

## Chapter 4

# Type 2 Diabetes

(previously referred to as  
adult onset diabetes or  
non-insulin dependent diabetes)

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This is the most common type of diabetes in adults over age 40. It is also becoming more common in overweight pre-teens and teenagers. Type 2 diabetes occurs in all ethnic groups, but is more frequent in people of Hispanic, Native-American, Asian and African-American heritages. It is often referred to as a “disease of lifestyles.” For thousands of years in the past, people, by necessity, were very active. However, we now live in a world of automobile travel, television, computers and video games. The main exercise many people receive is walking from their car or bus into work or school. Schools also no longer have the resources to offer daily exercise. In addition, high calorie convenience foods, fast foods and sugar-containing drinks have become a major part of our meals and snacks. The result has been a great increase in the incidence of type 2 diabetes in the U.S. and worldwide. The prevention of type 2 diabetes in people at high risk is discussed in Chapters 13 and 28.

### TOPICS:

Diabetes Disease Process  
(type 2)

Medications (type 2 diabetes)

Nutritional Management  
(also see Chapters 11 and 12)

Physical Activity  
(also see Chapter 13)

Monitoring  
(checking blood sugars and ketones;  
also see Chapters 5 and 7)

Prevent, Detect and Treat Acute  
and Chronic Complications  
(also see Chapter 22)

### TEACHING OBJECTIVES:

1. Present the basic concepts of type 2 diabetes and management.
2. Introduce the medications to be used including dosing and side effects.
3. Assess current dietary habits and develop an individual nutritional management program.
4. Assess current activity level and develop an individualized exercise program.
5. Discuss monitoring blood sugars, ketones and laboratory tests.
6. Introduce acute and chronic complications.

### LEARNING OBJECTIVES:

Learner (parents, child, relative or self) will be able to:

1. State two differences between type 1 and type 2 diabetes.
2. Identify the name, dose, schedule and side effects of medication(s) to be used.
3. Identify the individualized nutritional management program (see Chapter 12).
4. Work with healthcare provider to develop an exercise program (see Chapter 13).
5. Identify time frames for monitoring blood sugars, ketones and laboratory tests.
6. List two possible acute and two possible chronic complications.

# DIFFERENCES BETWEEN TYPE 2 AND TYPE 1 DIABETES

## Type 2 diabetes

1. In type 2 diabetes, the primary disorder is a problem with the action of insulin, so that insulin is not as effective in controlling the metabolism as it is supposed to be. This is called “insulin resistance” and is usually due to being overweight and inactive. Insulin resistance means that insulin cannot act normally to keep blood sugars in the desired range.
2. In response to the decreased action of insulin, increased amounts of insulin are made initially. (In type 1 diabetes the insulin levels are low or absent.) Later the amount of insulin decreases. This happens as the pancreas fails to keep up with the body’s higher demands for insulin. Even though there is now less insulin being produced, the person still has type 2 diabetes.

 The two types of diabetes are very different. One type does not turn into the other type.

 Islet cell antibodies (ICA) **ARE NOT PRESENT IN TYPE 2.** (In type 1, ICA are usually present.)

Sometimes it is easy to decide which type of diabetes a person has by doing blood tests. Measurement of insulin and C-peptide, an insulin related protein, as well as ICA (Chapter 3) may help in deciding between type 1 and type 2 diabetes. The insulin and C-peptide measurements will be normal or elevated in type 2 diabetes, but are generally low in type 1. However, sometimes it takes following the person with diabetes for a while to clarify the diabetes type.

# CAUSES

## Inheritance (genetics)

Type 2 diabetes has a stronger inherited risk than type 1. In almost all cases, a parent and/or grandparent will also have the disease. In the case of identical twins, if one twin develops type 2 diabetes, the other twin has an 80 percent chance of also developing the disease. (In type 1, an identical twin has a 35-50 percent chance.) There are some Native-American tribes in which half of the adults have type 2 diabetes.

In type 2 diabetes, there are many different inherited (genetic) defects, which vary between families. There is not just one common defect in all families. It is also **NOT** inherited in relation to the HLA system as is type 1 diabetes (Chapter 3).

Children born after their mothers were diagnosed with type 2 diabetes or if the mother had gestational diabetes have an increased risk. Children born with a low birth weight for length of the pregnancy (“small for date”) are also at an increased risk.

## Lifestyle

As mentioned above, most (not all) people with type 2 diabetes are overweight and don’t have very active lives. About 20 percent of adults presenting with type 2 diabetes are not overweight. This group often has an inherited (genetic) defect which causes the insulin resistance. The corresponding number for adolescents is unknown.

Insulin resistance usually occurs with excess weight and decreased physical fitness. Insulin resistance means the insulin doesn’t work to allow sugar to pass into the cells as it would normally (Chapter 2). In some cases this happens along with a darkening of the skin. The most common areas for this darkening are the neck, armpits and/or the elbows (called acanthosis nigricans). The excess weight and skin color changes are associated with insulin resistance. By losing weight (eating fewer

Table 1

**OGTT Blood Sugar Values (mg/dl and mmol/L)**

	NORMAL		BORDERLINE		DIABETIC	
	mg/dl	mmol/L	mg/dl	mmol/L	mg/dl	mmol/L
FASTING	< 100	5.5	100-126	5.5-7.0	> 126	> 7.0
TWO HOURS AFTER DRINKING THE GLUCOLA	< 140	7.8	140-200	7.8-11.1	> 200	> 11.1

calories and exercising more), the sensitivity to insulin may again return. The dark skin coloring may also lessen or disappear.

## DIAGNOSIS

People with type 2 diabetes can go several years with high blood sugar levels without signs of diabetes. Then, with an illness or stress and less effective function of the pancreas, symptoms begin. Although type 2 diabetes most often presents in adults, when it occurs in youth it is most apt to present around puberty. This is because insulin resistance normally increases at this time.

### How it can be discovered

- ✓ Sometimes sugar is found in the urine during a routine check-up. There may not be any signs or symptoms.
- ✓ The increased urination and drinking of fluids may be absent or mild with type 2 diabetes.
- ✓ Weight loss can occur (though variable).
- ✓ Increasing fatigue may be present.
- ✓ During an illness, blood sugar levels (and/or ketones) may become very high. The illness may be a deep skin infection (abscess) or a yeast infection.
- ✓ Numbness/tingling can occur in the toes. This is due to damage to the nerves caused by high blood sugars over time (neuropathy: Chapter 22).
- ✓ Trouble with vision (blurry/frequent change

of glasses) may occur due to swelling of the lens of the eye from high blood sugars.

### Laboratory testing for diabetes:

- if a blood sugar value is very high (e.g., > 200 mg/dl or 11.1 mmol/L), the glucose tolerance test (Table 1) may not be needed.
- the hemoglobin A1c (HbA<sub>1c</sub>) test is elevated (Chapter 14). Though this test is not currently accepted by the ADA as sufficient to diagnose diabetes, an elevated HbA<sub>1c</sub> can help identify patients in whom further testing is necessary.
- oral glucose tolerance test (OGTT): a fasting test (no food for 10 hours). After a fasting blood sugar is drawn, the person then drinks a high sugar drink (Glucola®) within five minutes. Blood samples are drawn before and two hours after the high-sugar drink is ingested. See Table 1 for blood sugar values.

## TREATMENT

As in type 1 diabetes, the family must learn as much as they can, as diabetes is a family disease. As stated in Chapter 17, a supportive family is important to any person with diabetes.

*The family must initially learn to give insulin shots (Chapters 8 and 9) if:*

- ketones are present (Chapter 5)
- symptoms of increased urination and thirst or of weight loss are severe
- there is uncertainty about the diabetes type

## Lifestyle Changes

Dietary treatment is **very important** in type 2 diabetes, since weight loss and changing the nutrient characteristics of the diet can make a very important difference in the underlying problem of insulin resistance. Lowering calorie, fat and carbohydrate intake through control of portion sizes and learning how to make healthier food choices is essential for losing weight and improving blood sugar control. Food management is discussed in detail in Chapter 12. Most importantly, the family **must** work with a knowledgeable dietitian. The dietitian will help to individualize the meal plan to fit the person and family preferences. Exercise is **equally important** (Chapter 13). The goal should be at least 30 minutes of moderate exercise every day. Examples of moderate exercise include brisk walking, bike riding and swimming. In addition, increasing general activity levels by walking more on errands, taking stairs instead of elevators, and parking further from the store, can make important differences in blood sugar control.

It is important that the entire family make lifestyle changes, particularly with activity and food. If family members are active along with the person with diabetes, success will be more likely. Similarly, if foods with little nutrition (e.g., sugar pop, chips) are brought into the home by other family members it will be more difficult for the person with diabetes to make healthy choices.

## Blood Sugar (Glucose) Testing

This is covered in detail in Chapter 7. In general, blood sugar testing for a person with type 2 diabetes is no different from a person with type 1 diabetes. If there is success in weight loss and returning the HbA<sub>1c</sub> (Chapter 14) to normal, continued sugar testing is still important. In people who are not taking insulin, the frequency of testing is often decreased to two tests per day. The aim would be to maintain the morning fasting sugar below 120 mg/dl (6.7 mmol/L). The value two hours after any meal should be below 140 mg/dl (below 7.8 mmol/L). More frequent testing is essential during illness.

## Insulin Shots

People with type 2 diabetes who present with ketones may initially be treated with insulin shots. Some doctors believe that a once daily shot of Lantus insulin along with oral medicines, can help keep insulin production in the pancreatic islet cells working longer. However, people who are able to lose weight and become more active may be able to come off insulin shots and try oral medicines (Table 2). However, they often need to return to insulin shots in later years.

It is important to remember that during times of illness, especially if ketones return, insulin shots may again have to be given. Some people with type 2 diabetes will always need to take insulin shots. Others may be able to take oral medication for the first few years. Eventually, those taking the oral medication may need to take insulin shots. Which medication is used and for how long depends upon blood sugar levels and success with changing the lifestyle.

## Oral Tablets

It is important to remember that the oral tablets are **NOT** insulin. If taken orally, insulin would be destroyed by the stomach acid. The tablets are medicines that make the person more sensitive to their own insulin. Some of the medicines also make the pancreas release extra amounts of insulin. (Table 2 lists some of these medications.)

**1. Metformin (Glucophage):** the medication we most frequently try first. In addition to helping to control blood sugar levels, it may help with weight loss.

- Main side effect: upset stomach, diarrhea, nausea, bloating. These side effects can be reduced by always taking the medicine with food.

Lactic acidosis is a very rare side effect which can occur if Metformin is not stopped when a person has the stomach flu or a severe illness. It can also happen during an x-ray procedure using dyes, and during episodes of vomiting, diarrhea, pneumonia or with lung diseases.

### ◆ Dosing

- start low with 500 mg (0.5g) once daily
- after one week, try this dose twice a day (at breakfast and dinner)
- after the 3rd week, if needed, try two tablets (1g) in the morning and one tablet (0.5g) at dinner
- the 4th week, if needed and stomach upset isn't a problem, try two tablets (1g) both at breakfast and dinner
- Some people can use the long-acting form. This can be taken in the morning with the dose gradually increased. As noted above, it is important to know a person is taking Metformin if they become ill. Metformin needs to be stopped during times of severe illness or with vomiting or diarrhea. (It is often best to take insulin shots during an illness. Consult your doctor or nurse.)

## 2. Other Oral Medications

Different physicians have their medication of

first choice. The sulfonylureas (Table 2) have been around the longest. They act to make the person's own pancreas secrete more insulin. Low blood sugar (Chapter 6) is a possible side effect.

Two relatively new agents are ACTOS® and Avandia® (Table 2). They belong to a new class of medicines which act to increase the body's sensitivity to insulin. Their most dangerous side effect is liver toxicity. Liver function tests should be done before starting either medication and then after 2-3 months.

### Glucagon-like peptide (GLP-1):

Amylin® and the GLP products received much attention at the 2005 ADA meeting. They are not yet approved for use in children. The two medicines recently approved by the FDA for use in adults are Amylin and Exenatide® (Byetta®). These agents may be particularly helpful in lowering blood sugars after meals. They do this by:

- increasing insulin production
- reducing glucagon secretion



- delaying stomach emptying
- decreasing appetite

They must be taken by injection prior to meals. They cannot be taken in the same syringe as insulin.

### Monitoring for Complications

**Acute:** Low blood sugars are less frequent with type 2 than with type 1 diabetes. However, they can occur. They are most frequently associated with the sulfonylurea and meglitinide medications (Table 2). Treatment is explained in Chapter 6.

Ketone production is also less frequent with type 2 than with type 1 diabetes. However, it can occur during times of illness. If a person is receiving oral medications, they usually need to return to using insulin shots when ketones are present.

**Chronic:** Blood pressure elevations and/or blood lipid abnormalities (high total or LDL cholesterol and/or triglyceride; Chapter 11) must be checked regularly. Treatment should be considered for any abnormalities.

Type 2 diabetes can be present for years prior to diagnosis. It is recommended that eye and kidney testing be done initially and then annually. This is explained in Chapter 22, but should include annual eye exams by an eye-specialist. It should include annual urinary microalbumin tests for the kidneys (Chapter 22). Evidence has shown that, as with type 1 diabetes, good control of blood sugars (as monitored by the HbA<sub>1c</sub> test every three months – Chapter 14), will help to prevent eye and/or kidney damage.

Two references for those wanting more information specifically on type 2 diabetes in youth are:

1. American Diabetes Association. “*Diabetes Care*” 28 (Suppl 1) S4-536, 2005
2. Gahagan S. Silverstein, J and the Committee on Native American Child Health and Section on Endocrinology. “*Pediatrics*” 112, 328, 2003.

## DEFINITIONS

**C-peptide:** An insulin-related protein. It is split off from proinsulin when the active insulin is formed.

**Glucagon-like peptide (GLP-1) and Amylin:** These agents were just approved by the FDA for use in adults and they may help in the treatment of type 2 diabetes. When injected prior to meals, they reduce glucagon and increase insulin release. They also delay stomach emptying.

**Lifestyle changes:** In this chapter, this means changing a sedentary (little exercise) lifestyle and decreasing high calorie, high fat, high carbohydrate food intake (e.g., fast foods). The changes must include at least 30 minutes of moderate exercise each day. They must also include a reduction in calorie, fat and carbohydrate intake.

**Oral glucose tolerance test (OGTT):** Blood sugar levels before and after drinking a high sugar drink. It is considered the “gold standard” test to diagnose diabetes when the diagnosis is uncertain. (Normal values are in Table 1 in this chapter.)

**Oral hypoglycemic agents:** These are pills which help to make the body more sensitive to insulin or to release more insulin. However, they are NOT insulin. Table 2 gives the names of a few of these agents.

**Type 2 diabetes:** The condition in which the body still makes insulin, but is unable to use it effectively to metabolize sugar. This is the most common type in adults over age 40. It is also becoming increasingly common in youth.

Table 2

## Commonly Used Oral Hypoglycemic Medications

Name	Action	Initial Dose	Maximum Dose	Side-effects
1. Metformin (Glucophage)	Reduces liver secretion of glucose; may help reduce weight	0.5g	2g	Stomach upset, diarrhea, nausea, bloating; acidosis with illness (rare)
Metformin XR (Glucophage XR)	a long acting form of Metformin	(dose same as above)		
2. Insulin sensitizers: help cells respond to insulin better.				
a. Pioglitazone (ACTOS)		15 mg	45 mg	Stuffy nose, headache,
b. Rosiglitazone (Avandia)		4 mg	8 mg	liver problems, weight gain
<b>For Both:</b> Must follow liver function tests initially and after 2-3 months.				
3. Sulfonylureas stimulate the pancreas to make more insulin.				
a. Chlorpropamide (Diabinese)		125-250 mg	500 mg	Low blood sugar, dizziness
b. Gliburide (Diabeta) (Micronase)		2.5-5.0 mg	20 mg	Skin rashes, headache and stomach upset
c. Glipizide (Glucotrol)		5 mg	40 mg	“ ”
d. Glucotrol XL (extended release)		5 mg	20 mg	“ ”
e. Glimeperide[a 24 hour product], (Amaryl)		0.4 mg	0.8 mg	“ ”
Others include: Glynase, Orinase and Tolinase.				
4. Meglitinides: stimulate early insulin release with meals.				
a. Nateglinide (Starlix)		60 mg (30 minutes before each meal)	120 mg	Diarrhea, nausea, low blood sugar
b. Repaglinide (Prandin)		0.5 mg (30 minutes before each meal)	16 mg	Stuffy nose, low blood sugar, chest pain

Successful treatment of type 2 diabetes may require the use of combinations of agents.

Some of these combinations are available as single tablets. Examples are:

- A sulfonylurea and metformin (e.g., Glucovance: combination of glyburide and metformin; Metaglip: combination of glipizide and metformin)
- Metformin and a thiazolidinedione (e.g., Avandamet: combination of metformin and rosiglitazone)
- A sulfonylurea and a thiazolidinedione
- A meglitinide and metformin
- Insulin and any of the oral agents (e.g., Lantus and metformin)

**NOTE:** There are many other oral agents which are preferred by some physicians, but were not included on this listing due to space.



Exercise is important