




Chapter 22

Long-Term Complications of Diabetes

INTRODUCTION

In addition to the acute complications of diabetes, insulin reactions and acidosis, there are also problems known as “long-term” complications. Generally, the long-term complications occur in people who have had diabetes and high blood sugar levels for many years.

About this chapter:

-  Many families may prefer to read this chapter when they are ready to deal with the subject.
-  Teenagers may be able to understand the material better than pre-teens.
-  Many new and difficult words are used in this chapter. They are introduced and defined in the back. If your diabetes care provider uses them you will have a place to find their meaning.

The four most common parts of the body to be affected by high sugar levels are:

1. Eyes (retinopathy)
2. Kidneys (nephropathy)
3. Nerves (neuropathy)
4. Heart and blood vessels

Three other areas that can be affected by high sugar levels are:

5. Joints (finger curvatures)
6. Children born to mothers with poorly controlled diabetes (birth defects)
7. Foot problems

TOPICS:

Prevent, Detect and Treat Chronic Complications Through Risk Reduction

Monitoring (Complications and Associated Diseases)

TEACHING OBJECTIVES:

1. Discuss the relationship between glucose control and diabetic complications (eye, kidney, nerve).
2. Summarize the tests, which monitor eye and kidney complications.
3. Present associated autoimmune diseases (e.g., thyroid and celiac).

LEARNING OBJECTIVES:

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

1. Describe the relationship between glucose control and complications.
2. Identify routine tests used to monitor the eyes and kidneys.
3. List one symptom associated with each disease (thyroid and celiac).

THE DCCT

The Diabetes Control and Complications Trial (DCCT) has been mentioned previously in this book (Chapter 14). The results of this study became available in 1993 and proved without question that **eye, kidney and nerve problems of type 1 diabetes were decreased in people ages 13-39 years whose blood sugars were kept closer to normal. In June, 2005 it was reported that the good control group also had a 57 percent reduction in nonfatal heart attacks, strokes and coronary vascular disease.**

For people with type 2 diabetes, studies in the U.K. and Japan showed the risks for eye, kidney and nerve complication were also reduced as a result of better sugar control.

Some important factors which affect the complications:

- ✓ **good blood sugar control:** Although this is one important factor in relation to these complications, **IT IS NOT THE ONLY FACTOR**
- ✓ **blood pressure** is important in relation to eye, kidney and heart complications
- ✓ **tobacco use** adds to the risk for kidney, eye and heart damage
- ✓ **increased blood clotting** is also a possible risk factor
- ✓ **other unknown factors**

Some facts about the occurrence of complications:

- ✓ Most of the long-term complications do not occur in young children.
- ✓ The years of greatest risk for complications seem to start after puberty. Research has shown that in people with diabetes, the small blood vessels show no changes before puberty, whether good sugar control was present or not.
- ✓ After puberty, the blood vessels usually remain normal in people with good sugar control, but changes may appear in people with poor sugar control.

- ✓ Around the time of puberty, levels of growth hormone, sex hormones and other hormones increase greatly. These hormones cause increased blood sugar levels.
- ✓ The risk of complications after puberty may increase because of the changes in hormone levels, because of poor sugar control caused by the changes in hormone levels or possibly due to both.

We do not know how the high blood sugar levels cause the complications.

Sugar does attach:

- ✓ to the protein (hemoglobin) in the red blood cells to form hemoglobin A_{1c} or HbA_{1c} (see Chapter 14)
- ✓ to the skin proteins in people who have curvatures of several fingers (see “Finger Curvatures” in this chapter)
- ✓ to other proteins in the blood vessels and other parts of the body when the blood sugar levels are very high

Once the sugar attaches to any body protein, the protein may not work as well as when sugar is not attached.

Even though the actual complications are not usually seen until puberty, it is important to work for good sugar control in the pre-pubertal years. There are some side effects of poor sugar control that can occur at any time (see Chapter 14 on Diabetes and Blood Sugar Control). Also, the habits for the future are formed when the person is young.

COMPLICATIONS IN PEOPLE WITH DIABETES

We have divided complications into two groups: Complications related at least in part to blood sugar control and complications not related to blood sugar control.

Complications related, at least in part, to blood sugar control:

1. EYE PROBLEMS

🐾 Cataracts

Cataracts are small thickenings in the lens (which is located at the front of the eye; see picture in this chapter).

- The damage to the lens is believed to be caused by sorbitol, a compound made in the lens from glucose.
- Sorbitol damage occurs when blood glucose (sugar) levels have been very high in the body for a long time.
- Sorbitol in foods is changed by the body (liver) and *does not* cause this damage.
- Damage to the lens can happen at any age.
- Cataracts can be present at the onset of diabetes if sugar levels have been high for a long time before insulin is started.
- They may show some improvement with good sugar control.
- These lens changes *are not* the same as the more severe retinal complications in the back of the eye that are discussed next.
- The eye doctor (ophthalmologist) will do a detailed exam for cataracts in the yearly eye exam.
- If cataracts interfere with vision they can be removed surgically by the eye doctor.

🐾 Retinal Changes or Retinopathy

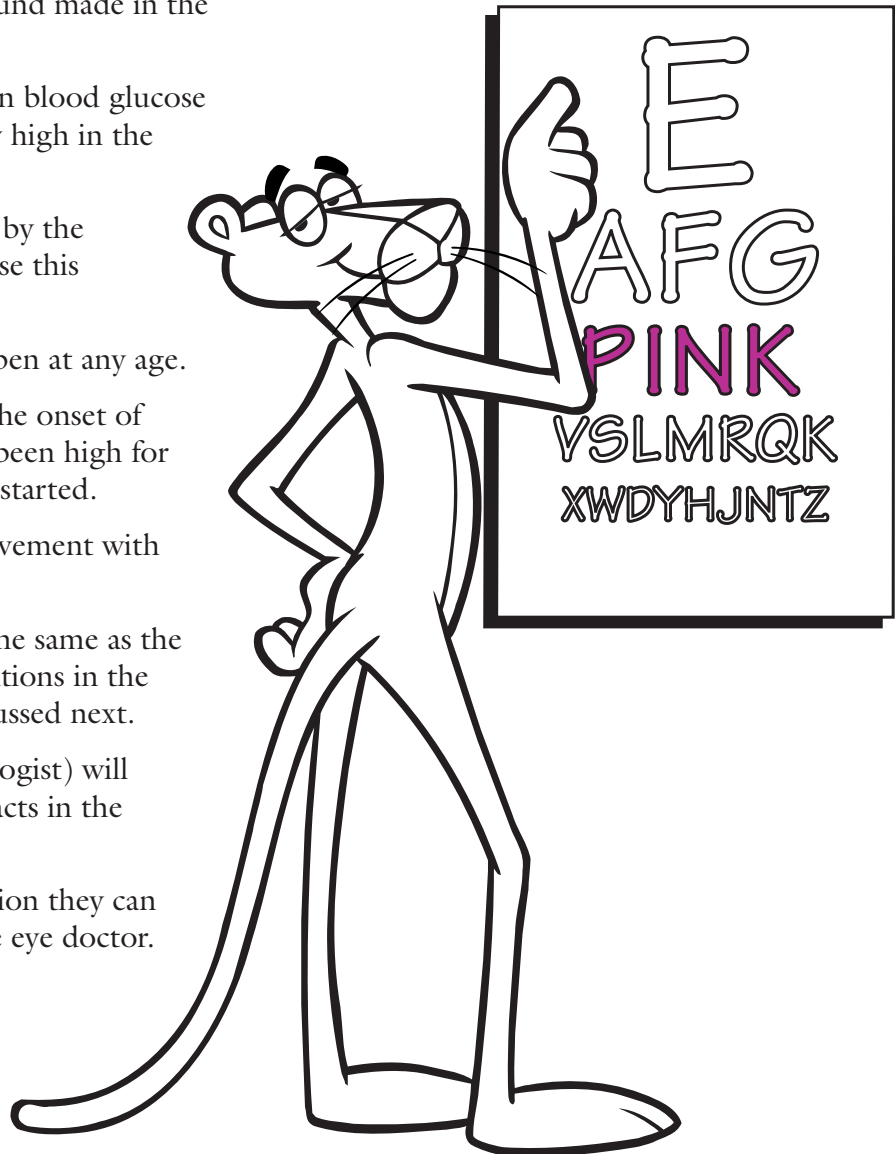
The word retinopathy refers to changes of the retina, which is the layer of tissue at the back of the eye. This part of the eye has many small blood vessels similar to those found in the kidney.

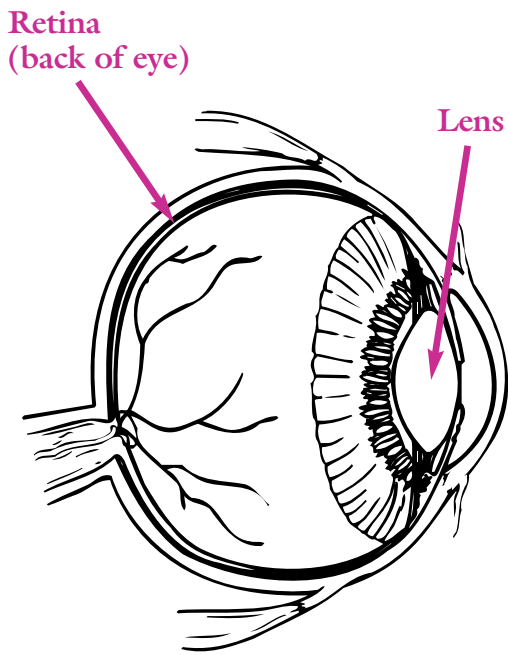
A. Retinopathy facts:

Retinopathy is a change in the small blood vessels found in the back of the eye (retina), which occurs mainly after puberty.

These changes depend on various factors:

- ▼ the duration of diabetes after puberty
- ▼ the degree of blood sugar control





The DCCT showed that in people without eye changes from diabetes, lower blood sugars delayed development of retinopathy by 76 percent. The DCCT also showed that, in people with known early eye changes from diabetes, intensive therapy slowed the progression of retinopathy by 54 percent and reduced the incidence of severe retinopathy by 47 percent.

- ▼ increased blood pressure also results in a greater risk for retinal changes
- ▼ tobacco use makes these changes progress more rapidly

We do not understand all of the causes of the eye changes of diabetes. There is a small group of people for whom the presence or absence of eye changes seems to not show a relation to sugar control.

B. Early detection:

- ✓ is very important and is one clear argument for having diabetes check-ups every three months.
- ✓ the diabetes care provider doing the physical exam should be able to detect eye changes and make appropriate referrals to an eye doctor (ophthalmologist) who specializes in diabetic changes (retinal specialist).

- ✓ The ADA does not suggest seeing an eye doctor for diabetic reasons before age 10 years. We usually wait until the person with type 1 diabetes has had diabetes three years and is ≥ 10 years old. How long someone has had type 2 diabetes before diagnosis is often not known. For this reason, people with type 2 diabetes should see the eye doctor soon after diagnosis (if ≥ 10 years old).
- ✓ Thereafter, if there are no diabetic eye changes, or if the changes are minor, yearly visits to the diabetes eye specialist are adequate.
- ✓ Minor eye changes include a ballooning of the small retinal blood vessels; these changes are reversible and are called “microaneurysms.” Some people can have these minor changes for many years and not develop more severe eye disease. Careful blood sugar control is particularly important when any changes are detected. If more severe eye changes occur, then more frequent visits to the diabetes eye specialist are needed.

C. More severe eye disease:

- ✓ “pre-proliferative” and “proliferative” retinopathy:
 - Usually involves formation of new (proliferative) and fragile retinal blood vessels, which are at a greater risk for breaking (hemorrhaging).
 - The more severe changes are referred for **laser treatment**. This involves the use of a very bright light. It was begun in the 1970s as a way to save vision in people with diabetes who have severe eye changes.
 - Laser treatment destroys the fragile (proliferative) new blood vessels and has been very effective in preventing loss of vision.
 - The most important factor is to have close follow-up once the more severe changes appear. Laser treatment can then be done at the proper time to prevent loss of vision.

- The biggest danger is a hemorrhage. It could damage the retina or send blood into the vitreous fluid between the lens and retina (vitreous hemorrhage) or cause the retina to separate from the other layers in the back of the eye (retinal detachment).

2. KIDNEY DISEASE OR DIABETIC NEPHROPATHY

A. *The job of the kidneys in the body:*

- ✓ They normally filter wastes and water from our blood and make urine (Chapter 2).
- ✓ When blood sugar levels are high, sugar is passed into the urine. When this happens, the pressures are higher in the kidney filtering system (the glomerulus) and changes in the small blood vessels of the kidney can occur. This increased pressure causes damage to the filtering system so that some proteins start leaking through the filter and appear in the urine.

B. *Kidney disease is one of the most feared of the complications of diabetes and is spoken of as “nephropathy.” Nephropathy is more likely to occur in people:*

- ✓ after puberty
- ✓ who have had diabetes for a long time
- ✓ with poor sugar control
- ✓ with elevated blood pressure
- ✓ who smoke or chew tobacco

It occurs in about one in three people with type 1 (insulin-dependent) diabetes, and in about one in four people with type 2 (adult onset) diabetes.

C. *Signs of kidney disease may include:*

- ▼ increased blood pressure
- ▼ ankle swelling, also known as edema (due to fluid collection)
- ▼ excessive urine protein spillage
- ▼ elevation of the waste materials in the blood (increased blood creatinine and urea nitrogen or BUN)

D. *The Microalbumin Test:*

- detects diabetic kidney damage at an early stage when it might still be reversible
- is usually done on a timed overnight or on a 24-hour urine sample
- is essential for people who have had type 1 diabetes for three or more years and are at least 10 years of age
- should be done soon after diagnosis for people with type 2 diabetes
- should then be done once yearly so that the interval is not missed when the early damage is still reversible
- is best done by collecting the overnight urine sample (see directions at the end of this chapter)

If there is an increased level of microalbumin in the urine:

- ▼ WITH A LEVEL ABOVE 20 MICROGRAMS (μg) PER MINUTE, IT IS NOW ACCEPTED THAT THERE IS A 95 PERCENT RISK FOR DEVELOPING NEPHROPATHY AND KIDNEY FAILURE IF NOTHING IS DONE.
- ▼ A “borderline microalbumin level” for timed overnight urine collections is a value between 7.6 $\mu\text{g}/\text{minute}$ and 20 $\mu\text{g}/\text{minute}$. This “borderline” range represents a time period when good sugar and/or blood pressure control may help to lower the value or keep it from going higher.
- ▼ Medications are not usually given for a “borderline” level, as it may still be possible to return the value to normal by lowering the HbA_{1c} .
- ▼ If the urine microalbumin value is between 20 and 200 $\mu\text{g}/\text{minute}$, it is called “**microalbuminuria**” and may still be reversible with good sugar and blood pressure control and medications (ACE-inhibitor, see part E).
- ▼ Smoking cigarettes and chewing tobacco

lead to a greater risk for kidney damage and must be avoided by people with diabetes.

- ▼ A decrease in protein intake is recommended (to lessen the load on the kidneys) for anyone who has microalbumin levels above 20 µg/minute, but particularly for those who have levels above 300 µg/minute (nephropathy or **macroalbuminuria**).
- ▼ The DCCT showed that improved glucose control reduced the occurrence of microalbuminuria by 39 percent. Gross kidney damage (nephropathy or albuminuria) was reduced by 54 percent. It must once again be remembered that glucose control is NOT the only cause of diabetic kidney damage.

E. The 1980s and the 1990s have brought significant advances in the prevention, detection and treatment of diabetic kidney damage.

- ✓ It is up to the family and the physician to make sure that the urine tests to detect kidney changes are done at the recommended times.
- ✓ If the family is unable to collect an overnight urine as described in the back of this chapter, bringing in a portion of the first morning void is second best. This provides a urine sample from when the person slept and it can be analyzed per mg of creatinine. It avoids the 10-15 percent false positives (due to “orthostatic proteinuria”) that occur with the “last resort,” collecting a random sample in the clinic.
- ✓ If the tests are not done, the “window” during which changes may be reversible could be missed.
- ✓ If the microalbumin levels are high on the overnight or 24-hour urine test, medicines may be effective in reversing or slowing the kidney damage.
- The usual medicine that is tried first is an **ACE-inhibitor** (ACE = Angiotensin-Converting Enzyme). This medication

prevents formation of angiotensin II, which is a very potent constrictor of blood vessels. The result is less pressure buildup in the kidneys. There are several varieties of ACE-inhibitors, all of which are probably effective if given in adequate dosage.

- Early kidney damage is detectable and methods to reverse or slow down kidney damage are available. This has now resulted in a decline in the incidence of renal kidney failure from diabetes.

3. NEUROPATHY (NERVE DAMAGE)

Diabetic neuropathy, or “damage to the nerves,” is a condition seen after puberty, usually in people who have had very high sugar levels for a long time.

About neuropathy:

- ✓ It is a complex condition that we still do not completely understand.
- ✓ The DCCT found that the incidence of neuropathy was 60 percent less in the group with the lower blood sugar levels.
- ✓ As with cataracts, neuropathy is believed to be related, at least in part, to increased sorbitol levels deposited in the nerves. The sorbitol is made from sugar.
- ✓ There is also a decrease in another compound (myoinositol) which is important for the nerves.
- ✓ Some people with type 2 diabetes have neuropathy when they are diagnosed with diabetes.

The neuropathy usually makes itself known with:

- ▼ numbness, tingling, sharp pains in the lower legs or feet
- ▼ changes in other parts of the body: e.g., the rate at which food moves through the intestines may change (gastroparesis)

Much research is being done to find new and better medications for the treatment of neuropathy.

4. CORONARY (HEART) AND OTHER BLOOD VESSELS

The “larger” blood vessels are in contrast to the very small (sometimes microscopic) ones found in our eyes and kidneys. The larger ones include the heart blood vessels that provide blood (and thus nutrition and oxygen) to our heart. When a heart blood vessel is blocked, a “heart attack” can result. Approximately 65 percent of deaths for people with diabetes are due to heart attacks. Heart attacks have many causes, but high risk factors include:

- ✓ **poor glycemic (sugar) control**
- ✓ **increased blood pressure**
- ✓ **family history** of relatives who had heart attacks before age 50
- ✓ **smoking**
- ✓ **elevated LDL** (low-density lipoprotein) **cholesterol, reduced HDL** (high-density lipoprotein), which is the “good” cholesterol
- ✓ **elevated total blood cholesterol levels**

Some causes of high cholesterol levels:

- ▼ Until a few years ago, diets that contained 40 percent of calories from fat were routinely recommended. Most dietitians now recommend that no more than 30 percent of calories be from fat sources (see Chapters 11 and 12).
- ▼ Heredity and poor sugar control also can be causes of high cholesterol levels.

Recommendations:

- Blood cholesterol levels should be checked each year. Desired levels are given in Table 2 of Chapter 11.
- Medications (the “statins”) that block our body’s cholesterol synthesis are available for people who have very high cholesterol or LDL levels. The statins have been shown to decrease the risk for heart attacks.
- The blood pressure should be checked at regular clinic visits. Increases in blood pressure should be treated early.
- People with diabetes should not use tobacco!

5. JOINT CONTRACTURES

Some facts:

- ✓ Some people cannot touch the knuckles of the second joint in their fifth fingers (little fingers) when their hands are in a “praying” position.
- ✓ The joints of the other fingers or other joints in the body can also be involved.
- ✓ When other joints or fingers other than just the fifth finger are involved, there has usually been a period of very high sugar levels and sugar has attached to the proteins in the skin over the joints.
- ✓ No pain or other problems are usually related to these changes.
- ✓ Some doctors believe the curvatures of the fifth fingers may be partly inherited.
- ✓ Parents and siblings of people with diabetes often have curvatures of the fifth fingers even though they don’t have diabetes.
- ✓ It is not yet known if the more severe curvatures will disappear as blood sugar control improves.

6. BIRTH DEFECTS (discussed in more detail in Chapter 27)

This complication is primarily important to a woman who might get pregnant.

Some facts:

- ✓ **IT IS VERY IMPORTANT TO TALK TO YOUR DIABETES PHYSICIAN BEFORE GETTING PREGNANT.**
- ✓ Insulin pumps and intensive diabetes management must be considered **PRIOR TO THE PREGNANCY.**
- ✓ If diabetes is not well controlled (e.g., high HbA_{1c}), a pregnant woman with diabetes is more likely to have a baby with one or more birth problems or defects.
- ✓ The first few months of pregnancy are the most important in preventing defects.

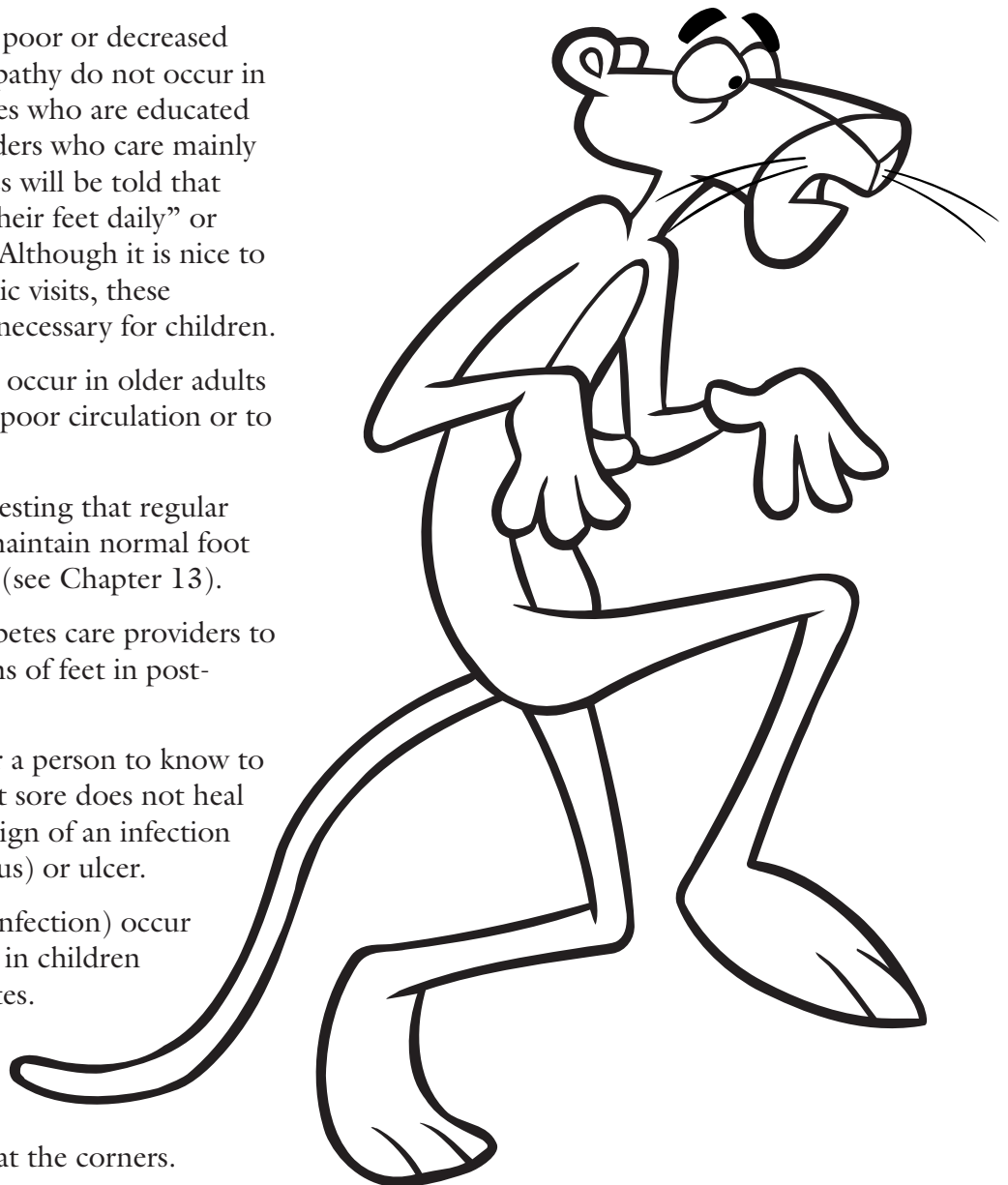
- ✓ A woman should not stop using birth control or decide to get pregnant until her diabetes is well controlled.
- ✓ If the HbA_{1c}, blood pressure and kidney tests are normal or low prior to the pregnancy, the likelihood of kidney deterioration during pregnancy is minimized.
- ✓ Diabetic eye changes do sometimes worsen during pregnancy and it is wise to be followed more closely by one's retinal specialist during this time.

7. FOOT PROBLEMS

Some facts:

- ✓ Foot problems due to poor or decreased blood flow and neuropathy do not occur in children. Some families who are educated by diabetes care providers who care mainly for adults with diabetes will be told that children must “wash their feet daily” or “never go barefoot.” Although it is nice to have clean feet for clinic visits, these precautions are NOT necessary for children.
- ✓ Foot problems usually occur in older adults and may be related to poor circulation or to neuropathy.
- ✓ There is research suggesting that regular exercise may help to maintain normal foot circulation later in life (see Chapter 13).
- ✓ It is important for diabetes care providers to do careful examinations of feet in post-pubertal patients.
- ✓ It is also important for a person to know to call the doctor if a foot sore does not heal well or if there is any sign of an infection (redness, warmth or pus) or ulcer.
- ✓ Ingrown toenails (an infection) occur with similar frequency in children with or without diabetes.
- ✓ The ingrown toenails are usually caused by toenails that are cut too short at the corners.

- ✓ The toenails should be cut straight across with a straight nail clipper and the length should be even with the end of the toe. Good prevention is much easier than treatment.
- ✓ Ingrown toenails are more of a problem in people with diabetes as infections cause high sugar levels. The high sugar levels, in turn, support the infection.
- ✓ Warts are not more common in people with diabetes. The best way to remove them is with the use of liquid nitrogen.



COMPLICATIONS NOT PRIMARILY RELATED TO SUGAR CONTROL

Other Autoimmune (self-allergy) Diseases Associated with Type 1 Diabetes

🐾 Thyroid Disorders

Some facts:

- ✓ Some thyroid enlargement occurs in about half of people with type 1 diabetes, although only about one in 20 ever needs treatment. The reason for this is believed to be a similar “self-allergy” (autoimmune) type of reaction that causes both diabetes and the related thyroid enlargement.
- ✓ People who get diabetes often have an antibody (allergic reaction) in their blood against their pancreas (specifically, the islet cells in the pancreas as discussed in Chapter 3). Likewise, people with diabetes who get thyroid problems usually have an antibody (allergic reaction) in their blood against the thyroid gland.
- ✓ Thyroid antibody tests can be done, but are usually not done as they are expensive and are often not paid for by insurance.
- ✓ It is important for the diabetes care provider to always check the size of the thyroid gland at the time of clinic visits.
- ✓ If the thyroid is not functioning normally, body growth may be slowed.
- ✓ The person may feel tired all the time.
- ✓ If the gland is enlarged, specialized blood tests should be done (particularly a TSH test, as this is almost always the first test to become abnormal). If thyroid problems are suspected, a TSH (\pm free T_4) test should be done.
- ✓ If the thyroid tests are abnormal, a thyroid tablet can then be taken once daily. Thyroid problems are not serious unless unrecognized or untreated. The treatment is excellent, easy, inexpensive and involves taking pills (not shots).

- ✓ Sometimes the tablets can be discontinued (under a doctor’s supervision) when the person is finished growing.
- ✓ Thyroid problems are common even in people who do not have diabetes (about one in 50 adults).

🐾 Adrenal Disorders (autoimmune adrenal insufficiency, Addison’s Disease)

Some facts:

- ✓ Autoimmunity against the adrenal gland can also occur.
- ✓ It is quite rare (about one in 500 people with type 1 diabetes), but it is important to diagnose and treat, as it can result in death if untreated. President Kennedy is an example of a famous person who had autoimmune adrenal insufficiency.

Some early signs for someone with diabetes may be:

- an increased frequency of severe low blood sugars
- episodes of feeling weak or faint (with normal blood sugars - but sometimes low blood pressure)
- two electrolytes in the blood, sodium (Na^+) and potassium (K^+), may be low and high, respectively
- later, darker skin coloring over the back of the hands (or knuckles or elbows) may occur
- ✓ Initial screening may be for an antibody against the adrenal gland.
- ✓ Eventually, a morning ACTH and cortisol (cortisone) blood levels (\pm an ACTH stimulation test) should be obtained.
- ✓ The treatment (as with thyroid disease) is with tablets. Treatment includes training the person (or family) to increase the tablets during periods of stress (as with an infection or with surgery).

Table 1

Ingredient Content Guideline for Celiac Disease

<u>Acceptable</u>	<u>Use with Caution</u>	<u>Not Acceptable</u>
Corn	Oats	White flour
Rice	Flax	Wheat, whole wheat
Soy and other beans		Rye
Tapioca		Barley
Potato		Durum
Hominy		Semolina
Amaranth		Spelt
Buckwheat		Kamut
Millet		Triticale
Quinoa		Graham
Teff		Bulgar
		Bran
		Wheat germ



Celiac Disease

Some facts:

- ✓ Celiac disease (Sprue, Gluten-enteropathy) is carried on one of the genes (DR types, DR3) that is also related to being at high risk for type 1 diabetes (see Chapter 3).
- ✓ Approximately one in 20 people with diabetes also has celiac disease.
- ✓ As other family members who do not have diabetes may also have the DR3 genetic type, they are also more likely to have celiac disease (even though they do not have diabetes).
- ✓ Celiac disease is an allergy to the protein, gluten.
- ✓ It can be diagnosed using a blood antibody test (transglutaminase and/or anti-endomysial antibodies). At present, an intestinal biopsy is usually also done to confirm the diagnosis.
- ✓ Some people with celiac disease have symptoms, whereas others may not have any symptoms at all.

Symptoms may include:

- stomach pain
- gas
- diarrhea
- in children, decreased height or weight gain
- ▼ The symptoms, the abnormal blood tests and the intestinal biopsy changes may return to normal within a few months after treatment is begun.
- ▼ *The treatment involves:*
 - removing all wheat, rye and barley products from the diet (rice, corn, oat products, and all foods except those containing gluten can still be eaten)
 - working with a dietitian to learn which foods contain the protein, gluten
 - ✓ Adults who have no symptoms may not wish to restrict all gluten from their diet. The main argument for doing so is that in a few case reports of adults dying with a cancer (lymphoma) of the intestine, celiac disease has been found present (and a possible causative factor).

There is a series of cookbooks called “*The Gluten Free Gourmet*”, which can be ordered from any of the on-line bookstores such as Amazon.com and there are also several good bread mixes now. It is easier if the entire family eats as “gluten free” as possible. In the U.S., products are available in most health food stores. The following are some other places you can shop/links:

www.glutenfree.com

www.glutenfreemail.com

www.causeyourespecial.com/index_nn4.html
(please note the underscore)

www.celiac.com

www.celiacdisease.com

There is much that we still do not know about this disease. Some people may have a secondary deficiency of vitamin B12. This deficiency can cause symptoms similar to those of neuropathy or multiple sclerosis (MS).

Skin Problems

Some facts:

- ✓ Yellow fatty deposits (**necrobiosis**) can collect in the skin over the front of the lower legs. No one knows what causes these fat deposits.
- ✓ A rare condition called **dermatitis herpetiformis** is also related to a sensitivity to the protein, gluten (see celiac disease). It is characterized by blisters on the elbows, buttocks and knees. Like celiac disease, it responds to a gluten-free diet.

Sexual Function

- ✓ Some males with diabetes have problems with penile erections. The cause of this problem is unknown. The medicine Viagra® may be helpful to some men with diabetes who have this problem.
- ✓ There is no evidence that women with diabetes have problems with sexuality related to diabetes.

SUMMARY

In summary, much is now known about the long-term complications of diabetes. Recent research suggests that good sugar control, normal blood pressure and not using tobacco can help prevent many of the complications.

DEFINITIONS

Adrenal gland: A hormone-producing gland located above each kidney, which has the function of making cortisone, salt-retaining hormones and other hormones.

Autoimmunity (self-allergy): As defined in Chapter 3, this involves forming an allergic reaction against ones own tissues. This happens in type 1 diabetes and can happen in thyroid disorders and, more rarely, with the adrenal gland.

Blood pressure: The blood pressure consists of a higher (systolic) pressure that reflects the pumping or working pressure of the heart and a lower (diastolic) pressure which reflects the resting pressure of the heart between beats. It is important to have the blood pressure checked regularly.

Blood Urea Nitrogen (BUN): A material in the blood normally cleared by the kidneys. It is elevated in advanced kidney disease as well as with dehydration.

Cataract: A density (clouding) in the lens that may cause spots, blurred or reduced vision.

Celiac disease (Sprue, Gluten-enteropathy): An allergy to the protein, gluten.

Creatinine: A material in the blood normally cleared by the kidneys. The test to measure its clearance from the blood is called a creatinine clearance test.

DCCT: Diabetes Control and Complications Trial. A very large trial of people ages 13-39 years old, which showed that lower HbA_{1c} values resulted in a lower risk for diabetic eye, kidney, nerve and heart problems. The trial ended in June, 1993.

Edema: Collection of fluid (swelling) under the skin.

Filter: To separate out or remove. The kidneys filter wastes from our blood.

Gastroparesis: Neuropathy involving the stomach and/or intestine.

Glomerulus: Small groups of blood vessels in the kidneys that filter the blood to remove wastes and water to make urine.

Gluten: The protein found in wheat that people are allergic to if they have celiac disease.

Hemorrhage: The breaking of a blood vessel. In the eye, this can occur in the retinal layer or, in more advanced cases, in the fluid (vitreous) in front of the retina (vitreous hemorrhage).

Laser treatment: Using a very bright beam of light to destroy the new (proliferative) blood vessels in the retina, which are at high risk for hemorrhaging and causing a loss of vision.

Lens (see picture of eye in this chapter): The oval structure in the front of the eye that changes shape to allow the eye to focus on near or distant objects.

Microalbumin: A test that can measure small amounts of a protein (albumin) in the urine to detect kidney damage from diabetes at a stage in which it might still be reversible.

Microaneurysm: A small dilatation (ballooning) of a blood vessel, which is a minor change that can be reversible. It is caused by diabetes.

Myoinositol: A compound, which is reduced in nerves when sorbitol levels are elevated (in neuropathy).

Necrobiosis: The name for yellow fatty deposits that can occur over the lower legs in people with diabetes.

Nephropathy: A generic name for kidney disease. It is usually used to indicate a more advanced stage of kidney involvement.

Neuropathy: A disease of the nerves. This is believed to happen in people with diabetes due to accumulation of sorbitol (formed from blood glucose), or possibly due to deficiency of another metabolite, myoinositol.

Ophthalmologist: The name for a doctor (MD) who specializes in eye diseases. The ophthalmologist may further specialize in the retinal layer in the back of the eye, which is affected by diabetes. The doctor is then called a “retinal specialist.”

Optometrist: A person who is primarily trained to check for the need for glasses. An optometrist is not an MD (although they are still important care providers).

Podiatrist: A person who is specially trained in the care of the feet. They are not MDs (although they are still important care providers).

Pre-proliferative or proliferative retinopathy: Terms for more advanced stages of eye involvement from diabetes (when a diabetes eye specialist needs to be seen more frequently).

Puberty: The time in a teen’s life when adult sexual changes start to occur.

Retina (see picture of eye in this chapter): The layers of small blood vessels and nerves in the back of the eye that are very important for vision.

Retinal detachment: Separation of the retinal layer in the back of the eye from other layers in the eye.

Retinopathy: Changes in the retinal (small blood vessel) layer in the back of the eye from diabetes. These are more likely to occur after puberty in people who have had diabetes for a long time and who have been in poor sugar control.

Sorbitol: A compound derived from glucose, which collects in the lens and nerves when blood sugars are high and is believed to cause cataracts and neuropathy.

Thyroid: A hormone-producing gland in the lower front of the neck on each side of the windpipe (trachea). The hormone is called thyroid hormone.

Vitreous fluid: The fluid between the lens and the retina. When retinal blood vessels break, they can bleed into the vitreous fluid (vitreous hemorrhage).

QUESTIONS AND ANSWERS FROM NEWSNOTES

Q What is the best way to screen for early microvascular (small vessel) disease of the kidneys and the eyes in people with diabetes and when should it be done?

A The microalbumin urine test is the best way to currently diagnose early kidney involvement in people with diabetes. The test is best done by measuring the microalbumin in a timed overnight urine collections. It is very important to repeat the two overnight urine collections every year. If a person has begun pubertal changes (usually ages 11-13 years) and has had diabetes for at least three years, we recommend doing the two overnight urine collections for microalbumin and having an eye exam by an ophthalmologist once yearly. Directions for the urine collections are in the back of this chapter.

Q Why is it necessary to reduce my protein intake as I lose protein in my urine? Shouldn't I eat more protein?

A The protein (albumin, microalbumin) loss in the urine is most likely due to kidney damage from diabetes. This is a result of HbA_{1c} levels being too high, the blood pressure being too high (hypertension) or as a result of using tobacco. There are probably other causes as well that we do not yet understand. When someone gets kidney damage from any cause (diabetes, hypertension, nephritis, lupus, etc.), it generally helps to slow down the process by eating less protein. The protein seems to be an extra load for the kidney to handle, and reducing the protein will make less work for the damaged kidneys. It is wise to meet with the dietitian at this stage to discuss what the correct amount of protein should be.

Q What level of glucose control is necessary to prevent the eye and kidney complications of diabetes?

A A study reported in the *Journal of the American Medical Association* in 1989 correlated longitudinal HbA_{1c} values with complications and showed that blood sugar control (HbA_{1c} levels) were definitely related to the eye and kidney complications. No person who had kept their HbA_{1c} levels below 6.8 percent for the DCA 2000 method (normal to 6.2 percent) had evidence of eye changes. Likewise, no person who had kept their HbA_{1c} below 7.4 percent had kidney changes, and only two of 230 had serious eye changes. This is in contrast to people who had a mean HbA_{1c} above 9.3 percent, where 41 percent of the people had more severe eye changes and 28 percent had evidence of kidney damage.

The extra effort to stay in good blood sugar control may indeed save much work later in life in dealing with diabetes complications, such as eye and kidney.

Q Is cigarette smoking bad for someone with diabetes?

A Yes. It is linked to lung cancer, high blood pressure and heart attacks in ALL people and is thus a poor choice for everyone. In addition, data from our Center has shown that smoking results in about a three-fold greater likelihood of diabetic kidney complications. Smoking also causes diabetic eye disease to progress more rapidly. The mechanism by which smoking does this is unknown, but as people who chew tobacco seem to have the same consequences, it may be from the absorption of nicotine into the body. HbA_{1c} levels are often high in smokers with diabetes. Therefore, these effects had to be removed before a conclusion about smoking could be reached. Smoking results in higher HbA_{1c} levels by increasing levels of other hormones, such as adrenaline, which raise the blood sugar. The heart rate and blood pressure also increase and this may be related to the increased eye and kidney problems.

Q Our son has been chewing tobacco. Is this really bad? Should we be bothered by it or just be glad he is not smoking cigarettes?

A The use of “smokeless” tobacco is increasing in teenagers and should be actively discouraged. One study of Denver high school students (mean age = 16 years) showed that more than 10 percent used smokeless tobacco.

The tobacco contains dangerous components that could be cancer-causing. In addition to the increased risk for cancer of the mouth, the nicotine is absorbed from the tobacco and can cause any of the following: stimulation, increased muscle tone, aggression, increase in heart rate and blood pressure, dizziness, nausea and shakiness of the extremities. **The latter three symptoms may be confused with the symptoms of low blood sugar.** Reduced taste is common and increased use of salt (and sugar) often occurs. Dentists note that users typically have discolored teeth, receding gums, periodontal destruction and excessive wear of the teeth due to abrasives in the tobacco. Withdrawal symptoms of irritability and decreased cognitive functions are frequently found between doses.

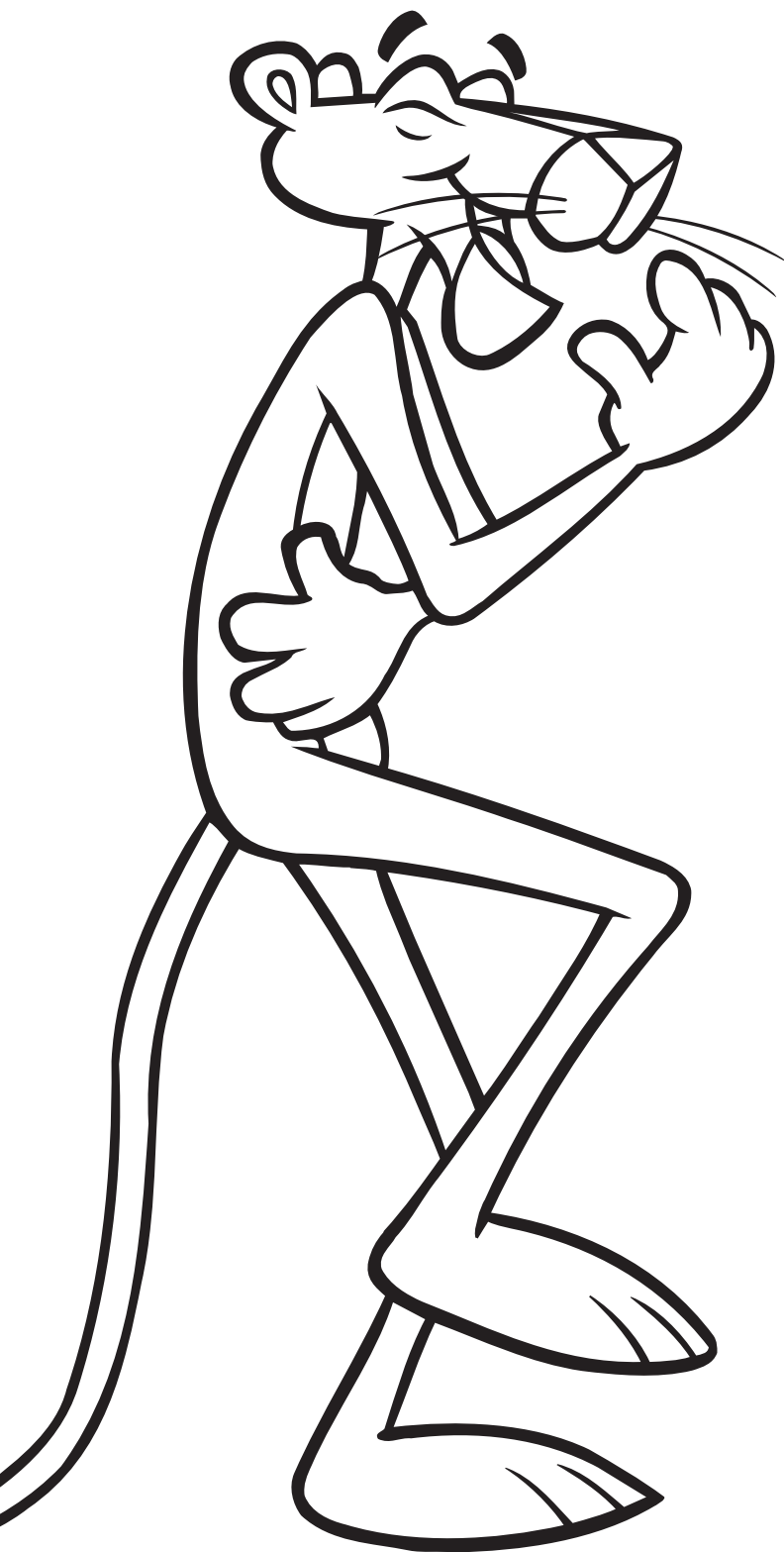
Fortunately, the Comprehensive Smokeless Tobacco Health Education Act, which bans radio and TV advertisements, was signed into law during the Reagan Administration. As a result, famous sports and movie stars are no longer seen promoting chewing tobacco on TV. Needless to say, it is well worthwhile for responsible people (including parents) to take a strong stand against chewing (or smoking) tobacco!

Q Are thyroid problems more common in children with diabetes, and if so, why?

A Yes, thyroid problems are more common in children with diabetes. They are caused by an “autoimmune” or allergic-type reaction that is very similar to

the allergic-type reaction that is believed to be important in causing diabetes. Thus, most people with new-onset diabetes have islet cell antibodies (an allergic reaction against the islet cells that make the insulin) at the time of diagnosis of type 1 (but not type 2) diabetes. Likewise, the people with diabetes who develop thyroid problems have an antibody in their blood against the thyroid gland. Both the pancreas and the thyroid are endocrine glands that make the hormones insulin and thyroid hormone, respectively. Thus, the two glands have much in common. Some physicians recommend thyroid blood tests yearly in children with diabetes. The practice in our Clinic is to do the tests if the thyroid gland is large or if there is a special indication, such as a fall-off in height. Fortunately, when low thyroid function is detected, it can be treated with a tablet. Also, the pills can sometimes be discontinued after growth is complete.





Q How common is kidney disease in association with diabetes, and can it be prevented?

A Kidney problems occur in up to 30 percent of people with type 1 diabetes, usually when the person reaches their 30s or 40s. There are things that we can do now to help reduce the likelihood of kidney problems. These include: good sugar control, keeping the blood pressure normal, prompt treatment of bladder and kidney infections and not smoking. It is very important to get the urine microalbumins checked yearly for people who have had type 1 diabetes for three or more years who have reached puberty.

Q Are contact lenses OK for a person with diabetes to use?

A Yes, people with diabetes can wear contact lenses, but there are some extra precautions. The contact lens fits over the superficial layer of the eye called the cornea. The cornea needs a constant supply of oxygen and tears to keep it healthy. Thus, the contact lens must fit properly so that the cornea is not injured and the tears are able to continue to flow. A qualified (experienced) eye doctor should fit the lenses - probably in a contact lens clinic.

It is even more important for people with diabetes to follow the instructions for care and cleaning of the contact lenses than it is for other people. The corneas of people with diabetes are sometimes less sensitive to pain or irritation, so people may be less likely to feel discomfort when their contacts are causing problems. Infections may also not clear as quickly if they do occur. Thus, use the solutions and disinfectants exactly as your eye doctor recommends. Don't get lazy in cleaning or try to cut corners. Don't leave the contacts in any longer than recommended. Don't mix cleaning solutions. Finally, it is probably better not to get the extended wear lenses.

MICROALBUMINS

Doctor: _____ Your Name: _____

A. INSTRUCTIONS FOR DOING THE OVERNIGHT URINE COLLECTIONS

COLLECTION #1

DATE: _____

1. Empty your bladder at bedtime and discard this sample. TIME: _____
2. Save **EVERY DROP** of urine during the night.
3. Save **EVERY DROP** of the first morning sample. TIME: _____
ALL urine from collection #1 should be placed in the same container.
4. Measure the volume of the urine sample. TOTAL VOLUME: _____

COLLECTION #2

DATE: _____

1. Empty your bladder at bedtime and discard this sample. TIME: _____
2. Save **EVERY DROP** of urine during the night.
3. Save **EVERY DROP** of the first morning sample. TIME: _____
ALL urine from collection #2 should be placed in the same container.
4. Measure the volume of the urine sample. TOTAL VOLUME: _____

B. IMPORTANT INFORMATION ABOUT YOUR COLLECTIONS

1. Label each container with your name and #1 or #2.
2. You may use any CLEAN container you have at home that will not leak to collect the sample. We do not provide containers.
3. Store urine aliquots in refrigerator until your visit (samples are good for one week if kept cold).
4. **DO NOT** mix collections #1 and #2 together in the same container.
5. **DO NOT** drink caffeinated or alcoholic beverages or use tobacco after 10 p.m. the evening of the collections.
6. **DO NOT** exercise strenuously for the four hours prior to bedtime.
7. **DO NOT** collect specimens during a menstrual period.
8. Failure to follow directions exactly may cause incorrect results.
9. If you have any questions, please call your healthcare provider.

C. DIRECTIONS FOR MEASURING THE VOLUME

1. Have a measuring cup or (better) a cylinder - preferably marked in cc (ml). One cup is 240cc. Urine is sterile and it is ok to use cooking measuring cups (just wash prior to next use for cooking).
2. Measure the total cc of each overnight sample and put the amounts in the blanks for step 4 for collections #1 and #2.
3. Put a sample of each urine collection in a clean tube. The rest may be discarded. Any clean red top tube from a doctor's office, clinic or hospital lab will work. Label which sample (#1 or #2) it is, put your name on the tube, and put the tube in a cup in the refrigerator until you get to your clinic. Bring this sheet with the times and total volumes with you.