

# DCCT and EDIC:

## The Diabetes Control and Complications Trial and Follow-up Study

*National Diabetes Information Clearinghouse*



U.S. Department  
of Health and  
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INSTITUTES  
OF HEALTH

**NIDDK**  
NATIONAL INSTITUTE OF  
DIABETES AND DIGESTIVE  
AND KIDNEY DISEASES

### What is the DCCT?

The Diabetes Control and Complications Trial (DCCT) was a major clinical study conducted from 1983 to 1993 and funded by the National Institute of Diabetes and Digestive and Kidney Diseases. The study showed that keeping blood glucose levels as close to normal as possible slows the onset and progression of the eye, kidney, and nerve damage caused by diabetes. In fact, it demonstrated that any sustained lowering of blood glucose, also called blood sugar, helps, even if the person has a history of poor control.

The DCCT involved 1,441 volunteers, ages 13 to 39, with type 1 diabetes and 29 medical centers in the United States and Canada. Volunteers had to have had diabetes for at least 1 year but no longer than 15 years. They also were required to have no, or only early signs of, diabetic eye disease.

The study compared the effects of standard control of blood glucose versus intensive control on the complications of diabetes. Intensive control meant keeping hemoglobin A1C levels as close as possible to the normal value of 6 percent or less. The A1C blood test reflects a person's average blood glucose over the last 2 to 3 months. Volunteers were randomly assigned to each treatment group.

### What is the EDIC?

When the DCCT ended in 1993, researchers continued to study more than 90 percent of participants. The follow-up study, called Epidemiology of Diabetes Interventions and Complications (EDIC), is assessing the incidence and predictors of cardiovascular disease events such as heart attack, stroke, or needed heart surgery, as well as diabetic complications related to the eye, kidney, and nerves. The EDIC study is also examining the impact of intensive control versus standard control on quality of life. Another objective is to look at the cost-effectiveness of intensive control.

### DCCT Study Findings

**Intensive blood glucose control reduces risk of**

- eye disease  
76% reduced risk
- kidney disease  
50% reduced risk
- nerve disease  
60% reduced risk

### EDIC Study Findings

**Intensive blood glucose control reduces risk of**

- any cardiovascular disease event  
42% reduced risk
- nonfatal heart attack, stroke, or death from cardiovascular causes  
57% reduced risk

## How did intensive treatment affect diabetic eye disease?

All DCCT participants were monitored for diabetic retinopathy, an eye disease that affects the retina. Study results showed that intensive therapy reduced the risk for developing retinopathy by 76 percent. In participants who had some eye damage at the beginning of the study, intensive management slowed the progression of the disease by 54 percent.

The retina is the light-sensing tissue at the back of the eye. According to the National Eye Institute, one of the National Institutes of Health, as many as 24,000 people with diabetes lose their sight each year. In the United States, diabetic retinopathy is the leading cause of blindness in adults less than 65 years of age.

## How did intensive treatment affect diabetic kidney disease?

Participants in the DCCT were tested to assess the development of diabetic kidney disease, or nephropathy. Findings showed that intensive treatment prevented the development and slowed the progression of diabetic kidney disease by 50 percent.

Diabetic kidney disease is the most common cause of kidney failure in the United States. After having diabetes for 15 years, one-third of people with type 1 diabetes develop kidney disease. Diabetes damages the small blood vessels in the kidneys, impairing their ability to filter impurities from blood for excretion in the urine. People with kidney failure must have a kidney transplant or rely on dialysis to cleanse their blood.

## How did intensive treatment affect diabetic nerve disease?

Participants in the DCCT were examined to detect the development of nerve damage, or diabetic neuropathy. Study results showed the risk of nerve damage was reduced by 60 percent in people on intensive treatment.

Diabetic nerve disease can cause pain and loss of feeling in the feet, legs, and fingertips. It can also affect the parts of the nervous system that control blood pressure, heart rate, digestion, and sexual function. Neuropathy is a major contributing factor in foot and leg amputations among people with diabetes.

### Elements of Intensive Management in the DCCT

- Testing blood glucose levels four or more times a day
- Injecting insulin at least three times daily or using an insulin pump
- Adjusting insulin doses according to food intake and exercise
- Following a diet and exercise plan
- Making monthly visits to a health care team composed of a physician, nurse educator, dietitian, and behavioral therapist

## How did intensive treatment affect diabetes-related cardiovascular disease?

People with type 1 diabetes have a tenfold greater risk of heart disease compared with nondiabetic patients because high blood glucose can damage the heart and blood vessels. That damage can lead to heart attacks and strokes, the leading causes of death for people with diabetes.

Another condition related to heart disease and common in people with diabetes is peripheral arterial disease (PAD), also called peripheral vascular disease (PVD). With this condition, the blood vessels in the legs are narrowed or blocked by fatty deposits, decreasing blood flow to the legs and feet. PAD is a sign of widespread atherosclerosis, and people with PAD are at increased risk of heart attack or stroke. Poor circulation in the legs and feet also raises the risk of amputation.

When the initial findings of the DCCT were announced in 1993, it was too early to detect the effects of the therapies on cardiovascular disease because patients were young. In 2005, however, EDIC researchers reported that the risk of any heart disease was reduced by 42 percent in people who had been in the intensive treatment group. Volunteers in the intensive treatment group also cut their risk of nonfatal heart attack, stroke, or death from cardiovascular causes by 57 percent.

Patients received the intensive therapy for an average of 6.5 years in the DCCT. More than 10 years after the DCCT ended, when both groups began receiving similar care, the benefits to the heart of the earlier treatment emerged. Moreover, the EDIC study found the benefits of tight glucose control on eye, kidney, and nerve problems persisted long after the DCCT ended. Researchers call the long-lasting benefit of tight control “metabolic memory.” Following the DCCT, blood glucose levels in the intensive treatment group rose, and those of the conventional treatment group declined, so that blood glucose levels are now nearly the same between treatment groups.

## What are the risks of intensive treatment?

In the DCCT, the most significant side effect of intensive treatment was an increase in the risk for hypoglycemia, also called low blood glucose, including episodes severe enough to require assistance from another person.

When blood glucose falls too low, a person can become confused, behave irrationally, have seizures, lose consciousness, or even die. The good news is that such episodes, while dangerous at the time, do not lead to a long-term loss of cognitive function—the ability to perceive, reason, and remember—as scientists originally feared. Researchers recently reported this finding after examining 1,144 of the original DCCT participants a mean of 18 years after enrollment in the DCCT.

The DCCT did not study intensive therapy in young children or in patients with severe complications, frequent hypoglycemia, or those with a limited life expectancy. While most patients benefit from keeping their blood glucose levels as close to normal as possible, less stringent goals may be appropriate for some patients.

DCCT researchers estimate that intensive management doubles the cost of managing diabetes because of increased visits to a health care professional and the need for more frequent blood testing at home. However, this cost is offset by the reduction in medical expenses related to long-term complications and by the improved quality of life of people with diabetes.

### **What do the results of the DCCT and EDIC studies mean for people with type 2 diabetes?**

Results of the DCCT and EDIC studies have important implications for preventing diabetes complications in people with type 2 diabetes because the microvascular disease development process is likely to be similar for both type 1 and type 2 diabetes. One study of people with type 2 diabetes, the United Kingdom Prospective Diabetes Study, demonstrated that controlling blood glucose levels reduced the risk of diabetic eye disease and kidney disease.

Other studies of the role of blood glucose control in people with type 2 diabetes are still under way. For example, the Action to Control Cardiovascular Risk in Diabetes

(ACCORD) trial, a multicenter, randomized trial, is studying approaches to preventing major cardiovascular events in individuals with type 2 diabetes. ACCORD is designed to compare current practice guidelines with more intensive glycemic control in 10,000 individuals with type 2 diabetes, including those at especially high risk for cardiovascular disease (CVD) events because of age, evidence of subclinical atherosclerosis, or existing clinical CVD. More intensive control of blood pressure than is called for in current guidelines and a medication to reduce triglyceride levels and raise HDL cholesterol levels will also be studied in subgroups of these 10,000 volunteers. Each treatment strategy will be accompanied by standard advice regarding lifestyle choices, including diet, physical activity, and smoking cessation, appropriate for individuals with diabetes.

The primary outcome to be measured is the first occurrence of a major CVD event, specifically heart attack, stroke, or cardiovascular death. In addition, the study will investigate the impact of the treatment strategies on other cardiovascular outcomes; total mortality; limb amputation; eye, kidney, or nerve disease; health-related quality of life; and cost-effectiveness.

In February 2008, the National Heart, Lung, and Blood Institute decided to stop one part of the study—the intensive glycemic control treatment—before the end of the entire trial because of safety concerns. However, the trial will continue with the other treatments until the planned end in 2009.

## What are the most important factors in preventing diabetes complications?

Research studies have shown that control of blood glucose, blood pressure, and blood lipid levels helps prevent complications in people with type 1 or type 2 diabetes.

Results of the DCCT are reported in the *New England Journal of Medicine*, 329(14), September 30, 1993.

Results of the EDIC are reported in the *New England Journal of Medicine*, 353(25), December 22, 2005.

Reprints of articles related to the DCCT or the EDIC can be ordered from the

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