of diabetes may start when their optician tells them to see your GP. This is because diabetes can damage the blood vessels in your eyes. An optician may pick up this damage during an eye examination.

Your GP will ask you about any symptoms you have, and he or she will probably do a test to see how much glucose (sugar) is in your blood.

Fasting plasma glucose test

Many GPs have small machines called blood glucose meters in their surgery. They can take a drop of your blood by pricking your finger, do the test and give you the result straight away. But these machines aren't as reliable as those in laboratories. You need to have a laboratory test before your doctor can say for sure that you have diabetes.

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You should have a test that measures how much glucose is in your blood first thing in the morning, before you have eaten.^[38] When you don't eat, it is called fasting. So doctors call this test a fasting plasma glucose test.

The result is your fasting plasma glucose level. If it is more than 7 mmol/L, you have diabetes (mmol/L stands for millimoles per litre).

Testing your blood after you've eaten isn't as reliable as testing it when you've been fasting. But you've probably got diabetes if your glucose level is more than 11.1 mmol/L at any time during the day.^[38]

For most people, the diagnosis of diabetes is quite easy. But you may need a second test if your glucose level is on the edge of the normal range. That test is called an oral glucose tolerance test.

Haemoglobin A1c test

Like the fasting plasma glucose test, this test is also done on a drop of blood. However, it does not require fasting.

Haemoglobin A1c is a chemical found in your blood. You might hear it called glycated haemoglobin, glycosylated haemoglobin, or glycohaemoglobin.

Your haemoglobin A1c level gives your doctor an idea of what your glucose level has been over time. It is kind of an average of your blood glucose level over the previous weeks. If your blood glucose level is often higher than normal, you will also have a high haemoglobin A1c level.

The result of this test may be given as a percentage or in the number of millimoles per mole (mmol/mol). A result above 6.5% or 48 mmol/mol indicates you have diabetes. You will have the test a second time to confirm these readings.^[39]

Oral glucose tolerance test

This test shows how your body copes with a lot of glucose. You may have to go to a hospital clinic to have this test. It isn't widely used to diagnose diabetes.

You take this test first thing in the morning, before you eat. First, your doctor measures how much glucose is in your blood (your fasting plasma glucose level). Then you drink a very sugary liquid. Two hours later, the level of glucose in your blood is measured again. This is called your two-hour plasma glucose level. If this level is more than 11.1 mmol/L, you have diabetes.

Other tests

If you've just been told you have diabetes, your GP or hospital specialist will probably want to do other tests on your blood and urine. These might include tests to check on your **thyroid gland**, **liver**, **kidneys**, and **cholesterol**.

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After you've been diagnosed with diabetes, you should have a thorough check-up once a year with a doctor experienced in treating diabetes.^[38] To learn more, see [Yearly check-up](#) .

How common is diabetes?

Diabetes is getting more common in the UK. But many people don't know that they have it.

This is what we know from research about diabetes.

- About 3 million people in the UK have diabetes. That's more than 4 in every 100 people.^[26]
- There are two main types of diabetes, type 1 and type 2. Type 2 diabetes is more common. In the UK, between 85 and 95 out of 100 people with diabetes have type 2 diabetes.^[26]
- Another 850,000 people in the UK probably have diabetes but don't know it.^[26] They are still at risk for extra problems that can happen with diabetes. Doctors call these [complications](#) . The longer diabetes is not diagnosed, the greater your chances of getting complications.
- Diabetes is getting more common. About 3 in 100 men had diabetes in 1994, compared with between 6 and 7 out of 100 in 2012.^[27] In 1994, 2 in 100 women had diabetes, compared with nearly 5 out of 100 in 2012.
- The increase in diabetes in the UK is linked to the rise in [obesity](#) .
- Worldwide, researchers estimate that the number of adults with diabetes will increase from 382 million in 2013 to 592 million in 2035.^[28]
- The older you get, the more likely you are to get diabetes. Around 10 out of every 100 people aged between 55 and 64 have diabetes. This rises to 14 out of 100 in people aged between 65 and 74.^[27] Type 2 diabetes also seems to be getting more common among children, teenagers, and young people.^[28]
- Between 2 and 5 out of 100 pregnant women get a kind of diabetes called gestational diabetes. About 40 in 100 women with gestational diabetes will go on to have diabetes later on. For more, see [Other types of diabetes and high blood glucose](#) .

What treatments work for type 2 diabetes?

There isn't a cure for diabetes. But treatments can help you lead a long and healthy life. The aim of treatment is to keep the amount of glucose in your blood as close to normal as possible. If your blood glucose level gets too high or too low, you can become ill.

Keeping your blood glucose (sugar) level close to normal can also prevent some of the extra problems linked with diabetes. Doctors call these complications (to learn more, see [What will happen to me?](#)). And if you already have complications, controlling your blood glucose might stop some of them getting worse.

Most people who get this type of diabetes are over 40, although it can affect younger people, and even children. You might be able to control your blood glucose (sugar) by watching what you eat or taking tablets. But some people need to have insulin injections. Whatever way you treat your diabetes, leading a healthy lifestyle will help you stay well.

Key points about treating type 2 diabetes

- The best way to treat your diabetes is usually to keep your blood glucose levels as close to normal as possible. This is called tight control. It can help you stay healthy and avoid complications.
- To keep your glucose levels under tight control, you need to watch what you eat and exercise regularly.
- Every few months, your doctor will measure your [haemoglobin A1c level](#). You can think of this as your average blood glucose level. You may hear this called HbA1C.
- You will probably have to take diabetes tablets at some point. Some examples are metformin and sulphonylureas.
- You can take two types of tablet together if you need to. But you might get more bouts of low blood glucose ([hypoglycaemia](#)) if you do this.
- Learning about diabetes and sticking to your treatment plan will probably help you control your blood glucose level better.
- If tablets stop working for you, you can use insulin. But you might get hypoglycaemia more often and gain more weight than with tablets.
- As well as treating your diabetes, your doctor will suggest keeping a check on your blood pressure, cholesterol levels and general health. If you smoke, your doctor can help you to give up.

Which treatments work best?

There are several treatments for diabetes. But which treatments work best? We've looked at the best research and given a rating for each treatment according to how well it works.

For help in deciding if a treatment is right for you, see [How to make the best decisions about treatment](#).

Treatment Group 1

Treatments for type 2 diabetes

Treatments that work

- [Metformin](#) : This drug (brand name Glucophage) lowers your blood glucose level. [More...](#)
- [Sulphonylureas](#) : These drugs help your body make more insulin. Examples are glimepiride (brand name Amaryl) and glipizide (Glibenese, Minodiab). [More...](#)

Treatment that are likely to work

- [Losing weight](#) : The first treatment doctors suggest for type 2 diabetes is often to watch what you eat and make sure you exercise. [More...](#)
- [Education](#) : This involves learning how to control your diabetes. [More...](#)
- [Intensive treatment programmes](#) : These are programmes where you get lots of advice, counselling, and support to help keep your blood glucose under control and stay healthy. [More...](#)
- [Meglitinides](#) : These are tablets that you take right before you eat. Examples are repaglinide (brand name Prandin) and nateglinide (Starlix). [More...](#)
- [Alpha-glucosidase inhibitors](#) : The alpha-glucosidase inhibitor used to treat diabetes is acarbose (brand name Glucobay). You can use this treatment along with other diabetes tablets. [More...](#)
- [Exenatide and liraglutide](#) : You take these drugs as injections. They're used in addition to other diabetes drugs, like metformin or a sulphonylurea. The brand name for exenatide is Byetta. The brand name for liraglutide is Victoza. [More...](#)
- [Sitagliptin and vildagliptin](#) : The brand name for sitagliptin is Januvia. The brand name for vildagliptin is Galvus. [More...](#)
- [Insulin plus metformin](#) : Insulin treatment can be combined with the drug metformin. [More...](#)

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Treatments that work, but whose harms may outweigh benefits

- [Taking two types of tablets together](#) : Your doctor may recommend you take more than one type of tablet to control your blood glucose. This often means taking metformin along with another drug, such as a sulphonylurea or a meglitinide. [More...](#)
- [Insulin](#) : You can take insulin if you need it to control your blood glucose. [More...](#)
- [Thiazolidinediones \(glitazones\)](#) : These are tablets that you take with other treatments. The only one available in the UK is called pioglitazone (Actos). [More...](#)

What will happen to me?

In the short term

If you have diabetes, you should be able to lead a fairly normal life. You may need to:

- Take tablets or insulin regularly
- Watch what you eat
- Exercise regularly
- Check your blood glucose (sugar) level throughout the day.

Apart from these changes, you should be able to take part in all your normal activities.

If you take insulin, you must inform the Driver and Vehicle Licensing Agency (DVLA) about your diabetes. You must also tell the DVLA if you control your diabetes with tablets or what you eat and if you have a complication that could affect your driving, such as a problem with your eyes. If you don't, your driving licence and car insurance may no longer be valid. ^[29]

In the long term

When you've had diabetes for a long time, you're likely to get some extra health problems. Your eyes, **kidneys**, feet, and heart are the parts of your body most likely to be affected.

Doctors call these problems complications. Not everyone with diabetes gets complications. Some people have diabetes for 40 or 50 years without getting complications. ^[30]

We know for certain that if you carefully control your blood glucose level, you are more likely to stay healthy. ^[21] For more information, see [Keeping tight control of your glucose level](#) .

The longer your blood glucose level stays above normal, the more damage it causes. So if you think you may have diabetes, see your doctor straight away.

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Doctors and scientists don't know for certain how complications happen. They know that large amounts of glucose in your blood can harm certain parts of your body. But your genes also play a part.^[30] This means that your chance of getting complications depends partly on the genes passed to you from your parents. It also may depend on other things such as your blood pressure or cholesterol.

Having high levels of glucose in your blood over many years can damage large blood vessels called arteries, making them more narrow inside. It can also damage some of your small blood vessels, making them leaky.

Complications can affect several different parts of the body. Changes to your large blood vessels can lead to complications in your heart, arms, and legs. Changes to your small blood vessels can lead to complications in your eyes, kidneys, and nerves. These problems might leave you feeling depressed and unable to cope.

Complications include:

- [Eye problems](#)
- [Kidney problems](#)
- [Nerve damage](#) (and problems with your feet)
- [Heart and blood problems](#)
- [Infections](#)
- [Psychological problems](#) .

You should always be on the lookout for signs of hyperglycaemia or hypoglycaemia. If your blood glucose level shoots up very high or drops very low, see your doctor or go to hospital straight away. For more, see [Medical emergencies: hyperglycaemia and hypoglycaemia](#) .

Questions to ask your doctor

If you've been told you have diabetes, you may want to talk to your GP, hospital specialist or diabetes nurse to find out more.

Here are some questions that you might want to ask:

- Why do I have diabetes?
- What type of diabetes do I have?
- Can I control my diabetes by eating better, exercising or taking tablets?
- Will I have to start giving myself insulin injections?

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- Could the food I eat be making my diabetes worse?
- Do I have to stop eating sweet foods?
- Should I be checking my blood glucose level myself?
- How often do I have to check my blood glucose?
- Will I get bouts of low blood glucose? If so, how can I recognise them and how should I treat them?
- Can I keep on driving?
- Is there anything I can't do?
- Should I exercise more?
- Is there anything special I should do before I exercise? (Take less insulin? Eat something, such as a banana?)
- Am I at risk of getting any other diseases?
- What can I do to avoid getting extra problems (complications)?
- Do I need treatment for my blood pressure?
- Do I need treatment for my cholesterol?
- How can you help me stop smoking?
- What should I do before planning to become pregnant?
- Are members of my family likely to get this type of diabetes too? If so, is there anything I can do to protect them?

Treatments:

Metformin

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[How good is the research on metformin?](#)

Diabetes, type 2

This information is for people who have type 2 diabetes. It tells you about metformin, a treatment used for type 2 diabetes. It is based on the best and most up-to-date research.

Does it work?

Yes. If you have type 2 diabetes, taking metformin will probably control your glucose levels better than just eating healthily. Metformin is also less likely to make you gain weight than other diabetes drugs.

What is it?

Metformin is one of a group of drugs called biguanides.^[41] You can take it as a tablet or a powder you dissolve in water. One brand name is Glucophage. You need a prescription from your doctor to get it.

Your doctor might tell you to take metformin on its own or with another drug to lower your blood glucose. For more about this, see [Taking two tablets together](#) .

How can it help?

If you take metformin, your blood glucose will be better controlled than if you take a dummy treatment (a placebo).^[42] And your blood glucose may be better controlled than if you just watch what you eat.^[43]

- Metformin may help lower your [haemoglobin A1c level](#) by about one point to two points.^{[43] [44] [45] [20]} Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.
- Over 10 years, your level may be better than if you are just careful about what you eat.^[20]

Metformin seems to control blood glucose levels at least as well as other diabetes drugs, and possibly better than [sitagliptin and vildagliptin](#) .^{[46] [47]} Metformin is also less likely to make you gain weight than [thiazolidinediones](#) or [sulphonylureas](#) .^{[42] [43] [47] [48] [49] [50]}

Taking metformin may also lower your chances of having a heart attack if you have type 2 diabetes and are overweight or obese .^[20] In one study, people who took metformin had fewer heart attacks over five years than people who just watched what they ate.^[22]

If you are overweight and take metformin to control your diabetes, you may live longer than if you just try to watch what you eat.^[20]

How does it work?

Metformin helps lower the amount of glucose (sugar) in your blood in two ways.

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- First, it causes your **liver** to make less glucose. This means that less glucose goes into your bloodstream.
- Second, it causes your muscles to use up more glucose from your blood.

Can it be harmful?

Metformin can make you feel sick. Or you might not feel like eating. It can also give you **diarrhoea** . But if you take metformin with food, these side effects may not happen so often. Or your doctor can start you on a low dose and increase it slowly.

If you take metformin, you may be slightly more likely to get low blood glucose ([hypoglycaemia](#)) than if you just watch what you eat. But you're less likely to get this than if you take a [sulphonylurea](#) or [insulin](#) . ^[20] ^[47]

Metformin has long been thought to increase the risk of a rare condition called lactic acidosis. When this happens, you get too much lactic acid in your body. This chemical makes you feel sick. You might also not feel like eating, have a stomach ache, throw up, lose weight, and feel very tired. Lactic acidosis usually happens in people who have heart or **kidney** problems or are over 65. However, reviews of the research have found that people who took metformin were no more likely to get lactic acidosis than those taking different drugs for their diabetes. ^[50] ^[51] But we need more research to look specifically at metformin's safety for people with kidney problems and other conditions that raise the risk of lactic acidosis.

How good is the research on metformin?

Many good studies (called **randomised controlled trials**) show that metformin can help people with type 2 diabetes. It can lower your [haemoglobin A1c level](#) by one point to two points over three months to 10 years, compared with just watching what you eat or taking a dummy tablet (a **placebo**). ^[43] ^[20] ^[52] ^[53] Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.

Metformin seems to control blood glucose levels at least as well as other diabetes drugs, and possibly better than [sitagliptin and vildagliptin](#) . ^[46] ^[47] Metformin is also less likely to make you gain weight than [thiazolidinediones](#) or [sulphonylureas](#) . ^[43] ^[47] ^[48] ^[49] ^[42] ^[50]

One study showed that overweight people with type 2 diabetes who took metformin for 10 years were less likely to die during this time than people who just watched what they ate. ^[20]

Sulphonylureas

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[How good is the research on sulphonylureas?](#)

This information is for people who have type 2 diabetes. It tells you about sulphonylureas, a treatment used for type 2 diabetes. It is based on the best and most up-to-date research.

Do they work?

Yes. Sulphonylureas can help you control the level of glucose (sugar) in your blood if you have type 2 diabetes.

What are they?

Sulphonylureas are a group of drugs that lower the amount of glucose (sugar) in your blood. They come as tablets. You need a prescription from your doctor to get these tablets.

Your doctor may prescribe a sulphonylurea drug on its own, or you might take it along with other drugs to treat your diabetes. For more, see [Taking two types of tablets together](#).

Your doctor is more likely to give you a sulphonylurea drug if you're not overweight, or if you can't take another drug called [metformin](#).^[54]

Some sulphonylureas (and their brand names) are listed below.

- glimepiride (Amaryl)
- glipizide (Glibenese, Minodiab)
- tolbutamide
- glibenclamide (Daonil, Euglucon)
- gliclazide (Diamicron).

How can they help?

Sulphonylureas can help lower your blood glucose levels. Here are some highlights from the research.

If you take glibenclamide, your [haemoglobin A1c level](#) may be about one point lower over 10 years than if you just watch what you eat.^[55] ^[56] Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.

Other sulphonylureas, such as glimepiride and glipizide, can also help to lower your haemoglobin A1c level.

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- Your haemoglobin A1c level may be one-and-a-half points to two-and-a-half points lower than if you didn't take the medicine. ^[57] ^[58] ^[59]
- You may also feel that you are getting more out of life. ^[57]

Studies also suggest that:

- Glimpiride and glibenclamide work about the same after about one year. ^[60] ^[61]
- Glipizide and glibenclamide also seem to work about the same. ^[62]

How do they work?

Sulphonylureas make your **pancreas** put more insulin into your bloodstream. Insulin is a **hormone** that helps glucose move from your bloodstream into your cells. This helps keep your level of glucose steady.

Can they be harmful?

If you take a sulphonylurea, you may gain weight.

- Over 10 years you may gain about 2 kilograms to 3 kilograms more (about 5 pounds more) than if you just watched what you ate. ^[55]
- A newer sulphonylurea, glimepiride, may cause a weight gain of about 5 kilograms (about 10 pounds) over three months. ^[58]

If you take a sulphonylurea you might also be more likely to get low blood glucose (hypoglycaemia) than if you just eat healthily. ^[55] This is more likely to happen with glibenclamide than with other sulphonylureas. ^[57] ^[58] ^[59] ^[60] ^[61]

You might get an **allergic reaction** in the first six weeks to eight weeks of treatment. This would probably affect your skin. You might get a rash or itchy red bumps. If this happens, you might need to switch to another treatment. If you are allergic to drugs containing sulphur compounds, you should not take sulphonylureas.

Some research suggests that sulphonylureas may increase the chance of serious heart and circulation problems, such as heart attacks and strokes. But we need more research to explore this. ^[63]

How good is the research on sulphonylureas?

We found one good study (called a **randomised controlled trial**) of more than 2,000 people. It showed that the sulphonylureas glibenclamide and chlorpropamide (which is no longer available) helped lower **haemoglobin A1c levels** over 10 years. ^[55] (Doctors

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use the haemoglobin A1c blood test to see how well your diabetes is controlled.) But the people in the study also had more bouts of low blood glucose ([hypoglycaemia](#)), and they gained more weight.

Three other good studies (randomised controlled trials) found that the sulphonylureas glimepiride and glipizide also helped lower haemoglobin A1c levels over about three months. ^[64] ^[65] ^[66] And one study found that the drugs gliclazide and glimepiride work as well as each other. ^[67]

In studies, sulphonylureas caused people to gain about 2 kilograms to 5 kilograms (about 5 pounds to 10 pounds). ^[55] ^[66]

Two studies found that different sulphonylureas work about as well as each other for lowering blood glucose levels. ^[68] ^[69] ^[70]

Losing weight

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[How good is the research on losing weight?](#)

This information is for people who have type 2 diabetes. It tells you about losing weight, a treatment used for type 2 diabetes. It is based on the best and most up-to-date research.

Does it work?

Probably. When you're first diagnosed with type 2 diabetes, your doctor is likely to suggest exercise and watching what you eat. Doctors think this helps to control your blood sugar. But in the long term, you may need to take medicines to get the best control of your blood sugar and to stay healthy. ^[55] ^[71]

If you are very overweight (obese), weight loss surgery may help your diabetes a lot. But weight loss surgery has risks.

What is it?

When you're first diagnosed with diabetes, you'll be given advice from a doctor or dietitian about healthy eating. If you're overweight, you're likely to be advised to lose weight. And you'll be asked to do some regular physical activity.

Eating healthily needn't be complicated. You don't need to cut sugar out of your diet or buy special diabetic foods. The rules about healthy eating for people with diabetes are the same rules for people without diabetes.

You should aim to: ^[72]

Diabetes, type 2

- Eat regular meals
- Eat fewer sugary and fatty foods
- Eat plenty of fruit and vegetables
- Reduce the amount of salt you eat
- Keep the amount of alcohol you drink to a minimum.

Guidelines in the UK recommend getting at least 30 minutes of exercise, five days a week.^[73] You may need to increase this to 60 minutes if you're trying to lose weight. Activity should be moderate, which means your heart rate and breathing speed up, but you can still talk easily.

To read more about a healthy lifestyle for people with diabetes, see [Advice on healthy living](#) .

You'll need regular check-ups to make sure your blood sugar levels are under control.

Weight loss surgery is known as bariatric surgery. It means you have an operation to make your stomach smaller. To find out more, see [Weight loss \(bariatric\) surgery](#) in our information on [Obesity](#) .

How can it help?

There's not much research looking at how well losing weight through diet and exercise works for people with type 2 diabetes. Most of the research compares going on a diet with taking medicines. In the long term, medicines are better at controlling diabetes, and they may help you live longer.^[55] ^[71] But in the short term, when you're first diagnosed with diabetes, diet and exercise may be all the treatment you need.

One study compared people who followed a diet plan or diet plus exercise plan with people who had only occasional counselling on diet. All had been newly diagnosed with diabetes. After six months, those in the diet and diet plus exercise groups had better control of their blood glucose than those in the counselling group. These differences continued for at least 12 months, despite the fact that those in the diet and diet plus exercise groups were taking less diabetes medicine.^[74]

Another study compared people who had regular support to follow a diet and exercise programme with people who had occasional diabetes education classes. After a year, more than 11 in every 100 people in the diet and exercise group had sizeable improvements in their diabetes, with some no longer having signs of the disease. This compared with around 2 in every 100 people in the other group.^[75]

Diabetes, type 2

Many studies show that people who've lost a lot of weight through weight-loss surgery have seen big improvements in their diabetes, very quickly. As many as 78 in 100 stopped being diabetic altogether after weight loss surgery.^[76]

How does it work?

Most doctors think that eating properly, getting some exercise and losing weight if you need to can help people with diabetes control their blood sugar levels. Being overweight is one of the biggest risk factors for getting diabetes.

A healthy lifestyle can also improve your general health and fitness, which may reduce your risk of some of the complications of diabetes. To read more about complications, see [What will happen to me?](#)

Can it be harmful?

You need to take care when exercising, to make sure your blood sugar level doesn't get too high or too low, either during or after exercise. Your doctor can give you advice about how to exercise. Or, to read more, see [Advice on healthy living](#) . However, you're less likely to get very low blood sugar with diet and exercise than you are if you take medicines.^[55] ^[71]

Weight loss surgery is a major operation and has some serious risks. To find out more, see [Weight loss \(bariatric\) surgery](#) in our information on [Obesity](#) .

How good is the research on losing weight?

Studies suggest that diet and exercise can improve blood glucose levels and reduce the need for diabetes medicines.^[74] ^[75] However, there hasn't been much good research. Most of the research compares people who went on a diet with people who took medicine as well as going on a diet.

In the long term, medicines seem to give the best control of people's diabetes, and may help people live longer.^[55] But in the short term, when you're first diagnosed with type 2 diabetes, a diet and some exercise may be the only treatments you need.

There have been a lot of good-quality studies looking at what happens to very overweight (obese) people with diabetes after they have weight loss surgery. A summary of the research ([systematic review](#)) found that 78 in 100 people with diabetes who had weight loss surgery no longer had signs of diabetes after their operation. And most of those who had surgery had a big improvement in their diabetes, even if it didn't go completely.^[76]

Education

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[Can it be harmful?](#)

[How good is the research on education?](#)

This information is for people who have type 2 diabetes. It tells you about education on type 2 diabetes. It is based on the best and most up-to-date research.

Does it work?

Yes. If you have type 2 diabetes, learning about diabetes is likely to help you lower your blood glucose. But you will need other treatments as well.

What is it?

Education teaches you about diabetes and your health. You can have diabetes education on your own or in a small or large group. You can be in touch with your diabetes team over one or two years for as little as six hours, or for as much as 30 to 50 hours. ^[77] ^[78] ^[79]

In one study, the education programme covered a variety of things: ^[77]

- Eating healthily
- [Checking blood glucose \(sugar\)](#)
- Injecting insulin correctly
- Taking care of your feet. Diabetes can cause problems with your nerves and circulation, and these can affect your feet.

You might also have education and support over the phone. In studies, people talked with a nurse or another health professional as often as once a week or as infrequently as every one to three months. The calls would usually focus on ways to improve people's blood glucose control and any questions the patients had. The health professional would also provide support and encouragement. ^[80]

Researchers have also looked at computer-based diabetes education and support, which you might have over the internet, on your mobile phone, or on a computer at a health clinic. ^[81]

How can it help?

If you learn about diabetes through an education programme, you'll probably be able to control your blood sugar levels better.

- Having diabetes education either in a group or on your own seems to help, as does having education and support over the phone. ^[80] ^[82] ^[83] ^[84]

Diabetes, type 2

- Having computer-based education and support might also help you better control your blood sugar levels, although the improvements may be small. However, studies have shown bigger improvements with programmes using mobile phones. ^[81]
- One study found that people who got group education had [haemoglobin A1c](#) levels that went down by about three-quarters of a point after one year. (Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.) ^[78]
- Over two years, if you get group education, you'll probably keep your average blood glucose level steady. But people who don't get education might see their level get worse. ^{[79] [85]}
- As little as three hours of group education, done again one year later, may help improve your haemoglobin A1c level. ^[77]
- If you get group education, you may also get more out of life. ^{[79] [85]}
- In some research, only those people with very high HbA1c levels saw their levels drop. ^[86]

How does it work?

It can be hard to control type 2 diabetes. You might need to learn about eating right, exercising or taking medicine. Education in a group or on your own might help you cope with and control your diabetes. Regular telephone calls can also provide ongoing support and education, and answer any questions you might have.

Can it be harmful?

None of the research about diabetes education looked at whether it could cause any harm.

It's possible that education could cause you to worry or get upset by making you focus more on your diabetes. ^[87]

How good is the research on education?

Two big summaries of the research (called [systematic reviews](#)) and two other good studies (called [randomised controlled trials](#)) looked at more than 3,000 people with type 2 diabetes. ^{[88] [89] [90] [91]} They showed that:

- Education programmes helped lower [haemoglobin A1c](#) levels over about one year to two years. (Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.)

Diabetes, type 2

- Group education seemed to work better than just getting usual medical care, and it worked just as well as getting education on your own.

Another summary of the research, involving nearly 1,900 people, looked at education and support provided over the phone. It found that this type of education also helped lower people's hemoglobin A1c levels. ^[80]

A separate summary looked at computer-based education and support programmes provided over the internet, on mobile phones, and on computers in clinics. The summary, which involved more than 3,500 people, found that computer-based education can lead to small improvements in blood sugar control. However, the improvements may be larger for education and support provided over mobile phones. ^[81]

In all of the summaries, the studies didn't say much about whether education helped people get more out of life. There were lots of problems with these studies. Most of them were small, and they looked at different types of programme and measured the results differently. So it's hard to say exactly why people got better.

We also don't know if education helps for longer than a year or two.

Intensive treatment programmes

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[How do they work?](#)

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[How good is the research on intensive treatment programmes?](#)

This information is for people who have type 2 diabetes. It tells you about intensive treatment programmes, used for type 2 diabetes. It is based on the best and most up-to-date research.

Do they work?

Yes. If you have type 2 diabetes, an intensive treatment programme may help you control the level of glucose (sugar) in your blood.

What are they?

If you take part in an intensive treatment programme you might:

- Get advice about healthy eating and exercise
- Get help sticking to treatment
- Get counselling about living with diabetes

Diabetes, type 2

- Take medicines and frequently check your blood glucose to keep it under [tight control](#) .

You might go into your GP surgery or diabetes clinic for your programme, or you might talk to a doctor or nurse over the telephone. ^[92]

You may have sessions about setting a target for your blood glucose level, how to reach your goals and things you need to do to stay healthy. You may get information from your doctor, and you may be able to check back in person or by phone. ^[93]

How can they help?

If you take part in an intensive treatment program, you may be able to control your blood sugar levels better. Your [haemoglobin A1c level](#) might be lower than if you just get usual medical care. (Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.) But it might not lower it by much.

One big study found that haemoglobin A1c levels went down by only one-twentieth of a point after three years. ^[92] But the people in this study had had diabetes for a long time (11 years, on average), and their diabetes was already well-controlled. So there might not have been much room for them to improve.

Another study found that an intensive programme helped lower haemoglobin A1c levels over four years by about three-quarters of a point, compared with getting usual medical care. ^[93]

A small study also found that people in an intensive treatment programme were more likely to reach their target hemoglobin A1c level after 12 months, compare with those who had usual medical care. ^[94]

How do they work?

Things about the way you live, such as what you eat and how much you exercise, are important for diabetes care. A programme that focuses on controlling your diabetes might help you reach your goals.

Can they be harmful?

The research didn't look at whether an intensive treatment programme could cause any harm.

How good is the research on intensive treatment programmes?

Three good studies (called [randomised controlled trials](#)) looked at more than 2,400 people, and found that an intensive treatment programme helped with type 2 diabetes.

People had lower [haemoglobin A1c levels](#) over one to four years. ^[95] ^[96] ^[94] (Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.)

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- In one study, people's haemoglobin A1c level went down by only one-twentieth of a point, on average. ^[97] People in this study had had diabetes for more than a decade, on average, and their blood glucose was already under control. So perhaps the programme didn't make much difference for them.
- In another study, people had a lot of education and were also very eager to take care of their diabetes. ^[98] So it's not clear if the study's results apply to everyone.

Meglitinides

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[How good is the research on meglitinides?](#)

This information is for people who have type 2 diabetes. It tells you about meglitinides, a treatment used for type 2 diabetes. It is based on the best and most up-to-date research.

Do they work?

Yes. If you have type 2 diabetes, drugs called meglitinides are likely to help you control the level of glucose (sugar) in your blood. But we don't know whether they help you avoid other problems from diabetes (complications).

What are they?

Meglitinides are newer drugs. The names of two meglitinides used to treat diabetes (and their brand names) are:

- nateglinide (Starlix)
- repaglinide (Prandin).

These drugs come as tablets. You need a prescription from your doctor to get them. In the UK, you can only take nateglinide together with another drug called metformin. ^[99] This combination might work better than taking just one drug on its own. To read more, see [Taking two types of tablets together](#) .

How can they help?

If you take a meglitinide, your [haemoglobin A1c](#) level is likely to get better. Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.

- Taking nateglinide might lower your haemoglobin A1c level by about one-half to one point over three months to six months. ^{[100] [101] [102]}

Diabetes, type 2

- Taking a meglitinide should work just as well as taking an older [sulphonylurea drug](#) (such as glibenclamide) or a newer sulphonylurea drug (such as glimepiride).^[100]
^[103] ^[50]

But we don't know whether a meglitinide can help you avoid getting complications from diabetes. There's no good evidence so far that meglitinides help you live longer or avoid illness.^[102] ^[50] But the studies may not have been long enough to show this.

How do they work?

These tablets cause your [pancreas](#) to make more insulin. Insulin is a [hormone](#) that helps glucose get from your bloodstream into your cells. This helps keep the level of glucose in your blood steady.

Meglitinides work in a similar way to sulphonylureas. The most important difference between meglitinides and sulphonylureas is that meglitinides work for a shorter time. So you have to take meglitinides shortly before your meal. They may work well for people who don't eat at the same time each day.

You can take meglitinides even if you've had an [allergic reaction](#) to one of the sulphonylurea drugs.

Can they be harmful?

The most common side effect of meglitinides is low blood glucose ([hypoglycaemia](#)).^[101]
^[104] ^[105] You might be more likely to get low blood glucose if you take a higher dose.
^[101] ^[102]

Some diabetes medicines cause you to gain weight. Meglitinides may cause a weight gain of up to 3 kilograms over three months compared with metformin.^[102]

How good is the research on meglitinides?

Several studies involving more than 1,000 people have shown that meglitinides can help lower [haemoglobin A1c](#) levels for people with type 2 diabetes. (Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.) People's A1c levels dropped by about one-half to one point over three to six months.^[100] ^[106] ^[102]

The main side effect in studies has been low blood glucose ([hypoglycaemia](#)).^[106] ^[107]
^[108] Meglitinides may cause a weight gain of up to 3 kilograms over three months compared with metformin.^[102]

Alpha-glucosidase inhibitors

In this section

Diabetes, type 2

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[How do they work?](#)

[Can they be harmful?](#)

[How good is the research on alpha-glucosidase inhibitors?](#)

This information is for people who have type 2 diabetes. It tells you about alpha-glucosidase inhibitors, a treatment used for type 2 diabetes. It is based on the best and most up-to-date research.

Do they work?

Yes, probably. They work to lower your blood glucose levels. But we don't know whether they help you avoid complications from diabetes.

What are they?

The alpha-glucosidase inhibitor used to treat diabetes in the UK is acarbose (the brand name is Glucobay). It comes as a tablet. You need a prescription from your doctor to get it. There is another alpha-glucosidase inhibitor, called miglitol, but it is not available in the UK.

You can take these tablets with other diabetes medicines like metformin. To read more, see [Taking two types of tablets together](#).

How can they help?

If you take acarbose, either alone or with other medicines like [metformin](#), your haemoglobin A1c level is likely to get better. ^[109] ^[110] Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.

But we don't know whether it can help you avoid getting complications from diabetes. There's no evidence so far that acarbose helps you live longer or avoid illness. But the studies may not have been long enough to show this. ^[109] ^[50]

How do they work?

Acarbose works by slowing down the amount of glucose that goes into your bloodstream.

After you eat, carbohydrates in your food are turned into glucose and other kinds of sugar. This happens in your intestines. These sugars travel in your bloodstream to your liver, where they're all made into glucose. Glucose goes from your liver into your bloodstream, so the amount of glucose in your blood goes up. The problem with diabetes is that your blood glucose level gets too high.

When you take an alpha-glucosidase inhibitor, the first step of this process (when food is turned into glucose) is slowed down. This means that your blood glucose level rises more slowly and doesn't go as high as before. The effect lasts all day, but it happens mainly right after you eat.

Can they be harmful?

The main side effects with acarbose are stomach problems, such as nausea and vomiting. You're more likely to have problems if you're taking higher doses. ^[109]

However, you are less likely to put on weight with acarbose than with some other diabetes medicines. ^[109]

How good is the research on alpha-glucosidase inhibitors?

There's some good evidence to show that acarbose can help improve your glucose levels. We found three big summaries of the research (called systematic reviews) looking at acarbose and similar drugs. ^{[109] [110] [111]}

But we need to see big, long-term studies to find out whether acarbose helps to reduce your chances of getting complications from diabetes.

Exenatide and liraglutide

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[How good is the research on exenatide and liraglutide?](#)

This information is for people who have type 2 diabetes. It tells you about exenatide and liraglutide, treatments used for type 2 diabetes. It is based on the best and most up-to-date research.

Do they work?

Yes, probably. Exenatide and liraglutide can improve your blood glucose control and may help you lose some weight. ^{[112] [113] [114]} But we don't know if they can help you avoid complications from diabetes

What are they?

You take exenatide and liraglutide as injections, just under your skin. They both come in a pen-shaped syringe. Both drugs are only available on prescription from a doctor. They belong to a class of drugs called incretin mimetics.

Exenatide and liraglutide are usually recommended for people already taking other medicines for diabetes, like [metformin](#) or a [sulphonylurea](#), but whose diabetes is not under control. ^{[115] [116]}

The brand names for exenatide are Byetta and Bydureon. Byetta is usually taken twice a day and Bydureon is usually taken once a week.

The brand name for liraglutide is Victoza. You take liraglutide once a day.

How can they help?

Taken along with other diabetes drugs like metformin, exenatide and liraglutide may: ^[112]
^[113] ^[114] ^[117] ^[118]

- [Improve your average blood glucose levels](#) (haemoglobin A1c)
- Help you lose some weight (around 1 to 2 kilograms, or 2 to 4 pounds)

But we don't know whether these drugs help you avoid complications from diabetes. Most studies have lasted less than a year, so we don't know about the long-term effects of treatment.

Exenatide may work better if you take it once a week, rather than twice a day. ^[114] But we need more research to be sure of this.

How do they work?

Exenatide and liraglutide can lower the level of glucose (sugar) in your blood after you eat. They both work in a similar way to one of your body's natural **hormones**, called glucagon-like peptide 1 (GLP-1).

Can they be harmful?

The main side effects you might get from taking exenatide are stomach problems like nausea, wind, and vomiting. Between 5 and 10 in every 100 people taking exenatide in studies stopped taking the drug because of these problems. ^[119]

The most common side effects with liraglutide are low blood glucose (hypoglycaemia), headaches, nausea, and diarrhoea.

There's a fairly low chance of having too-low glucose (hypoglycaemia) with exenatide. But some people do get this problem if they take exenatide along with a [sulphonylurea](#) drug. ^[120]

There have been a few cases of people getting inflammation in their pancreas (pancreatitis) while taking exenatide or liraglutide. ^[121] ^[122] There have also been people who've developed kidney failure while taking exenatide. Pancreatitis and kidney failure are serious illnesses. Because there have only been a few reports, it's hard to say how common these problems are, or even if they were caused by people's treatment. For example, one large study found that pancreatitis isn't more common among people taking exenatide than among those taking other diabetes medicines. ^[123] But if you get severe stomach pain while you're taking exenatide or liraglutide, see your doctor straight away.

How good is the research on exenatide and liraglutide?

We found some good evidence that exenatide and liraglutide can help improve your glucose control. ^[117] ^[112] ^[113] ^[114] ^[118] They also seem to help people lose weight.

But we need more big, long-term studies to see whether these drugs can help you avoid getting complications from diabetes.

Sitagliptin and vildagliptin

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[How good is the research on sitagliptin and vildagliptin?](#)

This information is for people who have type 2 diabetes. It tells you about sitagliptin and vildagliptin, treatments used for type 2 diabetes. It is based on the best and most up-to-date research.

Do they work?

Yes, probably. Sitagliptin and vildagliptin are likely to improve your blood glucose control.

What are they?

Sitagliptin and vildagliptin are drugs called DPP-4 inhibitors. (DPP-4 is short for dipeptidyl peptidase-4.) They come as tablets that you take once a day, when you are also taking other medicines for diabetes. The brand name for sitagliptin is Januvia. The brand name for vildagliptin is Galvus. You need a prescription from your doctor to get these medicines.

Sitagliptin and vildagliptin are usually used (separately, not together) by people who are already taking either [metformin](#) or [sulphonylurea](#) tablets, if their diabetes is not under control. ^[124] ^[125]

If you're taking metformin and sulphonylurea tablets together but still have high blood sugar, your doctor might recommend sitagliptin or vildagliptin as a third treatment. ^[116]

You may also take sitagliptin in addition to [insulin](#) .

Sitagliptin can also be used as the first choice of drug for people who can't take metformin for some reason, perhaps because of side effects.

Doctors sometimes prescribe a similar drug called saxagliptin (brand name Onglyza). However, this is a newer treatment and we haven't yet looked as closely at the research on how well it works.

How can they help?

Taking sitagliptin or vildagliptin, either alone or with other medicines, is likely to help reduce your average blood glucose levels (HbA1c) by about the same amount as most other medicines for diabetes. ^{[126] [119] [127] [128] [129] [130]} However, some research suggests they may not work quite as well as metformin. ^{[127] [129] [130] [47]}

Sitagliptin is also likely to help lower your blood glucose if it's still too high when taking insulin. ^[131]

Research suggests that saxagliptin works as well as sitagliptin to lower blood glucose levels. ^[132]

Compared with taking either one of these medicines or metformin alone, your haemoglobin A1c level may get better if you take both types of medicines together. ^{[130] [133]}

How do they work?

These drugs help your body control the level of glucose (sugar) in your blood, by encouraging your body to release more insulin.

Can it be harmful?

In some studies, people taking sitagliptin seemed to get more infections, such as coughs, colds and urine infections. We're not sure why this is. It might be because of an effect on the immune system. ^[127] However, other research has found that sitagliptin and other DPP-4 inhibitors don't raise the risk of infection. ^[134]

Generally, people didn't have many problems taking these drugs. In studies, no-one got very low blood sugar (severe hypoglycaemia). This is a big advantage compared to some other diabetes drugs.

However, some people got mild low blood sugar when taking them as well as sulphonylureas. ^[119]

There have been reports of people getting inflammation in their pancreas (pancreatitis) after starting treatment with sitagliptin. ^[135] Pancreatitis can be a serious illness. It's too early to know for certain whether sitagliptin causes pancreatitis. Indeed, some research suggests that it may not. ^[136] However, your doctor may want to keep a check on you when you start treatment, just in case. If you feel sick, vomit, lose your appetite, or get pain in your abdomen (which can sometimes spread to your back), talk to your doctor as soon as possible. These things can be signs of pancreatitis.

Other side effects you may get from sitagliptin include a stuffed up or runny nose, headaches, swelling in the lower limbs (peripheral oedema), or a sore throat. ^{[137] [138]}

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Possible side effects with vildagliptin include nausea, swelling in the lower limbs (peripheral oedema), headaches, shaking, lack of energy or strength (asthenia), and dizziness. ^[138]

There have been some reports of liver problems among people taking vildagliptin, so doctors have been advised to check how well a patient's liver is working before prescribing the drug and every three months during the first year of treatment. ^[138]

How good is the research on sitagliptin and vildagliptin?

We found some good evidence looking at sitagliptin and vildagliptin. We looked at several summaries of the research ([systematic reviews](#)). ^{[126] [119] [127] [128] [129] [130]} They all showed that these drugs can improve your blood glucose levels. Research also shows that sitagliptin can also help lower your blood glucose if it's still too high when taking insulin. ^[131]

But the studies so far have lasted only up to a year. We need to see longer studies to see what the long-term effects of these drugs are, and whether they can help people avoid getting complications from diabetes.

Taking two types of tablets together

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[How good is the research on taking two types of tablets together?](#)

This information is for people who have type 2 diabetes. It tells you about taking two types of tablets together, a treatment used for type 2 diabetes. It is based on the best and most up-to-date research.

Does it work?

Yes. If you have type 2 diabetes, taking two types of drugs together can lower your blood glucose (sugar) better than taking one drug on its own.

But by combining treatments, you might get more bouts of low blood glucose ([hypoglycaemia](#)).

What is it?

You can take two different drugs for type 2 diabetes. For example, you can take [metformin](#) along with a [sulphonylurea](#) , or a [meglitinide](#) , or an [alpha-glucosidase inhibitor](#) , or [sitagliptin](#) . Or you might take a [sulphonylurea](#) along with [exenatide](#) .

These are all drugs that lower the amount of glucose in your blood. You need a prescription from your doctor to get them.

The brand name for metformin is Glucophage.

Diabetes, type 2

Some sulphonylureas (and their brand names) are listed below.

- glimepiride (Amaryl)
- glipizide (Glibenese, Minodiab)
- tolbutamide
- glibenclamide (Daonil, Euglucon)
- gliclazide (Diamicron).

There are two meglitinides.

- nateglinide (Starlix)
- repaglinide (Prandin)

Acarbose (Glucobay) is an alpha-glucosidase inhibitor and sitagliptin (Januvia) is a DPP-4 inhibitor (DPP-4 is short for dipeptidyl peptidase-4).

Exenatide (Byetta, Bydureon) is an incretin mimetic.

Your doctor may also recommend adding other drugs, such as [vildagliptin](#) and saxagliptin. But we haven't looked in detail at these combinations. We also haven't looked at the research about taking three or more types of drugs together.

How can it help?

Taking a combination of two drugs for type 2 diabetes can help control your blood glucose better than taking just one. Overall, all the combinations seem to work about as well as each other. ^[47] ^[139]

Studies show that your [haemoglobin A1c](#) level can drop between one-half point and two points more if you take the following combinations than if you take just one drug: ^[100]
^[140] ^[141] ^[142] ^[143] ^[144] ^[145] ^[146] ^[147] ^[148] ^[149] ^[150] ^[151] ^[152] ^[46] ^[153]

- metformin plus a sulphonylurea
- metformin plus a meglitinide
- metformin or a sulphonylurea plus an alpha-glucosidase inhibitor (acarbose)
- metformin plus sitagliptin
- sulphonylurea plus exenatide

Diabetes, type 2

Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.

How does it work?

Different drugs work in different ways.

- Metformin makes your **liver** put less glucose into your bloodstream and makes your muscles take more glucose out of your bloodstream.
- Sulphonylureas and meglitinides make your **pancreas** put more insulin into your bloodstream. The insulin helps lower your blood glucose.
- Alpha-glucosidase inhibitors slow down how quickly carbohydrates from food are turned into glucose.
- Sitagliptin helps your body control the level of glucose (sugar) in your blood, by encouraging your body to release more **insulin**.
- Exenatide can lower the level of glucose (sugar) in your blood after you eat. It works in a similar way to one of your body's natural **hormones**, called glucagon-like peptide 1 (GLP-1).

Taking two different types of drugs together might work better than taking just one alone.

A combination might help you if you're taking the highest possible dose of one drug, but you still need more treatment.

Can it be harmful?

If you take two drugs together, you might get more bouts of low blood glucose (hypoglycaemia) than if you take just one drug.

- If you take metformin with the newer sulphonylurea glimepiride, you will have about double the chance of getting low blood glucose compared with if you take either drug alone. ^[154]
- If you take metformin with a meglitinide, you may be three times more likely to have bouts of low blood glucose than if you take metformin alone. ^[155] ^[156]

Taking exenatide and a sulphonylurea together seems more likely to cause low blood sugar than taking a sulphonylurea alone, ^[153] but more research is needed.

Also, if you take metformin with a sulphonylurea or meglitinide, you might gain more weight than if you just take metformin on its own. ^[141] ^[142] ^[144] ^[157]

But taking two drugs together may mean you can take a lower dose, so get fewer side effects. In one study, people taking metformin plus vildagliptin were less likely to have

Diabetes, type 2

stomach problems like feeling sick or getting diarrhoea, than people taking metformin alone. ^[146]

In studies looking at taking acarbose (an alpha-glucosidase inhibitor) with either metformin or a sulphonylurea, diarrhoea, wind (flatulence), and other problems with digestion were the most common side effects. ^{[147] [148] [149] [151] [152] [17]} Some people stopped taking these combinations because of these side effects.

One study also showed that people who took an older sulphonylurea (glibenclamide) plus metformin were more likely to die during the study than people who took only a sulphonylurea. ^[20] But it's not clear why.

How good is the research on taking two types of tablets together?

We looked at four big summaries of the research (called **systematic review**). ^{[100] [47] [139] [46]} We also looked separately at several good studies (called **randomised controlled trials**) involving thousands of people with type 2 diabetes. ^{[158] [159] [160] [161] [162] [20] [163] [164] [165] [166] [146] [147] [148] [149] [150] [151] [152] [153]}

These showed that taking two different diabetes tablets together helped lower [haemoglobin A1c levels](#) better than taking one tablet alone. (Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.)

The combinations tested were:

- [sulphonylureas](#) plus [metformin](#)
- [meglitinides](#) plus metformin.
- acarbose (an [alpha-glucosidase inhibitor](#)) plus either metformin or a sulphonylurea
- metformin plus sitagliptin
- sulphonylurea plus exenatide

But people who took a meglitinide or sulphonylurea plus metformin also had more bouts of low blood glucose ([hypoglycaemia](#)) than those taking single drugs. ^{[167] [168] [169]} And they gained more weight than those who took metformin alone. ^{[168] [170] [171] [172]} Taking exenatide and a sulphonylurea together seems more likely to cause low blood sugar than taking a sulphonylurea alone, ^[153] but more research is needed.

These problems weren't noted in the studies looking at adding acarbose to metformin or a sulphonylurea. However, people taking these combinations were more likely to get problems with their digestion, such as diarrhoea and wind (flatulence). ^{[147] [148] [149] [150] [151] [152]}

Diabetes, type 2

One of the studies also showed that people who took an older sulphonylurea plus metformin were more likely to die during the study than people who took a sulphonylurea alone. ^[20] But we don't know why.

Insulin

In this section

[Does it work?](#)

[What is it?](#)

[How can it help?](#)

[How does it work?](#)

[Can it be harmful?](#)

[How good is the research on insulin?](#)

This information is for people who have type 2 diabetes. It tells you about insulin, a treatment used for type 2 diabetes. It is based on the best and most up-to-date research.

Does it work?

Yes. If you have type 2 diabetes, insulin will help you to control the level of glucose (sugar) in your blood if tablets aren't working any more. But it has side effects.

Having insulin as your very first treatment for type 2 diabetes works about as well as having diabetes tablets as your first treatment. But you are more likely to get side effects than if you take tablets.

What is it?

Insulin is a **hormone** that your body uses to keep the amount of glucose (sugar) in your blood steady. Insulin is made by your **pancreas**, a **gland** that sits just behind your stomach.

If you have type 2 diabetes, your pancreas doesn't make enough insulin, or the insulin it does make doesn't work properly. This means you get too much glucose in your blood.

There are different ways to treat type 2 diabetes:

- If tablets don't control your blood glucose, you can take insulin.
- You can also add insulin to your tablets. And you might get insulin as a first treatment when you are diagnosed with type 2 diabetes.
- You can take insulin injections or you can use an insulin pump. To read more, see [Insulin therapy](#).

How can it help?

If your diabetes is not well-controlled and you take insulin injections instead of diabetes tablets, your [haemoglobin A1c level](#) is likely to be lower by one point to two points over

Diabetes, type 2

three months to four months.^{[173] [174] [175]} Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.

But having insulin injections as a first treatment for newly diagnosed diabetes probably won't help any more than taking tablets.^[176]

In one study, people took a kind of drug called a [sulphonylurea](#) (brand names glibenclamide and glipizide), or watched what they ate, or took insulin injections.^[177]

- People who took insulin injections or sulphonylureas had about the same haemoglobin A1c level after 10 years, and they had better blood glucose than people who just watched what they ate.
- All three groups seemed to enjoy life about the same.

If you use an insulin pump instead of having insulin injections, your blood glucose might be slightly lower after about six months.^[178]

How does it work?

If you have type 2 diabetes, your pancreas doesn't make enough insulin, or the insulin your pancreas does make doesn't work properly. This means you get too much glucose in your blood.

Some people with type 2 diabetes can control their blood glucose by watching what they eat or taking tablets. But after some years, the tablets might not work as well as they used to.

Also, some people might not be able to take tablets because they are **allergic** to the drugs or get side effects from them.

For these people, taking insulin can help to control their blood glucose.

Can it be harmful?

If you take insulin injections instead of tablets, you are more likely to get low blood glucose ([hypoglycaemia](#)) and to gain weight.^{[173] [174]}

If you take insulin injections as a first treatment for diabetes you are likely to:

- Get hypoglycaemia more often than if you take tablets (sulphonylureas) or just watch what you eat^[21]
- Gain more weight than if you take tablets. After 10 years, you might have gained about 4 kilograms (9 pounds), instead of only about 1.7 kilograms to 2.6 kilograms (about 4 pounds to 6 pounds) with tablets.

Diabetes, type 2

Using an insulin pump might not cause any more hypoglycaemia or weight gain than using insulin injections several times daily. ^[178]

How good is the research on insulin?

Studies have looked at two ways of using insulin in people with type 2 diabetes:

- As a treatment when diabetes tablets stop working
- As a first treatment.

Studies have also compared giving insulin by a pump with giving it by injections.

Insulin as a treatment when diabetes tablets stop working

Four good studies (called randomised controlled trials), involving about 300 people with type 2 diabetes, looked at taking insulin injections rather than keeping on taking tablets in people whose blood glucose was not well controlled. ^{[179] [180] [181] [182]}

The studies showed that taking insulin instead of tablets over three months to four months lowered [haemoglobin A1c levels](#) by about one point to two points. (Doctors use the haemoglobin A1c blood test to see how well your diabetes is controlled.) Two studies showed that insulin caused more low blood glucose ([hypoglycaemia](#)) and weight gain than tablets. ^{[179] [180]}

It's hard to say if the results of studies about taking insulin when tablets have stopped working apply to everyone. That's because the studies were fairly small and short. It's also not possible to do a study where doctors don't know which treatment is being given. That's because it's easy to tell which people are taking insulin. So it may be hard to get true results about things such as how much people are getting out of life with different treatments.

There are lots of different ways to take insulin. One summary of the research said the best way to start taking insulin was to continue with diabetes tablets, like metformin or a sulphonylurea, and also have one long-lasting daily injection of insulin (called basal insulin). ^[183]

Insulin as a first treatment

One good study looked at almost 4,000 people with newly diagnosed type 2 diabetes. ^[21] People who took either insulin or [sulphonylurea tablets](#) had about the same haemoglobin A1c levels after 10 years. Both the groups had better levels than people who just watched what they ate.

But people who took insulin gained more weight and had more bouts of hypoglycaemia than people who took tablets or ate healthily. ^[21]

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Insulin pump compared with injections

One good study looked at using an insulin pump instead of insulin injections for type 2 diabetes.^[184] It showed that an insulin pump helped to control blood glucose slightly better than several daily injections. And the pump didn't cause more hypoglycaemia or weight gain.

But this was a small study (only 132 people), and people's blood glucose levels got only a bit better. So we can't say for sure if using an insulin pump works better than having injections if you need insulin for your type 2 diabetes.^[184]

Insulin plus metformin

In this section

[Does it work?](#)

[What is it?](#)

[How can it help?](#)

[How does it work?](#)

[Can it be harmful?](#)

[How good is the research on insulin plus metformin?](#)

This information is for people who have type 2 diabetes. It tells you about insulin plus metformin, a treatment used for type 2 diabetes. It is based on the best and most up-to-date research.

Does it work?

Yes. Taking insulin and metformin together works better at controlling blood sugar than taking insulin alone.^{[185] [186] [187]} But you may be more likely to get side effects if you take both treatments. For example, you may feel sick.

What is it?

Metformin is one of a group of drugs called biguanides.^[41] Its brand name is Glucophage. You take metformin as tablets or as powder you dissolve in water. You need a prescription from your doctor to get it.

Insulin is a **hormone** that your body uses to keep the amount of glucose (sugar) in your blood steady. Insulin is made by your **pancreas**, a **gland** that sits just behind your stomach. It's used for people who have type 2 diabetes that isn't controlled by other treatments. You can take insulin injections or you can use an insulin pump. To read more, see [Insulin therapy](#).

Taking insulin and metformin together aims to combine the benefits of both treatments.

How can it help?

There's good-quality research showing that insulin and metformin work better together than insulin on its own.^[19] Together they give you better control of your blood sugar

Diabetes, type 2

levels. Taking both drugs may also mean you gain less weight and don't need to take as much insulin.

How does it work?

If you have type 2 diabetes, your pancreas doesn't make enough insulin, or the insulin your pancreas makes doesn't work properly. This means you get too much glucose in your blood.

Metformin helps lower the amount of glucose (sugar) in your blood in two ways.

- It causes your **liver** to make less glucose. This means that less glucose goes into your bloodstream.
- Metformin also causes your muscles to use up more glucose from your blood.

After some years, metformin might not work as well as it used to. If this happens, taking insulin can replace the missing insulin that your body doesn't make any more.

Can it be harmful?

Taking insulin and metformin together is more likely to cause side effects than the individual treatments on their own. ^[188] ^[189] In one study, about 6 in 10 people felt sick or got diarrhoea when they took both treatments. Only about 1 in 10 people just taking insulin got these problems. ^[189]

To read more about side effects, see [Metformin](#) and [Insulin](#) .

How good is the research on insulin plus metformin?

We found a summary of the research (a **systematic review**) that looked at 26 good-quality studies (**randomised controlled trials**) comparing insulin plus metformin with insulin on its own or with a dummy treatment (a **placebo**). ^[19]

The studies found that insulin plus metformin worked better than insulin alone to lower blood sugar levels. People taking both drugs also didn't need to take as much insulin and they gained less weight.

Thiazolidinediones (glitazones)

In this section

[Do they work?](#)

[What are they?](#)

[How can they help?](#)

[How do they work?](#)

[Can they be harmful?](#)

[How good is the research on thiazolidinediones \(glitazones\)?](#)

Diabetes, type 2

This information is for people who have type 2 diabetes. It tells you about thiazolidinediones (glitazones), a treatment used for type 2 diabetes. It is based on the best and most up-to-date research.

Do they work?

Yes, probably. But they can have serious side effects. You'll need to weigh up the risks and benefits of these drugs with your doctor. They are not suitable for everyone with diabetes.

What are they?

Thiazolidinediones are sometimes also called glitazones. The only thiazolidinedione available in the UK is called pioglitazone (brand name Actos).

Another thiazolidinedione, called rosiglitazone (Avandia), was withdrawn in September 2010. Research found that it increased the risk of heart failure and heart attacks.

Pioglitazone comes as tablets. It's only available on prescription from a doctor. If you're already taking [metformin](#) or a [sulphonylurea](#), but you can't take them both together for some reason, your doctor might suggest pioglitazone.^[116] Pioglitazone can also be used as a third treatment if taking both metformin and a sulphonylurea doesn't control your diabetes. Pioglitazone is sometimes used with [insulin](#) if high-dose insulin treatment doesn't work on its own.

How can they help?

Taking pioglitazone is likely to help reduce your average blood glucose levels (HbA1c), either alone or combined with another drug like metformin. The reduction is about the same as for other diabetes medicines such as metformin or a sulphonylurea.^[110] ^[190]

Some studies show that people with diabetes might live longer if they take pioglitazone.^[191]

But not all studies show this. Most studies say there's not enough long-term good quality research to tell.^[190] ^[111]

How do they work?

If you have diabetes, you have too much glucose in your blood. Thiazolidinediones help by lowering your levels of glucose.

These drugs make your cells react better to insulin. Insulin is a **hormone** that your body uses to control how much glucose (sugar) is in your blood.

Thiazolidinediones also stop your **liver** from making too much glucose.^[192]

Can they be harmful?

Yes. These drugs can have serious side effects.

The biggest problem is that thiazolidinediones seem to increase the risk of getting a condition called heart failure. ^[191] ^[111] ^[193] ^[194] ^[195]

[Heart failure](#) is when the heart doesn't pump blood around the body as well as it should. It can make you feel breathless and tired, and your ankles may swell and get puffy. Severe heart failure can cause an irregular heart beat, which can be fatal. However, in studies, people taking these drugs were not more likely to die from heart problems.

Doctors have been told not to prescribe pioglitazone to people with heart failure, or people who've had heart failure in the past. And they should carefully check anyone taking pioglitazone for signs of heart failure.

Pioglitazone may also slightly increase the risk of bladder cancer. Doctors are advised not to give the drug to people with a history of bladder cancer, or people with visible blood in their urine, until the cause has been investigated. ^[196] ^[197]

A thiazolidinedione called rosiglitazone was withdrawn from use after research found that it increased the risk of heart attacks as well as heart failure. ^[198] The European drug regulator ruled that the harms of rosiglitazone outweighed the benefits of treatment.

Another concern about these drugs is that they may increase the risk of breaking a bone, particularly in women who have passed the [menopause](#). ^[199] The drugs seem to affect the rate at which new bone is made in the bone marrow. Your doctor should check the health of your bones if you take a thiazolidinedione. Men don't seem to be affected by this. ^[200]

Other risks include: ^[138]

- Putting on weight
- Puffiness or swelling in your hands or feet because your body is holding on to extra water
- Liver damage. Your doctor will want to check your blood on a regular basis for any problems with your liver
- Anaemia, which can make you feel tired.

How good is the research on thiazolidinediones (glitazones)?

There's a lot of research about these drugs, but it's not clear whether the benefits outweigh the risks.

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We looked at 14 recent studies, which were all big summaries of smaller trials. ^[110] ^[201] ^[190] ^[191] ^[111] ^[193] ^[202] ^[194] ^[195] ^[199] ^[203] ^[204] ^[205] ^[206] They covered many thousands of patients in total. We found that:

- All the studies looking at this agreed that pioglitazone could reduce your average blood glucose (haemoglobin A1C) levels
- All the studies looking at this agreed that pioglitazone increases the chances of getting heart failure
- Some studies said people were likely to live longer if they took a thiazolidinedione. But other studies said there wasn't enough long-term research to say.

Research by the European Medicines Agency found that, for the thiazolidinedione drug rosiglitazone, the risk of heart problems outweighed the benefits of treatment. ^[198] Rosiglitazone has now been withdrawn in the UK.

Further informations:

What is glucose?

Glucose is your body's main source of energy. It's a type of sugar.

- Glucose comes from food. The main source of glucose is carbohydrates. You get carbohydrates from rice, pasta, potatoes and other starchy foods. Sugar is also a type of carbohydrate.
- You can also get glucose from some fruits and vegetables.
- When you eat these foods, your digestive system breaks them down into a form that your body can use.
- Broken-down food products from these foods travel to your liver. Your liver turns them into glucose. Your liver can also make glucose from scratch.
- Glucose goes into your bloodstream from your liver. The glucose can then be carried around your body, supplying all your cells with this vital fuel.

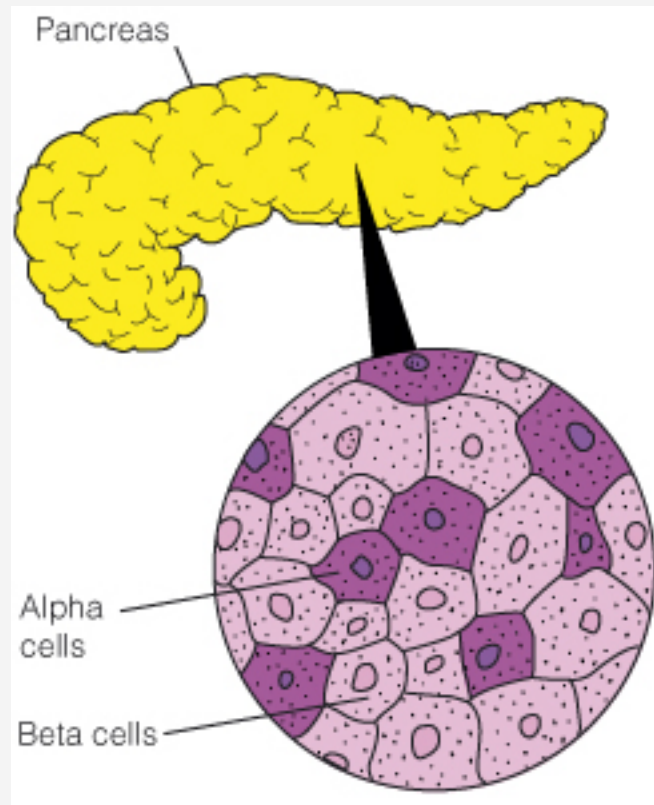
For more information, see [How does my body control my blood glucose level?](#)

Diabetes, type 2

How does my body control my blood glucose level?

Your body keeps the amount of glucose (sugar) in your blood fairly constant. If the level gets too high or too low, you can become ill. For more, see [What are the symptoms of type 2 diabetes?](#)

And if your blood glucose level stays high over a long period of time, it can damage your heart, kidneys, eyes, feet and other parts of your body. See [What will happen to me?](#) to find out about these extra problems.



In your pancreas, alpha cells make glucagon and beta cells make insulin.

Insulin and glucagon are two hormones that control how much glucose is in your blood. These hormones are made in your pancreas, a gland that sits just behind your stomach.

Your pancreas contains small groups of cells called the islets (or islands) of Langerhans. They are named after the German doctor who discovered them. These islets have two main types of cells.

- Alpha cells make glucagon.
- Beta cells make insulin.

Diabetes, type 2

What does insulin do?

When you eat, the amount of sugar in your blood rises. This causes the beta cells in your pancreas to make more insulin.

Almost all the cells in your body have special places on their surfaces that insulin sticks to. These are called insulin receptors.

When insulin attaches to an insulin receptor, several things happen.

- Glucose enters your cells (to give them energy).
- Your liver stops making glucose, and starts storing it until your body needs more energy.
- Cells in your muscles and in the fat under your skin pick up more glucose from your blood. This glucose is stored there until you need it.

These things lower the amount of glucose in your blood.

What does glucagon do?

Glucagon stops your blood glucose level dropping too low.

When you exercise, your muscles use the glucose in your blood for energy. Your pancreas senses that you're using up your glucose supply. As your blood glucose level drops:

- Your pancreas stops making insulin
- Your pancreas makes glucagon
- Glucagon makes your liver, your muscles and the fat under your skin release some of the glucose stored there.

These activities increase the level of glucose in your blood.

Other types of diabetes and high blood glucose

Impaired glucose tolerance and impaired fasting glucose

If you have impaired glucose tolerance, your body may be slow at getting your blood glucose (sugar) level back to normal after you eat.

In healthy people, the level of glucose in their blood rises after a meal. Then it drops down to normal in one or two hours. But if you have impaired glucose tolerance, it can take at least three hours for your blood glucose level to get back to normal after you eat.

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Doctors check for this condition with a test called an [oral glucose tolerance test](#) . If your glucose level on this test is above 7.8 mmol/L but below 11.1 mmol/L, you have impaired glucose tolerance.^[6] (The term mmol/L stands for millimoles per litre.)

Your doctor may also check for another condition called impaired fasting glucose by doing a test called a [fasting plasma glucose test](#) . If your level on this test is above 6.1 mmol/L but below 7.0 mmol/L, doctors say you have impaired fasting glucose.

If you have either of these conditions, your doctor may say you have pre-diabetes.

Having impaired glucose tolerance also means you're more likely to get diabetes. You may also be more likely to get heart disease .^[6] If you have impaired glucose tolerance or impaired fasting glucose, your doctor will want to test your blood glucose level regularly. And he or she will talk to you about ways to lower your chances of getting diabetes.

Diabetes in pregnancy

Some women have high levels of glucose in their blood when they are pregnant. This is called **gestational diabetes**. If you get this kind of diabetes, it can be harmful to both you and your baby if it isn't treated.

Gestational diabetes affects less than 5 in 100 pregnant women.

If you're pregnant, you should have a test for diabetes at your booking appointment if:^[7]

- You're over 25
- You're very overweight
- You have a relative with diabetes
- You belong to a high-risk ethnic group (South Asian, black Caribbean or Middle Eastern)
- You have had gestational diabetes in the past
- You have previously had a large baby weighing more than 4.5 kilograms (about 9 pounds 9 ounces).

Many women with diabetes in pregnancy can control their diabetes just by watching what they eat and exercising. Others have to take drug treatments or [insulin injections](#) during pregnancy. Your doctor will discuss which treatment is best for you. Gestational diabetes will probably go away after your baby is born. But if you get gestational diabetes, you're about seven times more likely to get type 2 diabetes later in life, compared to women who don't have diabetes during their pregnancy.^[8]

The metabolic syndrome

What is it?

The metabolic syndrome isn't a disease. It's a group of features that are linked to your body's metabolism. Your metabolism is the name given to all the chemical processes that take place in your body.

The most common features of the metabolic syndrome are:

- Excess body fat around the abdomen
- High levels of harmful fats in the blood
- Low levels of a 'good' fat called high-density lipoprotein (HDL) cholesterol
- Blood pressure that is higher than normal
- Blood that clots too much
- Problems with how your body uses insulin. This means there may be too much sugar (glucose) in your blood.

If you think you have any of the features of the metabolic syndrome, your doctor will tell you what to do to stay healthy. Your doctor will tell you what to do to stay healthy. Losing weight and doing regular exercise are important. Your doctor may advise you to make other changes in the way you live, and you may also need to take medicine.

If you have metabolic syndrome, you are more likely to get type 2 diabetes, heart disease, a stroke and some other conditions.^[9]

How common is it?

The metabolic syndrome is very common. Up to a quarter of adults may have it.^[10]

What causes it?

If you have the metabolic syndrome, your body's insulin doesn't work as well as it should. This is called insulin resistance. Insulin resistance can be caused by:

- Being overweight
- Not getting enough exercise
- Your genes or things related to your family.

Diabetes, type 2

How is it diagnosed?

There is no special test for the metabolic syndrome. And you don't get symptoms straight away. The health problems it can cause, like type 2 diabetes, happen over time.

There are no guidelines for doctors in the UK about diagnosing the metabolic syndrome. But there are guidelines from the International Diabetes Federation. ^[10]

The guidelines say that you have the metabolic syndrome if you have a certain waist measurement, plus some other features. The waist measurement is different for men and women, and for different ethnic groups.

- If you are a man of South Asian, Japanese, or Chinese origin, the waist measurement is 90 centimetres (about 35 inches) or greater. For all other men, the measurement is 94 centimetres (37 inches) or greater.
- If you are a woman, the waist measurement is 80 centimetres (about 31 inches) or greater.

You also must have at least two of the following four things:

- The level of fats called triglycerides in your blood is 1.7 mmol/L or higher before breakfast, or you are taking medicine to lower your triglyceride levels. (The term mmol/L stands for millimoles per litre.)
- Your level of good (HDL) cholesterol is less than 1.03 mmol/L if you are a man, or less than 1.29 mmol/L if you are a woman or if you are taking medicine to raise your HDL cholesterol.
- The level of glucose in your blood is more than 5.6 mmol/L before breakfast, or you have diabetes.
- Your blood pressure is 130/85 or higher or you are taking medicine to lower your blood pressure. For more information, see [high blood pressure](#) .

To find out the levels of glucose, fats and cholesterol in your blood, your doctor will do a blood test.

How can it be prevented?

You can't change your genes. But you can:

- Keep your weight down
- Eat healthily
- Exercise

Diabetes, type 2

- Drink alcohol in moderation. Men shouldn't drink any more than three to four units a day. Women shouldn't drink any more than two to three units a day. One unit is half a pint of ordinary-strength lager or a single shot (25 millilitres) of a spirit. A small glass (125 millilitres) of wine is about one and a half units.

See your doctor if you think you might have the metabolic syndrome or any of the features of it.

What is nonketotic hyperosmolar state?

If you have type 2 diabetes, you can get a serious condition called nonketotic hyperosmolar state. Doctors call it NKHS for short. If you have symptoms of NKHS, you need to see a doctor straight away.

NKHS can happen if your diabetes isn't diagnosed (and so isn't treated). But it can also happen if your diabetes isn't treated properly. It happens most often in older people with type 2 diabetes who aren't taking [insulin therapy](#). Usually, it comes on because they get an [infection](#) and don't drink enough water. If you have NKHS, you can:

- Feel light-headed or dizzy
- Feel thirsty
- Need to urinate often
- Feel sick
- Feel confused
- Lose consciousness (black out).

NKHS happens when the amount of glucose (sugar) in your blood rises out of control. This normally makes you feel thirsty. But you might not get this symptom, or you might ignore it, so your body doesn't get enough liquid and you get [dehydrated](#). When this happens, your body tries to pull water out of your cells. Then you get NKHS.

If you have symptoms of NKHS, go to hospital straight away.

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Insulin therapy

Insulin is a hormone that your body uses to keep the amount of glucose (sugar) in your blood at a steady level. Insulin is made by your pancreas, a gland that sits just behind your stomach.

If you have type 2 diabetes, your pancreas doesn't make enough insulin or the insulin it does make doesn't work properly. You get too much glucose in your blood.

Some people with type 2 diabetes take insulin if they can't keep their blood glucose down by watching what they eat or by taking tablets.

You have to take insulin by injection. You can't take insulin as a tablet because the digestive juices in your stomach would destroy the insulin.^[11] There are special devices made for people with diabetes who need to take insulin (see below). These devices make injecting insulin much easier.

The insulin used to treat diabetes is almost the same as the insulin the pancreas makes. Some kinds of insulin treatments come from pigs or cows. But these kinds aren't used much any more. Today, most people who need insulin are treated with a human type. Human insulin is made in a laboratory. Bacteria or yeast are made to produce insulin that is the same as the insulin made in people.

Types of insulin

Different types of insulin are used to treat diabetes. Each type works at a different speed. Some are a mixture of two types.

The types of insulin and their important features are shown in the table below.^[12]

Fast-acting

Name	Brand names	Starts working in	Best effect in	Stops working in
Insulin lispro	Humalog	5 to 15 minutes	45 to 90 minutes	3 to 4 hours
Insulin glulisine	Apidra	5 to 15 minutes	45 to 90 minutes	3 to 4 hours
Insulin aspart	NovoRapid	10 to 20 minutes	1 to 3 hours	3 to 5 hours
Soluble insulin	Actrapid, Hypurin, Humulin S, Insuman Rapid	30 minutes	2 to 5 hours	5 to 8 hours

Medium- and long-acting

- Start working in 1 to 4 hours
- Best effect in 4 to 12 hours
- Stop working in 16 to 35 hours

Diabetes, type 2

Name	Brand names
Insulin zinc suspension	Hypurin Bovine, Monotard
Isophane insulin	Hypurin Bovine Isophane, Hypurin Porcine Isophane, Insulatard, Humulin I, Insuman Basal
Protamine zinc insulin	Hypurin Bovine Protamine Zinc

Premixed combinations (fast- and long-acting insulins together)

- Start working in 30 minutes
- Best effect in 2 to 3 hours, and 8 to 12 hours
- Stop working in 16 to 24 hours

Name	Brand names
Soluble and isophane insulin mixture	Hypurin Porcine 30/70 Mix, Humulin M3, Insuman Comb 15/25/50
Biphasic insulin aspart	NovoMix30
Biphasic insulin lispro	Humalog Mix 25/Mix 50

Your dosing schedule

The type of insulin your doctor recommends will depend on how your body responds to the insulin and how you want to use it. Your doctor or diabetes nurse will help you work out a dosing schedule that suits you.

It might take some time to get your dosing schedule to fit well with how you live. You may need to be patient. Different people need different dosing schedules.

Some people find that they can manage their blood glucose best by having an insulin injection just before they eat, and then by having an injection of long-acting insulin at night.

If you're using fast-acting insulin, medium-acting insulin or long-acting insulin, you will probably inject it 30 minutes before you eat a meal. But if you use certain types of fast-acting insulin (for example, Humalog or NovoRapid), you should inject yourself just before you eat. Medium-acting or long-acting insulin can also be used before bedtime. These schedules can take some getting used to. But you will learn how to match your insulin doses with mealtimes and exercise times.

You will have to adjust your dose of insulin if you plan to eat more or less than usual. It's the same for exercise. You'll have to change your dose of insulin if you plan to exercise more or less than usual.

How much insulin you need also changes if:

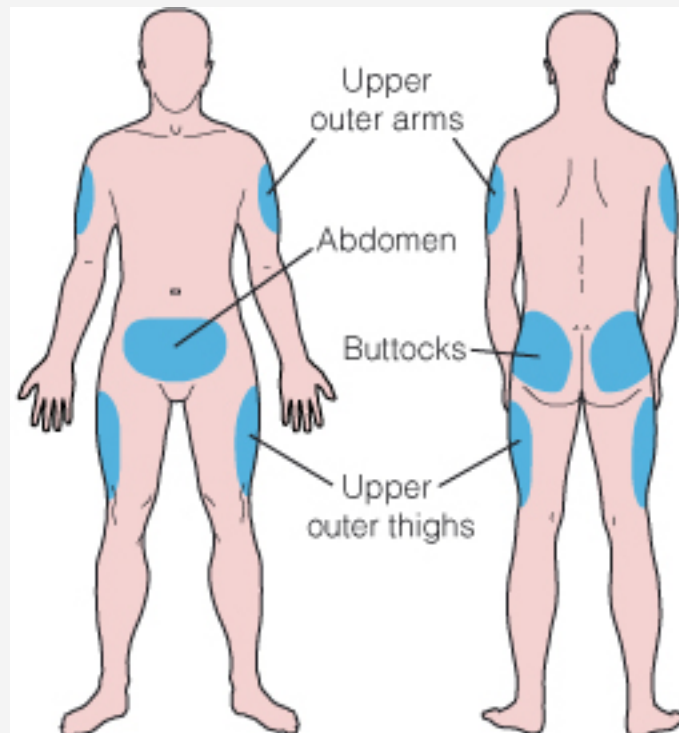
- You have an **infection** (for example, if you have a sore throat)

Diabetes, type 2

- You're stressed
- You've had an accident
- You're body is having hormone changes from **puberty** or pregnancy.

You will need to be extra careful during these times. You may need to see your doctor or diabetes nurse if you find it hard to control your blood glucose levels.

Where do I inject it?



You can inject insulin into several parts of your body. Your doctor or nurse will show you how.

You can inject insulin into several different places on your body, but here are a few rules to remember. ^[13]

- Insulin injected in your abdomen works fastest.
- Insulin injected into your thigh works slowest.
- Insulin injected into your arm works at medium speed.

Some doctors suggest injecting insulin into your abdomen all the time, to be sure the same amount gets into your bloodstream each time. But not everyone can do this. Ask your doctor what's best for you.

Diabetes, type 2

Giving yourself an injection might seem strange at first. But your doctor or diabetes nurse will show you how to do it.

Insulin devices

Many people who need insulin inject it using a needle and syringe. Needles are much easier to use than they used to be. Modern needles are very thin, so you hardly feel it when you inject yourself.

But using needles and syringes can be hard, especially if you have arthritis. The good news is you can get several devices that make injecting easier.

Insulin pens look like chunky pens. There are several kinds. They all work in the same way.

Some of the pens use an insulin cartridge. When it runs out of insulin, you get a new cartridge. Other pens are disposable. That means you throw them away when the insulin runs out.

With both kinds of pens, you set how much insulin you give yourself in each injection. Then you hold the pen against your skin, and you push a plunger or press a button to inject the insulin.

Insulin jet injectors don't use a needle. So if you don't like needles, jet injectors might suit you. The injector uses air pressure to push a fine spray of insulin through your skin. The downside is that these devices are expensive, and you have to boil them often to sterilise them.

An insulin pump looks a bit like a pager. It's about the same size and shape as a pack of cards. You can keep the pump in your pocket or you can hang it on your belt. You need to keep it with you all the time.

Inside the pump is a supply of insulin. This is pumped out through a long tube. To get the insulin into your bloodstream, you stick the tube into your body. You do this through a special kind of needle that stays in your skin. You attach the tube to this needle. Most people put the needle into their stomach area, but your doctor can also show you other places it can go.

The pump supplies a constant trickle of insulin into your bloodstream. You can change the programme on the pump according to what you're doing. So you could give yourself a dose just before you eat a meal.

You might not like the idea of having something attached to you all the time. But most people get used to it. And you can take out the tube for short periods. You might want to remove it while you're having a shower, going swimming, getting dressed, or having sex, for example.

A problem with insulin pumps is that the needle can get infected. But if you change the needle and tubing every two or three days, this is less likely to happen.

Diabetes, type 2

The National Institute for Health and Care Excellence, which advises the government on health care, says insulin pumps are not recommended for people with type 2 diabetes. ^[14]

Can it be harmful?

The biggest problem with taking insulin is getting a good balance between your insulin dose and your eating and activity.

If you take too much insulin, you could get hypoglycaemia. This happens because your blood glucose drops too low.

But if you don't take enough insulin, your blood glucose goes too high. Then you get hyperglycaemia.

For more, see [Medical emergencies: hyperglycaemia and hypoglycaemia](#) .

If you have insulin therapy, you need to check your blood glucose level regularly. Try to avoid letting your blood glucose get too high or too low. To learn more, see [Checking your blood glucose](#) .

Medical emergencies: hyperglycaemia and hypoglycaemia

If you have diabetes and your blood glucose level shoots up very high or drops very low, this can be a medical emergency. If you don't get treatment straight away, you could lose consciousness (black out). You may fall into a coma and you may even die.

If you have diabetes, your body can't control how much glucose (sugar) is in your blood. When your blood glucose level goes too high, doctors call this hyperglycaemia. When your blood glucose drops too low, it's called hypoglycaemia.

See [Checking your blood glucose](#) to find out how you can keep an eye on your blood glucose level and avoid these problems.

Hyperglycaemia

If you have type 2 diabetes, a high level of glucose in your blood can lead to a problem called nonketotic hyperosmolar state (or NKHS for short). ^[11]

NKHS can happen if your diabetes isn't diagnosed (and so isn't treated). But it can also happen if your diabetes isn't treated properly. It happens most commonly in older people with type 2 diabetes who aren't taking [insulin therapy](#) . Usually, it comes on because they get an [infection](#) and don't drink enough water.

If you have NKHS, you might:

- Feel light-headed or dizzy

Diabetes, type 2

- Feel thirsty
- Need to urinate often
- Feel sick
- Feel confused
- Lose consciousness.

NKHS happens when the amount of glucose (sugar) in your blood rises out of control. This normally makes you feel thirsty. But you might not get this symptom. Or you might ignore it, so your body doesn't get enough liquid and you get **dehydrated**. When this happens, your body tries to pull water out of your cells. Then you get NKHS.

If you have symptoms of NKHS, go to hospital straight away.

Hypoglycaemia

Hypoglycaemia (hypo for short) happens when the amount of glucose in your blood drops too low.

For most people, blood glucose is too low when it's less than about 4 millimoles per litre (mmol/L for short). Your doctor may talk about your blood glucose level using just the number. For example, you doctor may say, "Your blood glucose is 4."

But you may get symptoms of hypoglycaemia when your blood glucose is below or above this level. Everyone's need for glucose is slightly different. To learn more about why your body needs glucose, see [What is type 2 diabetes?](#)

Hypoglycaemia is much more common with [type 1 diabetes](#) than with type 2 diabetes. But if you're being treated for type 2 diabetes with [insulin therapy](#) or with a type of drug called a [sulphonylurea](#), you may also get hypoglycaemia.

Hypoglycaemia can make you lose consciousness (black out) and go into a coma. If you don't get treatment, you may die. Getting hypoglycaemia can be scary, and you might worry that it will happen again. But your doctor will give you advice on how to avoid hypoglycaemia.

What causes hypoglycaemia?

Here are some of the things that can cause hypoglycaemia.

Too much insulin or too little food: Most people get hypoglycaemia when they accidentally use too much insulin. For example, if you think you're going to eat a big meal, you may give yourself insulin just before you eat. But if you eat much less than you thought you would, you'll end up with too much insulin in your blood. This will make your blood glucose

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drop too low. Try to match the amount of insulin you take with the amount and type of food you're going to eat. For tips on taking insulin, see [Insulin therapy](#) .

Exercise: Your body uses up more glucose when you exercise, so you may need less insulin. If you know you're going to an exercise class, for example, you should take less insulin than you usually would and have a snack.

Illness: Your body usually needs more insulin when you're ill, so you may have to increase your dose of insulin. ^[11]

Alcohol: Alcohol can lower your blood glucose. So you need to be especially careful when you drink. Don't drink on an empty stomach.

Tightly controlling your blood glucose: Some people with diabetes watch their blood glucose level closely and try to keep it as normal as possible. This is called tight control. (For more information, see [Keeping tight control of your glucose level](#) .) Other people choose not to worry about their blood glucose and get treatment only if they have symptoms. If you use tight control, you may be more likely to get hypoglycaemia.

Action points: how to recognise hypoglycaemia

You may feel: ^[15]

- Weak
- Drowsy
- Shaky
- Nervous
- Confused.

You may also:

- Feel hungry
- Feel dizzy or light-headed
- Feel sweaty
- Feel your heart pounding
- Turn pale
- Get a headache

Diabetes, type 2

- Become irritable
- Behave oddly
- Have difficulty speaking
- Start shaking
- Start sweating
- Feel cold and clammy.

Action points: what to do if you have hypoglycaemia

- Treat your symptoms quickly. ^[15]
- Eat or drink something sugary, such as sweets or a sweet drink. You need five to six sweets, about one-third of a chocolate bar, or at least half a cup of sugary drink. Or you can eat three or four glucose tablets.
- If you are taking a type of diabetes medicine called acarbose (brand name Glucobay), you need to eat some glucose gel or glucose tablets rather than other kinds of sugar. (Acarbose is a kind of drug called an [alpha-glucosidase inhibitor](#) .)
- Don't eat or drink too much sugar if your symptoms are mild. Be patient. It takes 10 to 15 minutes to feel better.
- Test your blood glucose afterwards and see if it's low. Test it again after 15 minutes. If it's still low, or if you still feel the symptoms of hypoglycaemia, eat some more sugar.
- Call an ambulance if your blood glucose is very low and you can't seem to come out of the hypo.

Action points: how to avoid hypos

- Talk to your doctor about what blood glucose level you should aim for.
- Ask your doctor how often you should test your blood glucose.
- Stay in tune with your body. Some people can't spot the symptoms of hypoglycaemia even after they've had diabetes for a while. And your symptoms can change over time. Try to listen to your body and note what happens to you when your blood glucose drops. This will help you know when to act.

Diabetes, type 2

- Keep some sugary food with you at all times.
- If your doctor thinks that you're at risk of hypos, he or she may prescribe a glucagon injection to carry with you. ^[16] This injection helps release a burst of glucose into your blood. Your friends and family should be taught to spot the signs of hypoglycaemia, and they should be ready to use the glucagon injection.

Keeping tight control of your glucose level

If you have diabetes, tight control means keeping your blood glucose (sugar) level as close to normal as possible.

There are many studies showing that if you have diabetes and you use tight control:

- You can prevent some of the extra problems that can happen with diabetes. Doctors call these complications.
- And if you already have complications, you might be able to stop some of them getting worse.

However, tight control does increase your chance of getting glucose levels that are too low (called [hypoglycaemia](#)).

What does tight control mean?

To keep your diabetes under tight control, you need to follow a strict treatment plan. This means making a big effort to keep your blood glucose level as close to normal as you can, all the time. You also need to check your blood glucose levels more regularly.

In comparison, standard treatment is a more relaxed approach, which doesn't focus on having blood glucose at normal levels all the time.

Many tablets are used to treat type 2 diabetes. These include:

- [Alpha-glucosidase inhibitors](#) : acarbose (brand name Glucobay). [More...](#)
- [Metformin](#) : brand name Glucophage. [More...](#)
- [Meglitinides](#) : nateglinide (Starlix), repaglinide (Prandin). [More...](#)
- [Sulphonylureas](#) : glibenclamide (Daonil, Euglucon), gliclazide (Diamicon), glimepiride (Amaryl), glipizide (Glibenese, Minodiab), tolbutamide. [More...](#)
- [DPP-4 inhibitors](#) : sitagliptin (Januvia), vildagliptin (Galvusyou) and saxagliptin (Onglyza). [More...](#)

Diabetes, type 2

- [Thiazolidinediones \(glitaziones\)](#) : pioglitazone (Actos). [More...](#)

How does tight control compare with standard treatment?

Researchers have compared tight control with standard treatment. Here are some things studies have shown.

- Tight control can help you control your diabetes from day to day.
- It can also help you avoid getting complications. To read more, see [What will happen to me?](#)

If you have type 2 diabetes and you keep your glucose level under tight control, you are:

- Less likely to get problems with your eyes, kidneys, or nervous system than if you have standard treatment. ^[17] ^[18] ^[19]

Researchers have also looked at whether keeping your blood glucose levels under tight control reduces your risk of getting heart disease or atherosclerosis (sometimes called narrowing of the **arteries**). Many people with diabetes get heart disease.

- In the long term (over 10 years) people with type 2 diabetes have less chance of having a heart attack if they use tight control. ^[20]

However, it's not clear if tight control helps people with type 2 diabetes live any longer. ^[19]

Can it cause side effects?

If you're keeping your blood glucose under tight control, you're more likely to have times when your blood glucose level accidentally gets too low. This is called [hypoglycaemia](#) (hypo for short). It makes you feel dizzy, confused, and tired. You feel like this because your body isn't getting enough energy. ^[21] ^[17] ^[22]

The risk of getting hypos is higher if you're using insulin therapy. In one big study, people with type 2 diabetes who took insulin had hypos two-and-a-half times more often than people who just watched what they ate. ^[21]

Another problem with tight control using drugs is weight gain. If you take diabetes medicines to achieve tight control, you're more likely to put on weight than if you have standard treatment. ^[21] ^[17] ^[22] In studies, people using tight control gained about 2 kilograms to 4 kilograms (4 pounds to 9 pounds) over six years to 10 years. The people who gained the most weight were those who took insulin.

Diabetes, type 2

Tight control takes a lot of effort. But for many people, doctors think that the benefits make it worth the extra effort.

Some people are more likely to have hypos, and others aren't good at spotting when they're having a hypo. If you're in one of these two groups, tight control might not be right for you.

Checking your blood glucose

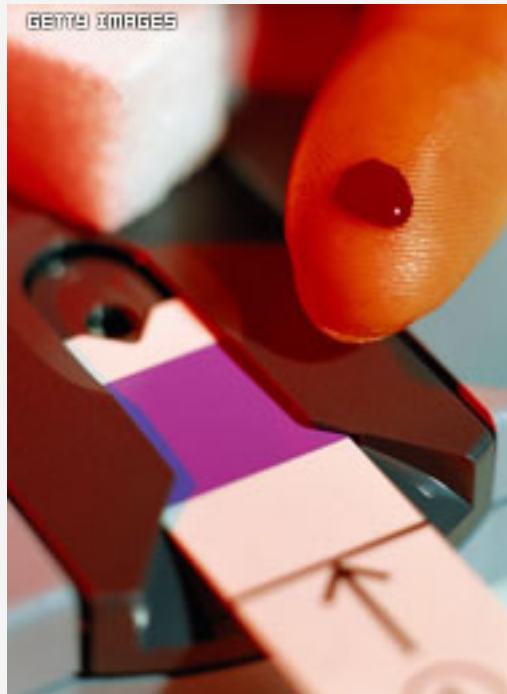
To control your diabetes, you need to get a good balance among the treatments you take (insulin, tablets or both), the food you eat and your physical activity.

Your doctor may suggest you check your blood glucose regularly, to see if it's in the right range. Regular checks will also tell you if your blood glucose is dropping too low (hypoglycaemia or hypo) or climbing too high (hyperglycaemia). Both of these can be dangerous.

For example, if you're about to do some exercise and you find that your blood glucose level is quite low, you need to eat something before you exercise. If you don't eat anything, exercising could lower your blood glucose level even more. You could have a hypo.

Testing your blood glucose is most important if you use insulin. People with type 2 diabetes who use insulin need to be sure that they don't have a dangerous hypo. But we don't know whether testing your blood glucose yourself is helpful if you have type 2 diabetes but don't use insulin.

Testing kits



You can test your own blood glucose level regularly using a simple kit.

There are kits to help you test your blood glucose. The kits make testing simple. Here's what you do.

- First, take some of your blood, usually one or two drops from your finger or your forearm. To get blood for the test, most people use a special needle that springs out when they press a button. You put this needle on your finger. When you press the button, the needle makes a prick that gives you exactly the right amount of blood.
- When you have a drop of blood on your finger, you touch the drop to a test strip. The test strip is usually held in place on a meter.
- There are many types of meters. But they all do the same thing. The meter analyses your blood. Then it tells you how much glucose is in it. The number usually shows on a little screen on the meter.

Your doctor will help you decide how often to test your blood. You also need to decide when you will do the test. Some people need just one test a day. Others need to do it before they take their [insulin therapy](#) (three or four times a day).

You also need to get used to adjusting your insulin dose or your activities based on what you find in your test. You will get used to this over time. But if you're not sure what to do, ask your diabetes nurse or your doctor for advice.

Diabetes, type 2

If you are having a treatment called peritoneal dialysis because your kidneys aren't working or if you are getting injections called immune globulin to boost your immune system, check with your doctor. Some blood glucose meters might not give you a reliable reading. Your blood glucose might read high when it isn't. It is very important to have a reliable reading to avoid getting low blood glucose. ^[23]

It's a good idea to keep track of your blood glucose level over a period of time. This will help your doctor see how you're controlling your diabetes. You can carry a notebook with you to write this down. Or you can plot your blood glucose levels right onto a graph. This will help you see how your levels change.

Also, most modern meters have an internal memory. This means that you don't have to keep a record yourself. You can simply show the meter to your doctor.

Keeping a record of your blood glucose level helps your doctor decide if you need to change your treatment, change to a different kind of insulin or change when you give yourself insulin (this is called your dosing schedule). For example, when you go to bed, you might find that your blood glucose is always a little bit higher than it should be. If this happens, your doctor may advise you to take more insulin before your evening meal. ^[24]

Haemoglobin A1c test

Another test you'll get used to is the test for haemoglobin A1c (HbA1c for short). Haemoglobin A1c is a chemical found in your blood. You might hear it called glycated haemoglobin, glycosylated haemoglobin, or glycohaemoglobin.

Your haemoglobin A1c level gives your doctor an idea of what your glucose level has been over time. It is kind of an average of your blood glucose level over the previous weeks. If your blood glucose level is often higher than normal, you will also have a high haemoglobin A1c level. So this test is useful for seeing how well controlled your diabetes is. Most people with diabetes should have their haemoglobin A1c checked every three months to six months.

The result of this test may be given as a percentage or in the number of millimoles per mole (mmol/mol). A good result is 53 mmol/mol (7 percent). Your ideal result depends on your own situation, but it should usually be between 48 and 58 mmol/mol (6.5 percent and 7.5 percent). ^[25] The higher the number, the greater your chance of getting [complications](#) from your diabetes. But most likely it would have to stay high for many years before you got problems.

Driving

If you take insulin, you must inform the Driver and Vehicle Licensing Agency (DVLA) about your diabetes. You must also tell the DVLA if you control your diabetes with tablets or diet and you have a complication that could affect your driving, such as a problem with your eyes.

Diabetes, type 2

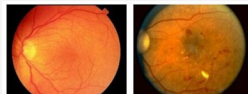
You need to be especially careful about checking your blood glucose level when you're driving. If it drops too low when you're at the wheel, you could have a hypo and black out. To reduce your chances of getting hypo while driving, check your blood glucose level just before you get into the car. ^[12] If it is low, have a snack and check again before you set off. Try to always have some sugary drinks or sweets in the car. If you feel you're going into a hypo, you can stop and have a drink or sweet, to boost your blood glucose.

If you feel you're going into a hypo while you're driving: ^[12]

- Stop the vehicle in a safe place
- Switch off the engine
- Have a sweet drink or snack, such as a sweet or glucose tablet. Wait until you feel better before setting off. This can take 15 minutes
- It's a good idea to check your blood again before driving.

Eye problems in diabetes

Diabetes can cause damage to the delicate blood vessels in the backs of your eyes. Doctors call this problem retinopathy. About 20 in 100 people with type 2 diabetes have this eye problem when their diabetes is diagnosed. That's probably because they have already had diabetes for many years.



Inside a normal eye (left) and an eye with retinopathy (right). The yellow spots and red spots are signs of damage.

An eye doctor can look at the back of each eye to see if you have any problems. If you get blurred vision or other problems with your sight, tell your doctor straight away.

If your retinopathy isn't treated, you might go blind. If you have diabetes, you're 25 times more likely to go blind than someone who doesn't have diabetes. ^[11]

The good news is that if your eye problems are picked up early and treated with laser therapy, you're unlikely to go blind. ^[30]

To reduce your chances of losing your sight:

- Have your eyes examined every year if you've got type 2 diabetes
- If you're a woman planning to have a baby, have an eye exam before getting pregnant

Diabetes, type 2

- Stop smoking
- Keep your blood glucose (sugar) level and your blood pressure as close to normal as possible
- Tell your doctor straight away if you have any problems with your sight. You might see dark spots, flashing lights or rings around lights. These can be signs that you have retinopathy.

Kidney problems in diabetes

Your kidneys help your body get rid of waste products. They work like sieves. In your kidneys, waste products are filtered out of your blood into your urine. Your blood also contains cells and particles called proteins, which you need. These are too big to go through your kidneys, so they normally stay in your blood.

Your kidneys also help keep the amounts of water and salt in your blood fairly constant.

Having too much glucose (sugar) in your blood can harm your kidneys over time. The filtering cells in your kidneys get damaged and start to leak. This lets the larger particles (cells and proteins) escape from your blood into your urine.

Your doctor may tell you that you have microalbuminuria or proteinuria. This means that some protein is passing through your kidneys when it shouldn't. It's a sign that your kidneys are damaged.

Over time this damage can lead to kidney failure. This means your kidneys stop working. If this happens, you'll need dialysis (a machine to clean your blood) or a kidney transplant. But most people with diabetes don't get kidney failure.

Doctors have learned how to stop kidney damage happening, so fewer people with diabetes get kidney failure. You should have regular checks for protein in your urine.

You may also be given drugs to keep your blood pressure down. This will help keep your kidneys healthy. If you do have protein in your urine, your doctor may give you certain blood pressure tablets even if you don't have high blood pressure. This can help protect your kidneys from more damage.

Action points

- Watch your blood glucose levels closely. For more information, see [Checking your blood glucose](#).
- Watch your blood pressure. If it is high, you may need to take drugs to treat it. Two groups of drugs used to treat high blood pressure, called ACE inhibitors and angiotensin II receptor antagonists, can slow kidney damage.

Diabetes, type 2

- Ask your doctor or your dietitian if you should eat less protein (meat, cheese, milk, fish) or fewer eggs.
- See your doctor straight away if you get an infection in your bladder or in your kidneys. Signs of an infection in these areas are cloudy or bloody urine, pain or burning when you urinate, or having to urinate often or in a hurry. Back pain, chills and fever are other signs that you might have an infection in your kidneys.
- If you smoke, stop.

Nerve damage in diabetes

Over time, high levels of glucose (sugar) in your blood can stop your nerves sending signals from your limbs (especially your legs and feet) to your brain. Other nerves, called autonomic nerves, also can become damaged. Autonomic nerves control many functions in your body, such as your heartbeat, digestion, and blood pressure .

About half of people who have had diabetes for a long time will get some kind of nerve damage.^[11] This nerve damage is called diabetic neuropathy.

Nerves in your arms and legs

Damage to nerves in your arms and legs can lead to:

- Numbness
- Pins and needles
- A burning feeling (you might not be able to bear anything touching your feet)
- Pain
- Feeling cold.

You might not be able to feel your toes or your feet. Or you might have painful and burning feet. Nerves in your legs and arms also can get damaged. If this happens, you might have numb areas or get shooting pains in your arms or legs, especially at night.^[31]

If you have damaged nerves, you may not notice if you get a cut or a sore on your foot. This means that small sores can turn into serious problems because you don't know they're there. If you also have poor blood circulation (see [Heart and blood problems in diabetes](#)), your wounds can take even longer to heal.

Diabetes, type 2

For example, you could be walking around barefoot and step on a nail. Nerve damage in your foot means you don't feel this, and your wound gets infected . Because there's lots of glucose in your blood, the germs that get into your wound grow fast. So the infection gets worse.

If it's not treated quickly, a bad infection can cause gangrene. This is when the tissue around the wound dies. In extreme cases, people with gangrene need to have the affected area removed (amputated). But these days, it's unusual for someone with diabetes to need an amputation.

Your feet are most at risk. You may get the following problems in your feet:

- You can't feel pain
- You can't feel hot or cold
- You get foot ulcers (areas of broken skin that don't heal)
- Your foot swells
- The shape or position of your foot changes, and you can't use it properly.

Nerves in other parts of your body

If you've had diabetes for a long time, nerves in other parts of your body may get damaged.

Your heart: If the nerves in your heart are damaged, your heart may not work as well as it should. This means you're more likely to have a heart attack . You may also find that your blood pressure changes. And you may feel dizzy if you stand up suddenly.

Your digestive system: This includes your throat, stomach and intestines. Damage to nerves in these parts of your body can affect how fast your food passes through. You may get diarrhoea .

Your genital area: If the nerves in this area are damaged, you can get sexual problems. You may not feel like having sex. If you're a man, you may not be able to get or keep an erection. These problems are more likely if you have had diabetes for a long time.^[11] If the nerves in your bladder are damaged, you may have problems controlling when you pass urine.

Your skin: Certain nerves control when you sweat. If these nerves are damaged, you won't sweat as much as you should. This makes your skin drier and more fragile, especially the skin on your feet.

Action points

Here are some tips for keeping your nervous system in good shape.

Diabetes, type 2

- Keep your [blood glucose level](#) and your blood pressure as close to normal as possible. Your doctor will help you do this.
- Don't drink too much alcohol. Too much alcohol can cause nerve damage.
- Check your bare feet every day, especially if you can't feel them well.
- If you smoke, stop.

Here are some more tips to protect your feet.

- When you check your feet, look for cuts, sores, bruises, or spots. See your GP or diabetes doctor or nurse if you find any problems.
- If you have difficulty seeing the bottoms of your feet, use a mirror. Or ask someone to help.
- Wash your feet in warm water every day using mild soap. Don't soak your feet, as this can dry your skin. Don't have very hot baths.
- Dry your feet with a soft towel. Pay close attention to the areas between your toes.
- After washing your feet, cover them with a lotion (such as baby lotion) before putting your shoes and socks on. (But don't put lotion or cream between your toes.) Your feet will be drier than normal, because diabetes makes you sweat less.
- File your toenails straight across, using a nail file. Make sure you don't leave sharp edges that could cut the next toe.
- Don't try to remove corns, calluses or warts yourself. See a foot doctor (a chiropodist or podiatrist) instead.
- If your feet have changed shape, wear trainers or shoes that are extra deep or wide. Or you can get specially moulded shoes that cushion your feet and let your toes move.
- Don't wear flip-flops or plastic shoes. Avoid shoes with pointed toes or high heels. Never go barefoot.
- Check your shoes before you put them on. Make sure they don't have any sharp edges or objects in them.
- Don't wear stockings or socks with holes, seams or repairs that might rub against your feet.

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- Don't put heating pads or hot water bottles next to your feet. If your feet get cold at night, wear thick socks.
- Make sure a nurse or doctor checks your feet and the feeling in your feet regularly.

Heart and blood problems in diabetes

Heart disease is the biggest problem for people with diabetes. Having diabetes makes it more likely that you will have a heart attack or a stroke. They are the most common reasons why people with diabetes die.

If you have diabetes, you're two to four times more likely to die of heart disease than someone who doesn't have diabetes.^[32] Heart disease can also cause problems with blood flow (circulation) in your legs and feet.

Unfortunately, diabetes tends to give you more bad fats and cholesterol in your blood. High cholesterol, high blood pressure, and smoking all make it more likely that you'll get a condition called atherosclerosis. This is when the walls of your blood vessels become thicker. It makes it harder for blood to flow through your blood vessels. If you have atherosclerosis, you're more likely to have a heart attack or a stroke.

If you have diabetes, your doctor should check your blood pressure and cholesterol regularly. You may need to have treatment if either of these is too high (or too low). Your doctor should also check that blood is flowing well through your legs, feet and neck.

Your doctor will probably tell you to follow a low-fat diet. The aim is to lower the amount of bad fats in your blood. For more information, see [Advice on healthy living](#).

Action points

- If you smoke, stop.
- If you have high blood pressure, you need treatment. Get it checked.
- If you have high cholesterol, you need treatment. Get it checked.
- Watch your blood glucose level closely. See [Checking your blood glucose](#).
- If you're overweight, lose some weight.
- Take regular exercise.

We've prepared some more detailed information for people with diabetes, who are worried about heart and blood problems. For more information, see [What treatments work to prevent heart and circulation problems in diabetes?](#)

Advice on healthy living

Keeping your diabetes under control is important. If it isn't kept under control, you can get serious health problems. You could go blind or have kidney failure. So you need to keep your blood glucose (sugar) level as close to normal as possible. That doesn't just mean taking your medicine. Eating healthily and staying active can also help keep your blood glucose level near normal.

What you eat

Doctors used to tell people with diabetes to stop eating sugary foods. Now the advice is to eat a healthy, low-fat diet. This means eating regular, well-balanced meals, and sticking to a certain number of calories each day. Eating the right amounts of healthy foods and keeping your weight in the right range for your height will help you control your diabetes. ^[33]

There are six kinds of food that fit into what nutritionists call the food pyramid: ^[34]

- Grains
- Vegetables
- Fruits
- Milk (low fat is best)
- Meat and beans
- Oils.

Try to eat foods from each group every day. By doing this, you will make sure that your body has all the nourishment it needs.

You need to include lots of starchy foods, fruits and vegetables in your diet. And you need to eat fewer sweet foods, fats and proteins.

Below are some tips to help you eat healthily and keep your weight down.

Action points for healthy eating

Your GP or hospital doctor should refer you to a dietitian who can help you make a food plan that suits you. ^[35] A good meal plan should fit in with your schedule and eating habits. The right plan will also help you keep your weight in the healthy range.

- Eat regular meals based on starchy foods such as bread, pasta, chapatis, potatoes, rice, and cereals. Choose whole-grain kinds when you can.

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- Cut down on the fat you eat. Choose low-fat dairy foods like skimmed milk and low-fat yoghurt. Grill, steam or bake foods instead of frying.
- Eat more fruits and vegetables. Aim for at least five portions a day.
- You can eat fatty foods and sweets, but try not to eat them too often. Look at biscuits, pastries, cakes, puddings, fizzy drinks, mayonnaise, salad dressings, butter, and oils as treats rather than everyday foods.
- Every day try to eat two portions of meat, fish, or similar foods, such as eggs, pulses, beans, and nuts. Choose lower-fat kinds when you can. Oily fish such as salmon, mackerel, pilchards, trout and herring are especially good for you. Try to eat two portions of these types of fish each week.

Exercise

If you haven't exercised much in the past, making exercise part of your life might seem hard. You might feel you're too old to change your habits. Getting started is probably the hardest part.

Exercise has great benefits. It will help keep down the level of glucose in your blood. It will also help keep your weight down, and it can make you feel great.

Be sure to talk to your doctor before starting or changing an exercise programme. Most doctors advise their patients to do some kind of exercise every day. This doesn't need to be strenuous. Walking for 30 minutes each day might be all you need to do.

If you do any vigorous exercise, such as taking an exercise class or playing squash, you may find that your blood glucose level changes a lot afterwards. See the Action points below for some tips on how to avoid letting your glucose level go too high ([hyperglycaemia](#)) or too low ([hypoglycaemia](#)) during or after exercise. ^[36]

Action points for exercising

How to get started exercising:

- Taking a brisk walk each day might be enough to keep you fit and healthy
- You might enjoy swimming or joining a fitness class.

How to exercise safely:

- Ask your doctor what type of exercise is best for you
- Also ask your doctor if you need to change your medicine when you exercise. Exercise uses up glucose, so you might need to take less medicine or take it later.

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How to avoid hypoglycaemia and hyperglycaemia when you exercise:

- Check your blood glucose before, during and after you exercise. For more, see [Checking your blood glucose](#)
- Wait to start exercising if your blood glucose level is more than 15 mmol/L or less than 5.5 mmol/L. The term mmol/L stands for millimoles per litre. It's the way doctors measure your blood glucose
- Eat a meal one hour to three hours before you exercise
- If you plan to exercise for a long time, have a carbohydrate snack (such as a banana or a sandwich made with brown bread) at least every 30 minutes
- Take less insulin than normal or have a snack before you exercise. You can talk about this with your doctor
- If you use insulin, inject it into an area of your body that you won't be using. For example, inject it into your stomach if you're going running
- Learn how your body responds to different types of exercise. Then adjust your eating and treatment to match
- If you have exercised hard, eat more over the next 24 hours. This will help replace the glucose you've used up.

Infections in diabetes

If you have diabetes, you're more likely to get some types of infections. Also, diabetes can make your blood circulation more sluggish. So infections might take longer to clear.

You may be more likely to get infections in these parts of your body: ^[11] ^[37]

- Your lungs (an infection here is called pneumonia)
- Your kidneys or your bladder
- Your skin
- Your teeth or gums
- And if you're a woman, in your vagina.

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An infection in your gums can give you a condition called gingivitis. This is when your gums get sore and swollen. If infections in your teeth or gums aren't treated, your teeth may get loose and fall out.

You may also get sicker than someone without diabetes if you get **pneumonia** or flu.

Action points

- Keep your blood glucose level as close to normal as possible. This makes it less likely that you'll get an infection. ^[11] For more information, see [Checking your blood glucose](#).
- Get a flu jab every year.
- Ask your GP about a **vaccination** against pneumonia.
- Take good care of your teeth and see your dentist regularly. This can help stop you getting gum infections and bad teeth.
- If you get a fever, cough, pain when you urinate, or another symptom of an infection, see your doctor straight away.

Psychological problems in diabetes

Diabetes is a serious illness. It takes a lot of time and effort to look after yourself, especially if you get extra problems (complications). On top of [checking your blood glucose](#), you have to watch what you eat and take regular exercise.

Also, you may have to see your GP, hospital specialist or diabetes nurse quite often. And you may have to visit hospital clinics for treatment on your eyes, **kidneys** or heart. Your family life may be upset. And you may not be able to hold down a job or do the job you want to do.

All of these stresses can take a toll. You may get [depressed](#), especially if you have other health problems or a disability. ^[24] If you feel stressed or depressed, talk to your doctor. Depression can be treated, and you can get advice about how to cope with your diabetes.

You may find it helps to talk to other people who have diabetes. Someone from your diabetes team may be able to put you in touch with a support group in your area.

Yearly check-up

If you have diabetes, you should have certain tests and see your doctor every year to stay as healthy as possible. ^[40]

Here are some tests you should have at least once a year.

- A test of your blood glucose control: Doctors usually use a haemoglobin A1c blood test to see how well treatment is controlling the level of glucose (sugar) in your blood. For more, see [Checking your blood glucose](#) .
- A test to see how your kidneys are working: Blood and urine tests for **protein** will show if your **kidneys** are working properly.
- A cholesterol test: A blood test for **cholesterol** can tell if your level is too high.

Here is a list of things your doctor should check during your check-up.

- Your weight: Your doctor will work out your body mass index (BMI for short). This looks at both your weight and your height. It shows if you need to lose weight to control your diabetes better.
- Your legs and feet: Your doctor will examine your skin and will check to see if your circulation and nerves are working properly. You may need to see a chiropodist or podiatrist if you have any problems in these areas.
- Your blood pressure: Your doctor will take your **blood pressure** . If it gets high, you can have problems. Ideally your blood pressure should be 140/80 or less.
- Your injection areas: If you inject insulin, your doctor will examine the areas where you give yourself the injections.
- Your eyes: Your eye doctor will do an examination to check the backs of your eyes. That area is called your retina. Diabetes can cause problems there that affect your vision.

You should also have time to discuss with your doctor:

- How you're coping
- Your treatment
- How well your diabetes is controlled
- Any problems you're having.

Diabetes, type 2

Glossary:

kidney

Your kidneys are organs that filter your blood to make urine. You have two kidneys, on either side of your body. They are underneath your ribcage, near your back.

hormones

Hormones are chemicals that are made in certain parts of the body. They travel through the bloodstream and have an effect on other parts of the body. For example, the female sex hormone oestrogen is made in a woman's ovaries. Oestrogen has many different effects on a woman's body. It makes the breasts grow at puberty and helps control periods. It is also needed to get pregnant.

pancreas

Your pancreas is an organ that's behind your stomach. It makes several different chemicals. Some of the chemicals help your body digest food. Your pancreas also makes a chemical called insulin, which helps your body use the sugar in your blood.

gland

A gland is any group of cells in the body that makes and releases something for use by another part of the body. For example, the thyroid gland makes a hormone called thyroxine. This acts on receptors within cells. By acting on the receptors it gives the cells a message to speed up their metabolism and work harder.

obesity

If your body stores more energy than you need, this can make you overweight. The excess energy is stored in your fat cells. If your weight goes above a certain level, doctors call this obesity. Obesity is considered a medical condition. The excess weight can be a strain on your bones and joints. And if you are obese, you're more likely to get other diseases. Doctors have developed a scale for telling how much excess weight you have. This measure, called the body mass index (BMI), depends on your height.

liver

Your liver is on the right side of your body, just below your ribcage. Your liver does several things in your body, including processing and storing nutrients from food, and breaking down chemicals, such as alcohol.

genes

Your genes are the parts of your cells that contain instructions for how your body works. Genes are found on chromosomes, structures that sit in the nucleus at the middle of each of your cells. You have 23 pairs of chromosomes in your normal cells, each of which has thousands of genes. You get one set of chromosomes, and all of the genes that are on them, from each of your parents.

heart disease

You get heart disease when your heart isn't able to pump blood as well as it should. This can happen for a variety of reasons.

stroke

You have a stroke when the blood supply to a part of your brain is cut off. This damages your brain and can cause symptoms like weakness or numbness on one side of your body. You may also find it hard to speak if you've had a stroke.

triglycerides

Triglycerides are the form in which fat is stored in your body. Triglycerides are made from the fat found in food. They can be used by your body for energy.

HDL cholesterol

Cholesterol is a fatty substance in your blood. You can get it from food and it is also made by the liver. Having a lot of cholesterol in your blood can cause health problems. But HDL cholesterol is sometimes called 'good' cholesterol, because it may lower the risk of heart disease. HDL stands for high-density lipoprotein.

yeast infection

Infections with certain types of fungus are called yeast infections. These infections are common and can affect many different parts of your body. For example, a yeast infection called thrush can affect people's mouths or, if they're women, their vaginas. If you get infected with thrush in your mouth, it makes white spots appear on your tongue or on the roof of your mouth. If thrush affects your vagina, you can get itchy, sore and have a discharge. You're more likely to get a yeast infection if your immune system is weakened.

infection

You get an infection when bacteria, a fungus, or a virus get into a part of your body where it shouldn't be. For example, an infection in your nose and airways causes the common cold. An infection in your skin can cause rashes such as athlete's foot. The organisms that cause infections are so tiny that you can't see them without a microscope.

dehydrated

When you're dehydrated, you don't have enough fluid in your blood. This could be because you're not drinking enough or because you're losing water by sweating or having diarrhoea.

bacteria

Bacteria are tiny organisms. There are lots of different types. Some are harmful and can cause disease. But some bacteria live in your body without causing any harm.

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yeasts

Yeasts are a type of fungus. They can cause infections in your body, such as thrush.

puberty

Puberty is the time when boys and girls develop secondary sexual characteristics. For boys, the major changes include pubic hair, a deeper voice, and growth of their penis and testicles. For girls, major changes include pubic hair, breasts and starting to have periods. After puberty, girls are able to become pregnant and boys are able to father children.

arthritis

Arthritis is when your joints become inflamed, making them stiff and painful. There are different kinds of arthritis. Osteoarthritis is the most common type. It happens when the cartilage at the end of your bones becomes damaged and then starts to grow abnormally. Rheumatoid arthritis happens because your immune system attacks the lining of your joints.

atherosclerosis

Atherosclerosis is also called 'hardening of the arteries'. It happens when fatty material sticks to the inner wall of your arteries. Over time, cholesterol, fats and other things in your blood stick to the same area and the artery wall becomes thick and narrow, making it progressively more difficult for blood to flow through the affected vessels.

arteries

Arteries are the blood vessels that take blood that is rich in oxygen and food away from your heart. The arteries carry this blood to all the tissues in your body.

immune system

Your immune system is made up of the parts of your body that fight infection. When bacteria or viruses get into your body, it's your immune system that kills them. Antibodies and white blood cells are part of your immune system. They travel in your blood and attack bacteria, viruses and other things that could damage your body.

laser therapy

Laser therapy is when surgeons use a laser to perform certain operations. For example, diabetes can make people grow new blood vessels in their eyes, which can affect their sight. Laser surgery can be used to remove these blood vessels.

blood pressure

Blood pressure is the amount of force that's exerted by your blood on to your blood vessels. You can think of it like the water pressure in your home: the more pressure you have, the faster and more forcefully the water flows out of the shower. Blood pressure is measured in millimetres of mercury (written as mm Hg). When your blood pressure is taken, the measurement is given as two numbers, for example 120/80 mm Hg. The first, higher, number is called the systolic pressure, and the second, lower, number is the diastolic pressure. The systolic number is the highest pressure that occurs while your heart is pushing blood into your arteries. The diastolic number is the lowest pressure that happens when your heart is relaxing and is not pushing your blood.

proteins

A lot of your body's tissues are made out of proteins. Proteins can be made in your cells. Proteins are also part of the food you eat, particularly meat and dairy products. Your body breaks down the protein you eat into amino acids. Your cells then use these amino acids to build new proteins, which make up muscles, joints, hair and other parts of your body.

kidney failure

Kidney failure is when your kidneys can't make urine properly. Kidney failure happens because of kidney disease. People with kidney failure need to have dialysis, which is a way to get rid of the substances in your blood that normally go in your urine.

ACE inhibitors

ACE inhibitors are drugs used mainly to lower blood pressure and reduce strain on your heart. ACE stands for 'angiotensin converting enzyme'. Angiotensin is a chemical that can make your blood vessels narrower. ACE inhibitors stop this happening, which helps to lower your blood pressure.

angiotensin II receptor antagonists

This class of drugs works similarly to ACE inhibitors to reduce blood pressure and strain on your heart. Angiotensin II receptor antagonists, also called angiotensin receptor blockers (ARBs), work by blocking the formation of angiotensin II, a substance that makes blood vessels narrower. Stopping it from being made helps to lower blood pressure.

bladder

Your bladder is the hollow organ at the top of your pelvis that stores urine. It is similar to a balloon, only with stronger walls. It fills up with urine until you go to the toilet.

acute myocardial infarction

Acute myocardial infarction is what doctors call a heart attack. A heart attack is when your heart muscle gets damaged because it isn't getting enough blood and oxygen. This can happen if a branch of your coronary arteries becomes blocked. During a heart attack, you may have pain or heaviness over your chest, and pain, numbness or tingling in your jaw and left arm.

diarrhoea

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Diarrhoea is when you have loose, watery stools and you need to go to the toilet far more often than usual. Doctors say you have diarrhoea if you need to go to the toilet more than three times a day.

cholesterol

Cholesterol is a fat-like substance made by your liver or absorbed from food. It is used by your body to make bile acids (which help your intestines absorb nutrients) and steroid hormones (like testosterone or oestrogen). Cholesterol is also an important part of cell membranes, which are the structures that surround cells. 'Good cholesterol' is called HDL; 'bad cholesterol' is LDL.

high cholesterol

If you've been told that you have high cholesterol it usually means that your total cholesterol level is 5mmol/l or higher. But doctors also look at the amount of good (HDL) and bad (LDL) cholesterol you have in your blood. Having high levels of bad cholesterol can make it more likely that you'll get certain diseases in your heart and arteries.

high blood pressure

Your blood pressure is considered to be high when it is above the accepted normal range. The usual limit for normal blood pressure is 140/90. If either the first (systolic) number is above 140 or the lower (diastolic) number is above 90, a person is considered to have high blood pressure. Doctors sometimes call high blood pressure 'hypertension'.

insulin

Insulin is a hormone that helps your body use glucose. Glucose is a type of sugar that gives you energy. Insulin keeps the levels of glucose in your body steady. Insulin also helps glucose to be carried in your blood, so that the glucose can get into your cells. People who have diabetes do not have enough insulin or do not react to insulin strongly enough. This means they can get too much glucose in their blood.

pneumonia

Pneumonia is an infection in your lungs. Anything that causes infections (bacteria, viruses or fungi, for example) can give you pneumonia.

vaccination

A vaccination is an injection a doctor can give you to protect you from getting an infectious illness (an illness that spreads between people).

thyroid gland

Your thyroid gland is a small organ that sits in your neck, just in front of your windpipe. It sends out a hormone called thyroxine. This acts on receptors within cells. By acting on the receptors it gives the cells a message to speed up their metabolism and work harder.

placebo

A placebo is a 'pretend' or dummy treatment that contains no active substances. A placebo is often given to half the people taking part in medical research trials, for comparison with the 'real' treatment. It is made to look and taste identical to the drug treatment being tested, so that people in the studies do not know if they are getting the placebo or the 'real' treatment. Researchers often talk about the 'placebo effect'. This is where patients feel better after having a placebo treatment because they expect to feel better. Tests may indicate that they actually are better. In the same way, people can also get side effects after having a placebo treatment. Drug treatments can also have a 'placebo effect'. This is why, to get a true picture of how well a drug works, it is important to compare it against a placebo treatment.

randomised controlled trials

Randomised controlled trials are medical studies designed to test whether a treatment works. Patients are split into groups. One group is given the treatment being tested (for example, an antidepressant drug) while another group (called the comparison or control group) is given an alternative treatment. This could be a different type of drug or a dummy treatment (a placebo). Researchers then compare the effects of the different treatments.

allergic reaction

You have an allergic reaction when your immune system overreacts to a substance that is normally harmless. You can be allergic to particles in the air you are breathing, like pollen (which causes hay fever) or to chemicals on your skin, like detergents (which can cause a rash). People can also have an allergic reaction to drugs, like penicillin.

systematic reviews

A systematic review is a thorough look through published research on a particular topic. Only studies that have been carried out to a high standard are included. A systematic review may or may not include a meta-analysis, which is when the results from individual studies are put together.

allergy

If you have an allergy to something (such as pollen or a medicine), your body always overreacts to it. The reaction happens because your immune system (your body's system for fighting infection) is too sensitive to it.

randomised controlled trials

Randomised controlled trials are medical studies designed to test whether a treatment works. Patients are split into groups. One group is given the treatment being tested (for example, an antidepressant drug) while another group (called the comparison or control group) is given an alternative treatment. This could be a different type of drug or a dummy treatment (a placebo). Researchers then compare the effects of the different treatments.

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menopause

When a woman stops having periods, it is called the menopause. This usually happens around the age of 50.

Sources for the information on this leaflet:

1. Diabetes UK. Monitoring your diabetes. Available at <http://www.diabetes.org.uk/Guide-to-diabetes/Monitoring> (accessed on 5 March 2014).
2. Diabetes UK. What is diabetes? Available at http://www.diabetes.org.uk/Guide-to-diabetes/Introduction-to-diabetes/What_is_diabetes/ (accessed on 11 February 2014).
3. American Diabetes Association. The genetics of diabetes. Available at <http://www.diabetes.org/diabetes-basics/genetics-of-diabetes.html> (accessed on 11 February 2014).
4. Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *New England Journal of Medicine*. 2002; 346: 393-403.
5. Ford ES, Li C, Sattar N. Metabolic syndrome and incident diabetes: current state of the evidence. *Diabetes Care*. 2008; 31: 1898-1904.
6. British Cardiac Society, British Hypertension Society, Diabetes UK, et al. JBS 2: Joint British Societies' guidelines on prevention of cardiovascular disease in clinical practice. *Heart*. 2005; 91: 1-52.
7. National Institute for Health and Care Excellence. Diabetes in pregnancy: management of diabetes and its complications from pre-conception to the postnatal period. March 2008. Clinical guideline 63. Available at <http://www.nice.org.uk/cg63> (accessed on 11 February 2014).
8. Bellamy L, Casas JP, Hingorani AD, et al. Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis. *Lancet*. 2009; 373: 1773-1779.
9. Grundy SM, Cleeman JI, Daniels SR, et al. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Circulation*. 2005; 112: 2735-2752.
10. International Diabetes Federation. The IDF consensus worldwide definition of the metabolic syndrome. Available at http://www.idf.org/webdata/docs/IDF_Meta_def_final.pdf (accessed on 14 February 2014).
11. Powers AC. Diabetes mellitus. In: Braunwald E, Fauci AS, Kasper DL, et al (editors). *Harrison's Principles of Internal Medicine*. McGraw-Hill, New York, NY; 2001.
12. British National Formulary. Insulins. Section 6.1.1. British Medical Association and Royal Pharmaceutical Society of Great Britain. Also available at <http://bnf.org> (accessed on 5 March 2014).
13. National Institute of Diabetes and Digestive and Kidney Diseases. What I need to know about diabetes medicines. December 2013. Available at http://diabetes.niddk.nih.gov/dm/pubs/medicines_ez (accessed on 11 February 2014).
14. National Institute for Health and Care Excellence. Continuous subcutaneous insulin infusion for the treatment of diabetes mellitus. July 2008. Technology appraisal 151. Available at <http://www.nice.org.uk/TA151> (accessed on 11 February 2014).
15. Diabetes UK. Short term complications. Available at <http://www.diabetes.org.uk/Guide-to-diabetes/Complications> (accessed on 11 February 2014).
16. Thomas MJ, Thomas JA. Insulin, glucagon, somatostatin and orally effective hypoglycaemic drugs. In: Craig CR, Stitzel RE. *Modern pharmacology with clinical applications*. 5th edition. Little, Brown and Co, Boston, MA; 1997.
17. Holman RR, Paul SK, Bethel MA, et al. 10-year follow-up of intensive glucose control in type 2 diabetes. *New England Journal of Medicine*. 2008; 359: 1577-1589.
18. Perkovic V, Heerspink HL, Chalmers J, et al. Intensive glucose control improves kidney outcomes in patients with type 2 diabetes. *Kidney International*. 2013; 83: 517-523.

Diabetes, type 2

19. Hemmingsen B, Lund SS, Gluud C, et al. Targeting intensive glycaemic control versus targeting conventional glycaemic control for type 2 diabetes mellitus (Cochrane review). In: The Cochrane Library. Wiley, Chichester, UK.
20. UK Prospective Diabetes Study Group. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). *Lancet*. 1998; 352: 854-865.
21. UK Prospective Diabetes Study Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*. 1998; 352: 837-853.
22. Egger M, Davey Smith G, Stettler C, et al. Risk of adverse effects of intensified treatment in insulin-dependent diabetes mellitus: a meta-analysis. *Diabetic Medicine*. 1997; 14: 919-928.
23. U.S. Food and Drug Administration. 2005 safety alerts for drugs, biologics, medical devices, and dietary supplements: parenteral maltose/parenteral galactose/oral xylose-containing products. April 2008. Available at <http://www.fda.gov> (accessed on 11 February 2014).
24. Williams G, Pickup JC. *Handbook of Diabetes*. Blackwell Science, Oxford, UK; 1992.
25. National Institute for Health and Care Excellence. NICE issues national guidelines for the management of blood glucose levels in people with type 2 diabetes. May 2008. Available at <http://guidance.nice.org.uk/CG66> (accessed on 14 February 2014).
26. Diabetes UK. What is diabetes? Available at http://www.diabetes.org.uk/Guide-to-diabetes/Introduction-to-diabetes/What_is_diabetes/ (accessed on 11 February 2014).
27. Department of Health. Health survey for England - 2012: Trend tables. December 2013. Available at <http://www.hscic.gov.uk/catalogue/PUB13219> (accessed on 11 February 2014).
28. International Diabetes Federation. *Diabetes atlas*. Available at <http://www.diabetesatlas.org> (accessed on 11 February 2014).
29. Diabetes UK. Driving & Diabetes. Available at http://www.diabetes.org.uk/Guide-to-diabetes/Living_with_diabetes/Driving (accessed on 5 March 2014).
30. Watkins PJ. *ABC of Diabetes*. 5th edition. BMJ Books, London, UK; 2002.
31. Diabetes UK. Complications. Available at <http://www.diabetes.org.uk/Guide-to-diabetes/Complications> (accessed on 11 February 2014).
32. Diabetes UK. Complications. Available at <http://www.diabetes.org.uk/Guide-to-diabetes/Complications> (accessed on 11 February 2014).
33. Wheeler ML. Nutrition management and physical activity as treatments for diabetes. *Diabetes*. 1999; 26: 857-867.
34. United States Department of Agriculture. Steps to a healthier you. Available at http://www.foodinsight.org/Resources/Detail.aspx?topic=Your_Personal_Path_to_Health_Steps_to_a_Healthier_You_ (accessed on 11 February 2014).
35. Diabetes UK. Recipes. Available at <http://www.diabetes.org.uk/Guide-to-diabetes/Recipes/> (accessed on 5 March 2014).
36. Powers AC. Diabetes mellitus. In: Braunwald E, Fauci AS, Kasper DL, et al (editors). *Harrison's Principles of Internal Medicine*. McGraw-Hill, New York, NY; 2001.
37. Hu KK, Boyko EJ, Scholes D, et al. Risk factors for urinary tract infections in postmenopausal women. *Archives of Internal Medicine*. 2004; 164: 989-993.
38. National Institute for Health and Care Excellence. Diagnosis and management of type 1 diabetes in children, young people and adults. July 2004. Clinical guideline 15. Available at <http://www.nice.org.uk/guidance/CG15> (accessed on 11 February 2014).
39. Diabetes UK. Diagnosis & prevention: new diagnostic criteria for diabetes. January 2011. Available at <http://www.diabetes.org.uk/diagnostic-criteria> (accessed on 11 February 2014).

Diabetes, type 2

40. National Institute for Health and Care Excellence. Diagnosis and management of type 1 diabetes in children, young people and adults. July 2004. Clinical guideline 15. Available at <http://www.nice.org.uk/guidance/CG15> (accessed on 11 February 2014).
41. Thomas MJ, Thomas JA. Insulin, glucagon, somatostatin and orally effective hypoglycaemic drugs. In: Craig CR, Stitzel RE. Modern pharmacology with clinical applications. 5th edition. Little, Brown and Co, Boston, MA; 1997.
42. Saenz Calvo A, Fernandez Esteban I, Mataix Sanjuan A, et al. Metformin for type 2 diabetes mellitus. Systematic review and meta-analysis. *Atencion Primaria*. 2005; 36: 183-191.
43. Johansen K. Efficacy of metformin in the treatment of NIDDM: meta-analysis. *Diabetes Care*. 1999; 22: 33-37.
44. Hoffmann J, Spengler M. Efficacy of 24-week monotherapy with acarbose, metformin, or placebo in dietary-treated NIDDM patients: the Essen-II Study. *American Journal of Medicine*. 1997; 103: 483-490.
45. Garber AJ, Duncan TG, Goodman AM, et al. Efficacy of metformin in type II diabetes: results of a double-blind, placebo-controlled, dose-response trial. *American Journal of Medicine*. 1997; 103: 491-497.
46. Richter B, Bandeira-Echtler E, Bergerhoff K, et al. Dipeptidyl peptidase-4 (DPP-4) inhibitors for type 2 diabetes mellitus (Cochrane review). In: The Cochrane Library. Wiley, Chichester, UK.
47. Bennett WL, Maruthur NM, Singh S, et al. Comparative effectiveness and safety of medications for type 2 diabetes: an update including new drugs and 2-drug combinations. *Annals of Internal Medicine*. 2011; 154: 602-613.
48. Hoffmann J, Spengler M. Efficacy of 24-week monotherapy with acarbose, metformin, or placebo in dietary-treated NIDDM patients: the Essen-II Study. *American Journal of Medicine*. 1997; 103: 483-490.
49. Garber AJ, Duncan TG, Goodman AM, et al. Efficacy of metformin in type II diabetes: results of a double-blind, placebo-controlled, dose-response trial. *American Journal of Medicine*. 1997; 103: 491-497.
50. Agency for Healthcare Research and Quality. Comparative effectiveness and safety of oral diabetes medications for adults with type 2 diabetes. Available at <http://www.effectivehealthcare.ahrq.gov> (accessed on 11 February 2014).
51. Salpeter S, Greyber E, Pasternak G, et al. Risk of fatal and nonfatal lactic acidosis with metformin use in type 2 diabetes mellitus. In: The Cochrane Library. Update Software, Oxford, UK.
52. Hoffmann J, Spengler M. Efficacy of 24-week monotherapy with acarbose, metformin, or placebo in dietary-treated NIDDM patients: the Essen-II Study. *American Journal of Medicine*. 1997; 103: 483-490.
53. Garber AJ, Duncan TG, Goodman AM, et al. Efficacy of metformin in type II diabetes: results of a double-blind, placebo-controlled, dose-response trial. *American Journal of Medicine*. 1997; 103: 491-497.
54. British National Formulary. Sulphonylureas. Section 6.1.2.1. British Medical Association and Royal Pharmaceutical Society of Great Britain. Also available at <http://bnf.org> (accessed on 11 February 2014).
55. UK Prospective Diabetes Study Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet*. 1998; 352: 837-853.
56. Inzucchi SE. Oral antihyperglycemic therapy for type 2 diabetes: scientific review. *Journal of the American Medical Association*. 2002; 287: 360-372.
57. Testa MA, Simonson DC. Health economic benefits and quality of life during improved glycemic control in patients with type 2 diabetes mellitus: a randomized, controlled, double-blind trial. *Journal of the American Medical Association*. 1998; 280: 1490-1496.
58. Bautista JL, Bugos C, Dirnberger G, et al. Efficacy and safety profile of glimepiride in Mexican American patients with type 2 diabetes mellitus: a randomized, placebo-controlled study. *Clinical Therapy*. 2003; 25: 195-209.
59. Rosenstock J, Samols E, Muchmore DB, et al. Glimepiride, a new once-daily sulfonylurea: a double-blind placebo-controlled study of NIDDM patients. *Diabetes Care*. 1996; 19: 1194-1199.

Diabetes, type 2

60. Draeger KE, Wernicke-Panten K, Lomp HJ, et al. Long-term treatment of type 2 diabetic patients with the new oral antidiabetic agent glimepiride (Amaryl): a double-blind comparison with glibenclamide. *Hormone and Metabolic Research*. 1996; 28: 419-425.
61. Dills DG, Schneider J. Clinical evaluation of glimepiride versus glyburide in NIDDM in a double-blind comparative study. *Hormone and Metabolic Research*. 1996; 28: 426-429.
62. Birkeland KI, Furuseth K, Melander A, et al. Long-term randomized placebo-controlled double-blind therapeutic comparison of glipizide and glyburide. *Diabetes Care*. 1994; 17: 45-49.
63. Monami M, Genovese S, Mannucci E. Cardiovascular safety of sulfonylureas: a meta-analysis of randomized clinical trials. *Diabetes, Obesity & Metabolism*. 2013; 15: 938-953.
64. Rosenstock J, Samols E, Muchmore DB, et al. Glimepiride, a new once-daily sulfonylurea: a double-blind placebo-controlled study of NIDDM patients. *Diabetes Care*. 1996; 19: 1194-1199.
65. Testa MA, Simonson DC. Health economic benefits and quality of life during improved glycemic control in patients with type 2 diabetes mellitus: a randomized, controlled, double-blind trial. *Journal of the American Medical Association*. 1998; 280: 1490-1496.
66. Bautista JL, Bugos C, Dirnberger G, et al. Efficacy and safety profile of glimepiride in Mexican American patients with type 2 diabetes mellitus: a randomized, placebo-controlled study. *Clinical Therapy*. 2003; 25: 195-209.
67. Scherthaner G, Grimaldi A, di Mario U, et al. GUIDE study: double-blind comparison of once-daily gliclazide MR and glimepiride in type 2 diabetic patients. *European Journal of Clinical Investigation*. 2004; 34: 535-542.
68. Draeger KE, Wernicke-Panten K, Lomp HJ, et al. Long-term treatment of type 2 diabetic patients with the new oral antidiabetic agent glimepiride (Amaryl): a double-blind comparison with glibenclamide. *Hormone and Metabolic Research*. 1996; 28: 419-425.
69. Dills DG, Schneider J. Clinical evaluation of glimepiride versus glyburide in NIDDM in a double-blind comparative study. *Hormone and Metabolic Research*. 1996; 28: 426-429.
70. Birkeland KI, Furuseth K, Melander A, et al. Long-term randomized placebo-controlled double-blind therapeutic comparison of glipizide and glyburide. *Diabetes Care*. 1994; 17: 45-49.
71. UK Prospective Diabetes Study (UKPDS) Group. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). *Lancet*. 1998; 352: 854-865.
72. Diabetes UK. Healthy eating. Available at http://www.diabetes.org.uk/Guide-to-diabetes/Food_and_recipes/Eating-well-with-Type-1-diabetes/Ten-steps-to-eating-well/ (accessed on 11 February 2014).
73. Department of Health. Your weight, your health. May 2006. Available at <http://www.dh.gov.uk> (accessed on 11 February 2014).
74. Andrews RC, Cooper AR, Montgomery AA, et al. Diet or diet plus physical activity versus usual care in patients with newly diagnosed type 2 diabetes: the Early ACTID randomised controlled trial. *Lancet*. 2011; 378: 129-139.
75. Gregg EW, Chen H, Wagenknecht LE, et al. Association of an intensive lifestyle intervention with remission of type 2 diabetes. *The Journal of the American Medical Association*. 2012; 308: 2489-2496.
76. Buchwald H, Estok R, Fahrbach K, et al. Weight and type 2 diabetes after bariatric surgery: systematic review and meta-analysis. *American Journal of Medicine*. 2009; 122: 248-256.
77. Lozano ML, Armale MJ. Education for type 2 diabetics: why not in groups? *Atencion Primaria*. 1999; 23: 485-492.
78. Brown SA, Garcia AA, Kouzekanani K, et al. Culturally competent diabetes self-management for Mexican Americans: the Starr County Border Health Initiative. *Diabetes Care*. 2002; 25: 259-268.
79. Trento M, Passera P, Tomalino M, et al. Group visits improve metabolic control in type 2 diabetes: a 2-year follow-up. *Diabetes Care*. 2001; 24: 995-1000.

Diabetes, type 2

80. Wu L, Forbes A, Griffiths P, et al. Telephone follow-up to improve glycaemic control in patients with Type 2 diabetes: systematic review and meta-analysis of controlled trials. *Diabetic Medicine*. 2010; 27: 1217-1225.
81. Pal K, Eastwood SV, Michie S, et al. Computer-based diabetes self-management interventions for adults with type 2 diabetes mellitus (Cochrane review). In: *The Cochrane Library*. Wiley, Chichester, UK.
82. Hornsten A, Lundman B, Stenlund H, et al. Metabolic improvement after intervention focusing on personal understanding in type 2 diabetes. *Diabetes Research & Clinical Practice*. 2005; 68: 65-74.
83. Gary TL, Genkinger JM, Guallar E, et al. Meta-analysis of randomized educational and behavioral interventions in type 2 diabetes. *Diabetes Educator*. 2003; 29: 488-501.
84. Dalmau Llorca MR, Garcia Bernal G, Aguilar Martin C, et al. Group versus individual education for type-2 diabetes patients. *Atencion Primaria*. 2003; 32: 36-41.
85. Loveman E, Cave C, Green C, et al. The clinical and cost-effectiveness of patient education models for diabetes: a systematic review and economic evaluation. *Health Technology Assessment*. 2003; 7: 1-190.
86. Duke SA, Colagiuri S, Colagiuri R. Individual patient education for people with type 2 diabetes mellitus. In: *The Cochrane Library*. Wiley, Chichester, UK.
87. Steed L, Cooke D, Newman S. A systematic review of psychosocial outcomes following education, self-management and psychological interventions in diabetes mellitus. *Patient Education and Counselling*. 2003; 51: 5-15.
88. Loveman E, Cave C, Green C, et al. The clinical and cost-effectiveness of patient education models for diabetes: a systematic review and economic evaluation. *Health Technology Assessment*. 2003; 7: 1-190.
89. Gary TL, Genkinger JM, Guallar E, et al. Meta-analysis of randomized educational and behavioral interventions in type 2 diabetes. *Diabetes Educator*. 2003; 29: 488-501.
90. Lozano ML, Armale MJ. Education for type 2 diabetics: why not in groups? *Atencion Primaria*. 1999; 23: 485-492.
91. Dalmau Llorca MR, Garcia Bernal G, Aguilar Martin C, et al. Group versus individual education for type-2 diabetes patients. *Atencion Primaria*. 2003; 32: 36-41.
92. Sone H, Katagiri A, Ishibashi S, et al. Effects of lifestyle modifications on patients with type 2 diabetes: the Japan Diabetes Complications Study (JDACS) study design, baseline analysis and three year-interim report. *Hormone and Metabolic Research*. 2002; 34: 509-515.
93. Rachmani R, Levi Z, Slavachevski I, et al. Teaching patients to monitor their risk factors retards the progression of vascular complications in high-risk patients with type 2 diabetes mellitus: a randomized prospective study. *Diabetic Medicine*. 2002; 19: 385-392.
94. Menard J, Payette H, Baillargeon JP, et al. Efficacy of intensive multitherapy for patients with type 2 diabetes mellitus: a randomized controlled trial. *CMAJ Canadian Medical Association Journal*. 2005; 173: 1457-1466.
95. Sone H, Katagiri A, Ishibashi S, et al. Effects of lifestyle modifications on patients with type 2 diabetes: the Japan Diabetes Complications Study (JDACS) study design, baseline analysis and three year-interim report. *Hormone and Metabolic Research*. 2002; 34: 509-515.
96. Rachmani R, Levi Z, Slavachevski I, et al. Teaching patients to monitor their risk factors retards the progression of vascular complications in high-risk patients with type 2 diabetes mellitus: a randomized prospective study. *Diabetic Medicine*. 2002; 19: 385-392.
97. Sone H, Katagiri A, Ishibashi S, et al. Effects of lifestyle modifications on patients with type 2 diabetes: the Japan Diabetes Complications Study (JDACS) study design, baseline analysis and three year-interim report. *Hormone and Metabolic Research*. 2002; 34: 509-515.
98. Rachmani R, Levi Z, Slavachevski I, et al. Teaching patients to monitor their risk factors retards the progression of vascular complications in high-risk patients with type 2 diabetes mellitus: a randomized prospective study. *Diabetic Medicine*. 2002; 19: 385-392.

Diabetes, type 2

99. British National Formulary. Other antidiabetic drugs. Section 6.1.2.3. British Medical Association and Royal Pharmaceutical Society of Great Britain. Also available at <http://bnf.org> (accessed on 11 February 2014).
100. Inzucchi SE. Oral antihyperglycemic therapy for type 2 diabetes: scientific review. *Journal of the American Medical Association*. 2002; 287: 360-372.
101. Saloranta C, Hershon K, Ball M, et al. Efficacy and safety of nateglinide in type 2 diabetic patients with modest fasting hyperglycemia. *Journal of Clinical Endocrinology and Metabolism*. 2002; 87: 4171-4176.
102. Black C, Donnelly P, McIntyre L, et al. Meglitinide analogues for type 2 diabetes mellitus (Cochrane review). In: *The Cochrane Library*. Wiley, Chichester, UK.
103. Esposito K, Giugliano D, Nappo F, et al. Regression of carotid atherosclerosis by control of postprandial hyperglycemia in type 2 diabetes mellitus. *Circulation*. 2004; 110: 214-219.
104. Horton ES, Clinkingbeard C, Gatlin M, et al. Nateglinide alone and in combination with metformin improves glycemic control by reducing mealtime glucose levels in type 2 diabetes. *Diabetes Care*. 2000; 23: 1660-1665.
105. Hanefeld M, Bouter KP, Dickinson S, et al. Rapid and short-acting mealtime insulin secretion with nateglinide controls both prandial and mean glycemia. *Diabetes Care*. 2000; 23: 202-207.
106. Saloranta C, Hershon K, Ball M, et al. Efficacy and safety of nateglinide in type 2 diabetic patients with modest fasting hyperglycemia. *Journal of Clinical Endocrinology and Metabolism*. 2002; 87: 4171-4176.
107. Horton ES, Clinkingbeard C, Gatlin M, et al. Nateglinide alone and in combination with metformin improves glycemic control by reducing mealtime glucose levels in type 2 diabetes. *Diabetes Care*. 2000; 23: 1660-1665.
108. Hanefeld M, Bouter KP, Dickinson S, et al. Rapid and short-acting mealtime insulin secretion with nateglinide controls both prandial and mean glycemia. *Diabetes Care*. 2000; 23: 202-207.
109. van de Laar FA, Lucassen PL, Akkermans RP, et al. Alpha-glucosidase inhibitors for patients with type 2 diabetes: results from a Cochrane systematic review and meta-analysis. *Diabetes Care*. 2005; 28: 154-163.
110. Monami M, Lamanna C, Marchionni N, et al. Comparison of different drugs as add-on treatments to metformin in type 2 diabetes: a meta-analysis. *Diabetes Research & Clinical Practice*. 2008; 79: 196-203.
111. Bolen S, Feldman L, Vassy J, et al. Systematic review: comparative effectiveness and safety of oral medications for type 2 diabetes mellitus. *Annals of Internal Medicine*. 2007; 147: 386-399.
112. Norris SL, Lee N, Thakurta S, et al. Exenatide efficacy and safety: a systematic review. *Diabetic Medicine*. 2009; 26: 837-846.
113. Monami M, Marchionni N, Mannucci E, et al. Glucagon-like peptide-1 receptor agonists in type 2 diabetes: a meta-analysis of randomized clinical trials. *European Journal of Endocrinology*. 2009; 160: 909-917.
114. National Institute for Health and Care Excellence. Exenatide prolonged-release suspension for injection in combination with oral antidiabetic therapy for the treatment of type 2 diabetes. February 2012. Technology appraisal 248. Available at <http://www.nice.org.uk/ta248> (30 October 2012).
115. Eli Lilly and Company. Summary of product characteristics: Byetta 5 micrograms solution for injection, pre-filled pen, Byetta 10 micrograms solution for injection, pre-filled pen. January 2014. Available at <http://www.medicines.org.uk/emc/medicine/19257> (accessed on 11 February 2014).
116. National Institute for Health and Care Excellence. Type 2 diabetes - newer agents. May 2009. Clinical guideline 87. Available at <http://guidance.nice.org.uk/CG87> (accessed on 11 February 2014).
117. Amori RE, Lau J, Pittas AG. Efficacy and safety of incretin therapy in type 2 diabetes: systematic review and meta-analysis. *Journal of the American Medical Association*. 2007; 298: 194-206.

Diabetes, type 2

118. Shyangdan DS, Royle P, Clar C, et al. Glucagon-like peptide analogues for type 2 diabetes mellitus (Cochrane review). In: The Cochrane Library. Wiley, Chichester, UK.
119. Mikhail N. Incretin mimetics and dipeptidyl peptidase 4 inhibitors in clinical trials for the treatment of type 2 diabetes. *Expert Opinion on Investigational Drugs*. 2008; 17: 845-853.
120. Yoo BK, Triller DM, Yoo DJ. Exenatide: a new option for the treatment of type 2 diabetes. *Annals of Pharmacotherapy*. 2006; 40: 1777-1784.
121. U.S. Food and Drug Administration. Byetta (exenatide) injections. October 2011. Available at <http://www.fda.gov/Safety/MedWatch/SafetyInformation/ucm194556.htm> (accessed on 11 February 2014).
122. Medicines and Healthcare products Regulatory Agency. Drug safety update: volume 2, issue 8, March 2009. Available at <http://www.mhra.gov.uk/Publications/Safetyguidance/DrugSafetyUpdate/CON041211> (accessed on 11 February 2014).
123. Dore DD, Bloomgren GL, Wenten M, et al. A cohort study of acute pancreatitis in relation to exenatide use. *Diabetes, Obesity & Metabolism*. 2011; 13: 559-566.
124. Merck Sharp and Dohme Ltd. Summary of product characteristics: Januvia 100 mg film-coated tablets. September 2013. Available at <http://www.medicines.org.uk/emc/medicine/19609/SPC> (accessed on 11 February 2014).
125. Novartis Pharmaceuticals Ltd. Summary of product characteristics: Galvus 50mg tablets. August 2013. Available at <http://www.medicines.org.uk/emc/medicine/20734/SPC/> (accessed on 11 February 2014).
126. Gagliardino JJ, Santoro S, Arellano S, et al. New treatments for type 2 diabetes mellitus: combined therapy with sitagliptin. *Expert Opinion on Pharmacotherapy*. 2008; 9: 1495-1507.
127. Richter B, Bandeira-Echtler E, Bergerhoff K, et al. Dipeptidyl peptidase-4 (DPP-4) inhibitors for type 2 diabetes mellitus (Cochrane review). In: The Cochrane Library. Wiley, Chichester, UK.
128. Esposito K, Cozzolino D, Bellastella G, et al. Dipeptidyl peptidase-4 inhibitors and HbA1c target of <7% in type 2 diabetes: meta-analysis of randomized controlled trials. *Diabetes, Obesity & Metabolism*. 2011; 13: 594-603.
129. Karagiannis T, Paschos P, Paletas K, et al. Dipeptidyl peptidase-4 inhibitors for treatment of type 2 diabetes mellitus in the clinical setting: systematic review and meta-analysis. *British Medical Journal*. 2012; 344: e1369.
130. Wu D, Li L, Liu C. Efficacy and safety of dipeptidyl peptidase-4 inhibitors and metformin as initial combination therapy and as monotherapy in patients with type 2 diabetes mellitus: a meta-analysis. *Diabetes, Obesity & Metabolism*. 2014; 16: 30-37.
131. Vilsbøll T, Rosenstock J, Yki-Järvinen H, et al. Efficacy and safety of sitagliptin when added to insulin therapy in patients with type 2 diabetes. *Diabetes, Obesity & Metabolism*. 2010; 12: 167-177.
132. Gerrald KR, Van Scoyoc E, Wines RC, et al. Saxagliptin and sitagliptin in adult patients with type 2 diabetes: a systematic review and meta-analysis. *Diabetes, Obesity & Metabolism*. 2012; 14: 481-492.
133. Jadzinsky M, Pfützner E, Paz-Pacheco E, et al. Saxagliptin given in combination with metformin as initial therapy improves glycaemic control in patients with type 2 diabetes compared with either monotherapy: a randomized controlled trial. *Diabetes, Obesity and Metabolism*. 2009; 11: 611-622.
134. Gooßen K, Gräber S. Longer term safety of dipeptidyl peptidase-4 inhibitors in patients with type 2 diabetes mellitus: systematic review and meta-analysis. *Diabetes, Obesity & Metabolism*. Published online 20 Apr 2012.
135. U.S. Food and Drug Administration. Information for healthcare professionals - acute pancreatitis and sitagliptin (marketed as Januvia and Janumet). September 2009. Available at <http://www.fda.gov> (accessed on 11 February 2014).
136. Monami M, Dicembrini I, Mannucci E. Dipeptidyl peptidase-4 inhibitors and pancreatitis risk: a meta-analysis of randomized clinical trials. *Diabetes, Obesity & Metabolism*. 2014; 16: 48-56.

Diabetes, type 2

137. U.S. National Library of Medicine. Medline Plus: sitagliptin. January 2014. Available at <http://www.nlm.nih.gov/medlineplus/druginfo/meds/a606023.html> (accessed on 11 February 2014).
138. British National Formulary. Antidiabetic drugs. Section 6.1.2. British Medical Association and Royal Pharmaceutical Society of Great Britain. Also available at <http://bnf.org> (accessed on 11 February 2014).
139. Phung OJ, Scholle JM, Talwar M, et al. Effect of noninsulin antidiabetic drugs added to metformin therapy on glycemic control, weight gain, and hypoglycemia in type 2 diabetes. *Journal of the American Medical Association*. 2010; 303: 1410-1418.
140. Blonde L, Rosenstock J, Mooradian AD, et al. Glyburide/metformin combination product is safe and efficacious in patients with type 2 diabetes failing sulphonylurea therapy. *Diabetes Obesity and Metabolism*. 2002; 4: 368-375.
141. Marre M, Howlett H, Lehert P, et al. Improved glycaemic control with metformin-glibenclamide combined tablet therapy (Glucovance) in type 2 diabetic patients inadequately controlled on metformin. *Diabetic Medicine*. 2002; 19: 673-680.
142. Garber AJ, Donovan DS, Dandona P, et al. Efficacy of glyburide/metformin tablets compared with initial monotherapy in type 2 diabetes. *Journal of Clinical Endocrinology and Metabolism*. 2003; 88: 3598-3604.
143. Charpentier G, Fleury F, Kabir M, et al. Improved glycaemic control by addition of glimepiride to metformin monotherapy in type 2 diabetic patients. *Diabetic Medicine*. 2001; 18: 828-834.
144. Marre M, Van Gaal L, Usadel KH, et al. Nateglinide improves glycaemic control when added to metformin monotherapy: results of a randomized trial with type 2 diabetes patients. *Diabetes Obesity and Metabolism*. 2002; 4: 177-186.
145. Reboussin DM, Goff DC, Lipkin EW, et al. The combination oral and nutritional treatment of late-onset diabetes mellitus (CONTROL DM) trial results. *Diabetic Medicine* 2004; 21: 1082-1089.
146. Bosi E, Dotta F, Jia Y, et al. Vildagliptin plus metformin combination therapy provides superior glycaemic control to individual monotherapy in treatment-naive patients with type 2 diabetes mellitus. *Diabetes, Obesity & Metabolism*. 2009; 11: 506-515.
147. Halimi S, Le Berre MA, Grange V, et al. Efficacy and safety of acarbose add-on therapy in the treatment of overweight patients with Type 2 diabetes inadequately controlled with metformin: a double-blind, placebo-controlled study. *Diabetes Research & Clinical Practice*. 2000; 50: 49-56.
148. Rosenstock J, Brown A, Fischer J, et al. Efficacy and safety of acarbose in metformin-treated patients with type 2 diabetes. *Diabetes Care*. 1998; 21: 2050-2055.
149. Phillips P, Karrasch J, Scott R, et al. Acarbose improves glycemic control in overweight type 2 diabetic patients insufficiently treated with metformin. *Diabetes Care*. 2003; 26: 269-273.
150. Holman RR, Cull CA, Turner RC, et al. A randomized double-blind trial of acarbose in type 2 diabetes shows improved glycemic control over 3 years (U.K. Prospective Diabetes Study 44). *Diabetes Care*. 1999; 22: 960-964.
151. Costa B, Pinol C, Costa B, et al. Acarbose in ambulatory treatment of non-insulin-dependent diabetes mellitus associated to imminent sulphonylurea failure: a randomised-multicentric trial in primary health-care. *Diabetes Research & Clinical Practice*. 1997; 38: 33-40.
152. Lin BJ, Wu HP, Huang HS, et al. Efficacy and tolerability of acarbose in Asian patients with type 2 diabetes inadequately controlled with diet and sulphonylureas. *Journal of Diabetes & its Complications*. 2003; 17: 179-185.
153. Buse JB, Henry RR, Han J, et al. Effects of exenatide (exendin-4) on glycemic control over 30 weeks in sulphonylurea-treated patients with type 2 diabetes. *Diabetes Care*. 2004; 27: 2628-2635.
154. Charpentier G, Fleury F, Kabir M, et al. Improved glycaemic control by addition of glimepiride to metformin monotherapy in type 2 diabetic patients. *Diabetic Medicine*. 2001; 18: 828-834.
155. Reboussin DM, Goff DC, Lipkin EW, et al. The combination oral and nutritional treatment of late-onset diabetes mellitus (CONTROL DM) trial results. *Diabetic Medicine*. 2004; 21: 1082-1089.

Diabetes, type 2

156. Moses R, Slobodniuk R, Boyages S, et al. Effect of repaglinide addition to metformin monotherapy on glycaemic control in patients with type 2 diabetes. *Diabetes Care*. 1999; 22: 119-124.
157. Moses R, Slobodniuk R, Boyages S, et al. Effect of repaglinide addition to metformin monotherapy on glycaemic control in patients with type 2 diabetes. *Diabetes Care*. 1999; 22: 119-124.
158. Charpentier G, Fleury F, Kabir M, et al. Improved glycaemic control by addition of glimepiride to metformin monotherapy in type 2 diabetic patients. *Diabetic Medicine*. 2001; 18: 828-834.
159. Marre M, Van Gaal L, Usadel KH, et al. Nateglinide improves glycaemic control when added to metformin monotherapy: results of a randomized trial with type 2 diabetes patients. *Diabetes Obesity and Metabolism*. 2002; 4: 177-186.
160. Blonde L, Rosenstock J, Mooradian AD, et al. Glyburide/metformin combination product is safe and efficacious in patients with type 2 diabetes failing sulphonylurea therapy. *Diabetes Obesity and Metabolism*. 2002; 4: 368-375.
161. Marre M, Howlett H, Lehert P, et al. Improved glycaemic control with metformin-glibenclamide combined tablet therapy (Glucovance) in type 2 diabetic patients inadequately controlled on metformin. *Diabetic Medicine*. 2002; 19: 673-680.
162. Garber AJ, Donovan DS, Dandona P, et al. Efficacy of glyburide/metformin tablets compared with initial monotherapy in type 2 diabetes. *Journal of Clinical Endocrinology and Metabolism*. 2003; 88: 3598-3604.
163. Erle G, Lovise S, Stocchiero C, et al. A comparison of preconstituted, fixed dose combinations of low-dose glyburide plus metformin versus high-dose glyburide alone in the treatment of type 2 diabetic patients. *Acta Diabetologica*. 1999; 36: 61-65.
164. Horton ES, Clinkingbeard C, Gatlin M, et al. Nateglinide alone and in combination with metformin improves glycaemic control by reducing mealtime glucose levels in type 2 diabetes. *Diabetes Care*. 2000; 23: 1660-1665.
165. Moses R, Slobodniuk R, Boyages S, et al. Effect of repaglinide addition to metformin monotherapy on glycaemic control in patients with type 2 diabetes. *Diabetes Care*. 1999; 22: 119-124.
166. Reboussin DM, Goff DC, Lipkin EW, et al. The combination oral and nutritional treatment of late-onset diabetes mellitus (CONTROL DM) trial results. *Diabetic Medicine*. 2004; 21: 1082-1089.
167. Charpentier G, Fleury F, Kabir M, et al. Improved glycaemic control by addition of glimepiride to metformin monotherapy in type 2 diabetic patients. *Diabetic Medicine*. 2001; 18: 828-834.
168. Moses R, Slobodniuk R, Boyages S, et al. Effect of repaglinide addition to metformin monotherapy on glycaemic control in patients with type 2 diabetes. *Diabetes Care*. 1999; 22: 119-124.
169. Reboussin DM, Goff DC, Lipkin EW, et al. The combination oral and nutritional treatment of late-onset diabetes mellitus (CONTROL DM) trial results. *Diabetic Medicine*. 2004; 21: 1082-1089.
170. Marre M, Van Gaal L, Usadel KH, et al. Nateglinide improves glycaemic control when added to metformin monotherapy: results of a randomized trial with type 2 diabetes patients. *Diabetes Obesity and Metabolism*. 2002; 4: 177-186.
171. Marre M, Howlett H, Lehert P, et al. Improved glycaemic control with metformin-glibenclamide combined tablet therapy (Glucovance) in type 2 diabetic patients inadequately controlled on metformin. *Diabetic Medicine*. 2002; 19: 673-680.
172. Garber AJ, Donovan DS, Dandona P, et al. Efficacy of glyburide/metformin tablets compared with initial monotherapy in type 2 diabetes. *Journal of Clinical Endocrinology and Metabolism*. 2003; 88: 3598-3604.
173. Barnett AH, Bowen JD, Burden AC, et al. Multicentre study to assess quality of life and glycaemic control of Type 2 diabetic patients treated with insulin compared with oral hypoglycaemic agents. *Practical Diabetes International*. 1996; 13: 179-183.
174. Roach P, Koledova E, Metcalfe S, et al. Glycaemic control with Humalog Mix25 in type 2 diabetes inadequately controlled with glyburide. *Clinical Therapy*. 2001; 23: 1732-1744.
175. de Grauw WJ, van de Lisdonk EH, van Gerwen WH, et al. Insulin therapy in poorly controlled type 2 diabetic patients: does it affect quality of life? *British Journal of General Practice*. 2001; 51: 527-532.

Diabetes, type 2

176. UK Prospective Diabetes Study Group. Quality of life in type 2 diabetic patients is affected by complications but not by intensive policies to improve blood glucose or blood pressure control. *Diabetes Care*. 1999; 22: 1125-1136.
177. UK Prospective Diabetes Study Group. Quality of life in type 2 diabetic patients is affected by complications but not by intensive policies to improve blood glucose or blood pressure control. *Diabetes Care*. 1999; 22: 1125-36.
178. Raskin P, Bode BW, Marks JB, et al. Continuous subcutaneous insulin infusion and multiple daily injection therapy are equally effective in type 2 diabetes: a randomized, parallel-group, 24-week study. *Diabetes Care*. 2003; 26: 2598-2603.
179. Barnett AH, Bowen JD, Burden AC, et al. Multicentre study to assess quality of life and glycaemic control of Type 2 diabetic patients treated with insulin compared with oral hypoglycaemic agents. *Practical Diabetes International*. 1996; 13: 179-183.
180. Roach P, Koledova E, Metcalfe S, et al. Glycemic control with Humalog Mix25 in type 2 diabetes inadequately controlled with glyburide. *Clinical Therapy*. 2001; 23: 1732-1744.
181. de Grauw WJ, van de Lisdonk EH, van Gerwen WH, et al. Insulin therapy in poorly controlled type 2 diabetic patients: does it affect quality of life? *British Journal of General Practice*. 2001; 51: 527-532.
182. Tovi J, Engfeldt P. Well-being and symptoms in elderly type 2 diabetes patients with poor metabolic control: effect of insulin treatment. *Practical Diabetes International*. 1998; 15: 73-77.
183. Avendonk MJ, Rutten GE. Insulin therapy in type 2 diabetes: what is the evidence? *Diabetes, Obesity & Metabolism*. 2009; 11: 415-432.
184. Raskin P, Bode BW, Marks JB, et al. Continuous subcutaneous insulin infusion and multiple daily injection therapy are equally effective in type 2 diabetes: a randomized, parallel-group, 24-week study. *Diabetes Care*. 2003; 26: 2598-2603.
185. Yki-Jarvinen H, Ryysy L, Nikkila K, et al. Comparison of bedtime insulin regimens in patients with type 2 diabetes mellitus. A randomized, controlled trial. *Annals of Internal Medicine*. 1999; 130: 389-396.
186. Douek IF, Allen SE, Ewings P, et al. Continuing metformin when starting insulin in patients with Type 2 diabetes: a double-blind randomized placebo-controlled trial. *Diabetic Medicine*. 2005; 22: 634-640.
187. Hermann LS, Kalen J, Katzman P, et al. Long-term glycaemic improvement after addition of metformin to insulin in insulin-treated obese type 2 diabetes patients. *Diabetes, Obesity & Metabolism*. 2001; 3: 428-434.
188. Aviles-Santa L, Sinding J, Raskin P, et al. Effects of metformin in patients with poorly controlled, insulin-treated type 2 diabetes mellitus. A randomised, double-blind, placebo-controlled trial. *Annals of internal Medicine*. 1999; 131: 182-188.
189. Wulfele MG, Kooy A, Lehert P, et al. Combination of insulin and metformin in the treatment of type 2 diabetes. *Diabetes Care*. 2002; 25: 2133-2140.
190. Richter B, Bandeira-Echtler E, Bergerhoff K, et al. Pioglitazone for type 2 diabetes mellitus. In: *The Cochrane Library*. Wiley, Chichester, UK.
191. Eurich DTM. Benefits and harms of antidiabetic agents in patients with diabetes and heart failure: systematic review. *BMJ*. 2007; 335: 497-501.
192. Malinowski JM, and Bolesta S. Rosiglitazone in the treatment of Type 2 diabetes mellitus: a critical review. *Clinical Therapeutics*. 2000; 22: 1151-1168.
193. Singh S, Loke YK, Furberg CD. Thiazolidinediones and heart failure: a meta-analysis. *Journal of the American Medical Association*. 2007; 298: 1189-1195.
194. Lincoff AM, Wolski K, Nicholls S, et al. Pioglitazone and risk of cardiovascular events in patients with type 2 diabetes mellitus: a meta-analysis of randomized trials. *Journal of the American Medical Association*. 2007; 298: 1180-1188.
195. Lago RM, Singh PP, Nesto RW. Congestive heart failure and cardiovascular death in patients with prediabetes and type 2 diabetes given thiazolidinediones: a meta-analysis of randomised clinical trials. *Lancet*. 2007; 370: 1129-1136.

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196. European Medicines Agency. European Medicines Agency recommends new contra-indications and warnings for pioglitazone to reduce small increased risk of bladder cancer. July 2011. Available at <http://www.ema.europa.eu> (accessed on 11 February 2014).
197. Medicines and Healthcare products Regulatory Agency. Pioglitazone: risk of bladder cancer. August 2011. Available at <http://www.mhra.gov.uk/Safetyinformation/DrugSafetyUpdate/CON125962> (accessed on 11 February 2014).
198. European Medicines Agency. European Medicines Agency recommends suspension of Avandia, Avandamet and Avaglim. September 2010.
http://www.ema.europa.eu/ema/index.jsp?curl=pages/news_and_events/news/2010/09/news_detail_001119.jsp&mid=WC0b01ac058004d5c1 (accessed on 11 February 2014).
199. Murphy CE, Rodgers PT. Effects of thiazolidinediones on bone loss and fracture. *Annals of Pharmacotherapy*. 2007; 41: 2014-2018.
200. Loke YK, Singh S, Furberg CD. Long-term use of thiazolidinediones and fractures in type 2 diabetes: a meta-analysis. *Canadian Medical Association Journal*. 2009; 180: 32-39.
201. Richter B, Bandeira-Echtler E, Bergerhoff K, et al. Rosiglitazone for type 2 diabetes mellitus. In: *The Cochrane Library*. Wiley, Chichester, UK.
202. Singh S, Loke YK, Furberg CD. Long-term risk of cardiovascular events with rosiglitazone: a meta-analysis. *Journal of the American Medical Association*. 2007; 298: 1189-1195.
203. Ajjan RA, Grant PJ. The cardiovascular safety of rosiglitazone. *Expert Opinion on Drug Safety*. 2008; 7: 367-376.
204. Norris SL, Carson S, Roberts C. Comparative effectiveness of pioglitazone and rosiglitazone in type 2 diabetes, prediabetes, and the metabolic syndrome: a meta-analysis. *Current Diabetes Reviews*. 2007; 3: 127-140.
205. Berlie HD, Kalus JS, Jaber LA. Thiazolidinediones and the risk of edema: a meta-analysis. *Diabetes Research & Clinical Practice*. 2007; 76: 279-289.
206. Leslie WS, Hankey CR, Lean ME. Weight gain as an adverse effect of some commonly prescribed drugs: a systematic review. *Quarterly Journal of Medicine*. 2007; 100: 395-404.

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