

Diabetic Neuropathies: The Nerve Damage of Diabetes

What are diabetic neuropathies?

Diabetic neuropathies are a family of nerve disorders caused by diabetes. People with diabetes can, over time, develop nerve damage throughout the body. Some people with nerve damage have no symptoms. Others may have symptoms such as pain, tingling, or numbness—loss of feeling—in the hands, arms, feet, and legs. Nerve problems can occur in every organ system, including the digestive tract, heart, and sex organs.

About 60 to 70 percent of people with diabetes have some form of neuropathy. People with diabetes can develop nerve problems at any time, but risk rises with age and longer duration of diabetes. The highest rates of neuropathy are among people who have had diabetes for at least 25 years. Diabetic neuropathies also appear to be more common in people who have problems controlling their blood glucose, also called blood sugar, as well as those with high levels of blood fat and blood pressure and those who are overweight.

What causes diabetic neuropathies?

The causes are probably different for different types of diabetic neuropathy. Researchers are studying how prolonged exposure to high blood glucose causes nerve damage. Nerve damage is likely due to a combination of factors:

- metabolic factors, such as high blood glucose, long duration of diabetes, abnormal blood fat levels, and possibly low levels of insulin
- neurovascular factors, leading to damage to the blood vessels that carry oxygen and nutrients to nerves
- autoimmune factors that cause inflammation in nerves
- mechanical injury to nerves, such as carpal tunnel syndrome
- inherited traits that increase susceptibility to nerve disease
- lifestyle factors, such as smoking or alcohol use

What are the symptoms of diabetic neuropathies?

Symptoms depend on the type of neuropathy and which nerves are affected. Some people with nerve damage have no symptoms at all. For others, the first symptom is often numbness, tingling, or pain in the feet. Symptoms are often minor at first, and because most nerve damage occurs over several years, mild cases may go unnoticed for a long time. Symptoms can involve the sensory, motor, and autonomic—or involuntary—nervous systems. In some people, mainly those with focal neuropathy, the onset of pain may be sudden and severe.

Symptoms of nerve damage may include

- numbness, tingling, or pain in the toes, feet, legs, hands, arms, and fingers
- wasting of the muscles of the feet or hands
- indigestion, nausea, or vomiting
- diarrhea or constipation
- dizziness or faintness due to a drop in blood pressure after standing or sitting up
- problems with urination
- erectile dysfunction in men or vaginal dryness in women
- weakness

Symptoms that are not due to neuropathy, but often accompany it, include weight loss and depression.

What are the types of diabetic neuropathy?

Diabetic neuropathy can be classified as peripheral, autonomic, proximal, or focal. Each affects different parts of the body in various ways.

- Peripheral neuropathy, the most common type of diabetic neuropathy, causes pain or loss of feeling in the toes, feet, legs, hands, and arms.

- Autonomic neuropathy causes changes in digestion, bowel and bladder function, sexual response, and perspiration. It can also affect the nerves that serve the heart and control blood pressure, as well as nerves in the lungs and eyes. Autonomic neuropathy can also cause hypoglycemia unawareness, a condition in which people no longer experience the warning symptoms of low blood glucose levels.
- Proximal neuropathy causes pain in the thighs, hips, or buttocks and leads to weakness in the legs.
- Focal neuropathy results in the sudden weakness of one nerve or a group of nerves, causing muscle weakness or pain. Any nerve in the body can be affected.

Neuropathy Affects Nerves Throughout the Body

Peripheral neuropathy affects

- toes
- feet
- legs
- hands
- arms

Autonomic neuropathy affects

- heart and blood vessels
- digestive system
- urinary tract
- sex organs
- sweat glands
- eyes
- lungs

Proximal neuropathy affects

- thighs
- hips
- buttocks
- legs

Focal neuropathy affects

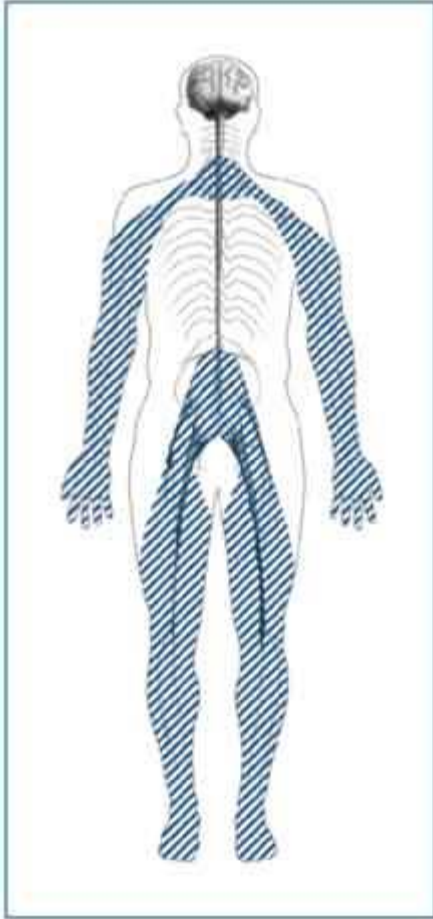
- eyes
- facial muscles
- ears
- pelvis and lower back
- chest
- abdomen
- thighs
- legs
- feet

What is peripheral neuropathy?

Peripheral neuropathy, also called distal symmetric neuropathy or sensorimotor neuropathy, is nerve damage in the arms and legs. Feet and legs are likely to be affected before hands and arms. Many people with diabetes have signs of neuropathy that a doctor could note but feel no symptoms themselves. Symptoms of peripheral neuropathy may include

- numbness or insensitivity to pain or temperature
- a tingling, burning, or prickling sensation
- sharp pains or cramps
- extreme sensitivity to touch, even light touch
- loss of balance and coordination

These symptoms are often worse at night.



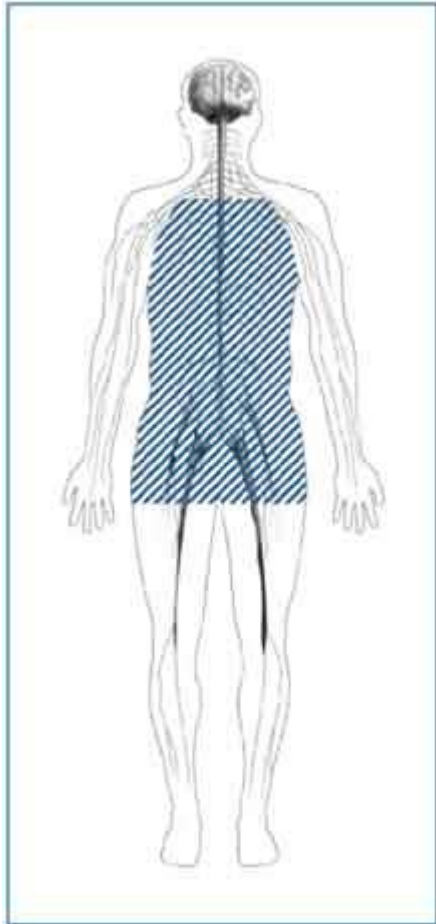
Peripheral neuropathy affects the nerves in your toes, feet, legs, hands, and arms.

Peripheral neuropathy may also cause muscle weakness and loss of reflexes, especially at the ankle, leading to changes in the way a person walks. Foot deformities, such as hammertoes and the collapse of the midfoot, may occur. Blisters and sores may appear on numb areas of the foot because pressure or injury goes unnoticed. If an infection occurs and is not treated promptly, the infection may spread to the bone, and the foot may then have to be amputated. Many amputations are preventable if minor problems are caught and treated in time.

What is autonomic neuropathy?

Autonomic neuropathy affects the nerves that control the heart, regulate blood pressure, and control blood glucose levels. Autonomic neuropathy also affects other internal organs, causing problems with digestion, respiratory function, urination, sexual

response, and vision. In addition, the system that restores blood glucose levels to normal after a hypoglycemic episode may be affected, resulting in loss of the warning symptoms of hypoglycemia.



Autonomic neuropathy affects the nerves in your heart, stomach, intestines, bladder, sex organs, sweat glands, eyes, and lungs.

Hypoglycemia Unawareness

Normally, symptoms such as shakiness, sweating, and palpitations occur when blood glucose levels drop below 70 mg/dL. In people with autonomic neuropathy, symptoms may not occur, making hypoglycemia difficult to recognize. Problems other than neuropathy can also cause hypoglycemia unawareness.

Heart and Blood Vessels

The heart and blood vessels are part of the cardiovascular system, which controls blood circulation. Damage to nerves in the cardiovascular system interferes with the body's

ability to adjust blood pressure and heart rate. As a result, blood pressure may drop sharply after sitting or standing, causing a person to feel light-headed or even to faint. Damage to the nerves that control heart rate can mean that the heart rate stays high, instead of rising and falling in response to normal body functions and physical activity.

Digestive System

Nerve damage to the digestive system most commonly causes constipation. Damage can also cause the stomach to empty too slowly, a condition called gastroparesis. Severe gastroparesis can lead to persistent nausea and vomiting, bloating, and loss of appetite. Gastroparesis can also make blood glucose levels fluctuate widely, due to abnormal food digestion.

Nerve damage to the esophagus may make swallowing difficult, while nerve damage to the bowels can cause constipation alternating with frequent, uncontrolled diarrhea, especially at night. Problems with the digestive system can lead to weight loss.

Urinary Tract and Sex Organs

Autonomic neuropathy often affects the organs that control urination and sexual function. Nerve damage can prevent the bladder from emptying completely, allowing bacteria to grow in the bladder and kidneys and causing urinary tract infections. When the nerves of the bladder are damaged, urinary incontinence may result because a person may not be able to sense when the bladder is full or control the muscles that release urine.

Autonomic neuropathy can also gradually decrease sexual response in men and women, although the sex drive may be unchanged. A man may be unable to have erections or may reach sexual climax without ejaculating normally. A woman may have difficulty with arousal, lubrication, or orgasm.

Sweat Glands

Autonomic neuropathy can affect the nerves that control sweating. When nerve damage prevents the sweat glands from working properly, the body cannot regulate its temperature as it should. Nerve damage can also cause profuse sweating at night or while eating.

Eyes

Finally, autonomic neuropathy can affect the pupils of the eyes, making them less responsive to changes in light. As a result, a person may not be able to see well when a light is turned on in a dark room or may have trouble driving at night.

What is proximal neuropathy?

Proximal neuropathy, sometimes called lumbosacral plexus neuropathy, femoral neuropathy, or diabetic amyotrophy, starts with pain in the thighs, hips, buttocks, or legs, usually on one side of the body. This type of neuropathy is more common in those with type 2 diabetes and in older adults with diabetes. Proximal neuropathy causes weakness in the legs and the inability to go from a sitting to a standing position without help. Treatment for weakness or pain is usually needed. The length of the recovery period varies, depending on the type of nerve damage.

What is focal neuropathy?

Focal neuropathy appears suddenly and affects specific nerves, most often in the head, torso, or leg. Focal neuropathy may cause

- inability to focus the eye
- double vision
- aching behind one eye
- paralysis on one side of the face, called Bell's palsy
- severe pain in the lower back or pelvis
- pain in the front of a thigh
- pain in the chest, stomach, or side
- pain on the outside of the shin or inside of the foot
- chest or abdominal pain that is sometimes mistaken for heart disease, a heart attack, or appendicitis

Focal neuropathy is painful and unpredictable and occurs most often in older adults with diabetes. However, it tends to improve by itself over weeks or months and does not cause long-term damage.

People with diabetes also tend to develop nerve compressions, also called entrapment syndromes. One of the most common is carpal tunnel syndrome, which causes numbness and tingling of the hand and sometimes muscle weakness or pain. Other nerves susceptible to entrapment may cause pain on the outside of the shin or the inside of the foot.

Can diabetic neuropathies be prevented?

The best way to prevent neuropathy is to keep blood glucose levels as close to the normal range as possible. Maintaining safe blood glucose levels protects nerves throughout the body.

How are diabetic neuropathies diagnosed?

Doctors diagnose neuropathy on the basis of symptoms and a physical exam. During the exam, the doctor may check blood pressure, heart rate, muscle strength, reflexes, and sensitivity to position changes, vibration, temperature, or light touch.

Foot Exams

Experts recommend that people with diabetes have a comprehensive foot exam each year to check for peripheral neuropathy. People diagnosed with peripheral neuropathy need more frequent foot exams. A comprehensive foot exam assesses the skin, muscles, bones, circulation, and sensation of the feet. The doctor may assess protective sensation or feeling in the feet by touching them with a nylon monofilament—similar to a bristle on a hairbrush—attached to a wand or by pricking them with a pin. People who cannot sense pressure from a pinprick or monofilament have lost protective sensation and are at risk for developing foot sores that may not heal properly. The doctor may also check temperature perception or use a tuning fork, which is more sensitive than touch pressure, to assess vibration perception.

Other Tests

The doctor may perform other tests as part of the diagnosis.

- **Nerve conduction studies or electromyography** are sometimes used to help determine the type and extent of nerve damage. Nerve conduction studies check the transmission of electrical current through a nerve. Electromyography shows how well muscles respond to electrical signals transmitted by nearby nerves. These tests are rarely needed to diagnose neuropathy.
- **A check of heart rate variability** shows how the heart responds to deep breathing and to changes in blood pressure and posture.
- **Ultrasound** uses sound waves to produce an image of internal organs. An ultrasound of the bladder and other parts of the urinary tract, for example, can be used to assess the structure of these organs and show whether the bladder empties completely after urination.

How are diabetic neuropathies treated?

The first treatment step is to bring blood glucose levels within the normal range to help prevent further nerve damage. Blood glucose monitoring, meal planning, physical activity, and diabetes medicines or insulin will help control blood glucose levels. Symptoms may get worse when blood glucose is first brought under control, but over time, maintaining lower blood glucose levels helps lessen symptoms. Good blood glucose control may also help prevent or delay the onset of further problems. As scientists learn more about the underlying causes of neuropathy, new treatments may become available to help slow, prevent, or even reverse nerve damage.

As described in the following sections, additional treatment depends on the type of nerve problem and symptom.

Pain Relief

Doctors usually treat painful diabetic neuropathy with oral medications, although other types of treatments may help some people. People with severe nerve pain may benefit from a combination of medications or treatments and should consider talking with a health care provider about treatment options.

Medications used to help relieve diabetic nerve pain include

- tricyclic antidepressants, such as amitriptyline, imipramine, and desipramine (Norpramin, Pertofrane)
- other types of antidepressants, such as duloxetine (Cymbalta), venlafaxine, bupropion (Wellbutrin), paroxetine (Paxil), and citalopram (Celexa)
- anticonvulsants, such as pregabalin (Lyrica), gabapentin (Gabarone, Neurontin), carbamazepine, and lamotrigine (Lamictal)
- opioids and opioidlike drugs, such as controlled-release oxycodone, an opioid; and tramadol (Ultram), an opioid that also acts as an antidepressant

Duloxetine and pregabalin are approved by the U.S. Food and Drug Administration specifically for treating painful diabetic peripheral neuropathy.

People do not have to be depressed for an antidepressant to help relieve their nerve pain. All medications have side effects, and some are not recommended for use in older adults or those with heart disease. Because over-the-counter pain medicines such as acetaminophen and ibuprofen may not work well for treating most nerve pain and can have serious side effects, some experts recommend avoiding these medications.

Treatments that are applied to the skin—typically to the feet—include capsaicin cream and lidocaine patches (Lidoderm, Lidopain). Studies suggest that nitrate sprays or patches for the feet may relieve pain. Studies of alpha-lipoic acid, an antioxidant, and evening primrose oil suggest they may help relieve symptoms and improve nerve function in some patients.

A device called a bed cradle can keep sheets and blankets from touching sensitive feet and legs. Acupuncture, biofeedback, or physical therapy may help relieve pain in some people. Treatments that involve electrical nerve stimulation, magnetic therapy, and laser

or light therapy may be helpful but need further study. Researchers are also studying several new therapies in clinical trials.

Gastrointestinal Problems

To relieve mild symptoms of gastroparesis—indigestion, belching, nausea, or vomiting—doctors suggest eating small, frequent meals; avoiding fats; and eating less fiber. When symptoms are severe, doctors may prescribe erythromycin to speed digestion, metoclopramide to speed digestion and help relieve nausea, or other medications to help regulate digestion or reduce stomach acid secretion.

To relieve diarrhea or other bowel problems, doctors may prescribe an antibiotic such as tetracycline, or other medications as appropriate.

Dizziness and Weakness

Sitting or standing slowly may help prevent the light-headedness, dizziness, or fainting associated with blood pressure and circulation problems. Raising the head of the bed or wearing elastic stockings may also help. Some people benefit from increased salt in the diet and treatment with salt-retaining hormones. Others benefit from high blood pressure medications. Physical therapy can help when muscle weakness or loss of coordination is a problem.

Urinary and Sexual Problems

To clear up a urinary tract infection, the doctor will probably prescribe an antibiotic. Drinking plenty of fluids will help prevent another infection. People who have incontinence should try to urinate at regular intervals—every 3 hours, for example—because they may not be able to tell when the bladder is full.

To treat erectile dysfunction in men, the doctor will first do tests to rule out a hormonal cause. Several methods are available to treat erectile dysfunction caused by neuropathy. Medicines are available to help men have and maintain erections by increasing blood flow to the penis. Some are oral medications and others are injected into the penis or inserted into the urethra at the tip of the penis. Mechanical vacuum devices can also increase blood flow to the penis. Another option is to surgically implant an inflatable or semirigid device in the penis.

Vaginal lubricants may be useful for women when neuropathy causes vaginal dryness. To treat problems with arousal and orgasm, the doctor may refer women to a gynecologist.

Foot Care

People with neuropathy need to take special care of their feet. The nerves to the feet are the longest in the body and are the ones most often affected by neuropathy. Loss of sensation in the feet means that sores or injuries may not be noticed and may become ulcerated or infected. Circulation problems also increase the risk of foot ulcers. Smoking increases the risk of foot problems and amputation. A health care provider may be able to provide help with quitting smoking.

More than 60 percent of all nontraumatic lower-limb amputations in the United States occur in people with diabetes. Nontraumatic amputations are those not caused by trauma such as severe injuries from an accident. In 2004, about 71,000 nontraumatic amputations were performed in people with diabetes. Comprehensive foot care programs can reduce amputation rates by 45 to 85 percent.

Careful foot care involves

- cleaning the feet daily using warm—not hot—water and a mild soap. Soaking the feet should be avoided. A soft towel can be used to dry the feet and between the toes.
- inspecting the feet and toes every day for cuts, blisters, redness, swelling, calluses, or other problems. Using a mirror—handheld or placed on the floor—may be helpful in checking the bottoms of the feet, or another person can help check the feet. A health care provider should be notified of any problems.
- using lotion to moisturize the feet. Getting lotion between the toes should be avoided.
- filing corns and calluses gently with a pumice stone after a bath or shower.
- cutting toenails to the shape of the toes and filing the edges with an emery board each week or when needed.

- always wearing shoes or slippers to protect feet from injuries. Wearing thick, soft, seamless socks can prevent skin irritation.
- wearing shoes that fit well and allow the toes to move. New shoes can be broken in gradually by first wearing them for only an hour at a time.
- looking shoes over carefully before putting them on and feeling the insides to make sure the shoes are free of tears, sharp edges, or objects that might injure the feet.

People who need help taking care of their feet should consider making an appointment to see a foot doctor, also called a podiatrist.

Points to Remember

- Diabetic neuropathies are nerve disorders caused by many of the abnormalities common to diabetes, such as high blood glucose.
- Neuropathy can affect nerves throughout the body, causing numbness and sometimes pain in the hands, arms, feet, or legs, and problems with the digestive tract, heart, sex organs, and other body systems.
- Treatment first involves bringing blood glucose levels within the normal range. Good blood glucose control may help prevent or delay the onset of further problems.
- Foot care is an important part of treatment. People with neuropathy need to inspect their feet daily for any injuries. Untreated injuries increase the risk of infected foot sores and amputation.
- Treatment also includes pain relief and other medications as needed, depending on the type of nerve damage.
- Smoking increases the risk of foot problems and amputation. A health care provider may be able to provide help with quitting.

Hope through Research

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) conducts and supports research to help people with diabetes.

Participants in clinical trials can play a more active role in their own health care, gain access to new research treatments before they are widely available, and help others by contributing to medical research. For information about current studies, visit www.ClinicalTrials.gov.

For More Information

See the following publications from the NIDDK for more information about topics related to diabetic neuropathies:

- *Gastroparesis*—stomach nerve damage—available online at www.digestive.niddk.nih.gov/ddiseases/pubs/gastroparesis
- *Hypoglycemia*—available online at www.diabetes.niddk.nih.gov/dm/pubs/hypoglycemia
- *Nerve Disease and Bladder Control*—available online at www.kidney.niddk.nih.gov/kudiseases/pubs/nervedisease
- *Prevent diabetes problems: Keep your feet and skin healthy* and *Prevent diabetes problems: Keep your nervous system healthy*, two publications in the Prevent Diabetes Problems Series—available online at www.diabetes.niddk.nih.gov/dm/pubs/complications
- *Sexual and Urologic Problems of Diabetes*—available online at www.diabetes.niddk.nih.gov/dm/pubs/sup
- *Take Care of Your Feet for a Lifetime*, available from the National Diabetes Education Program by calling 1–888–

693–NDEP (6337) or visiting
www.ndep.nih.gov/campaigns/Feet/Feet_overview.htm

These publications are also available by calling 1–800–860–8747.

For more information, contact the following organizations:

American Diabetes Association

1701 North Beauregard Street
Alexandria, VA 22311
Phone: 1–800–DIABETES (342–2383)
Email: AskADA@diabetes.org
Internet: www.diabetes.org

American Podiatric Medical Association

9312 Old Georgetown Road
Bethesda, MD 20814–1621
Phone: 1–800–FOOTCARE (366–8227) or 301–581–9200
Fax: 301–530–2752
Email: askapma@apma.org
Internet: www.apma.org

American Urological Association Foundation

1000 Corporate Boulevard
Linthicum, MD 21090
Phone: 1–800–828–7866 or 410–689–3700
Fax: 410–689–3998
Email: auafoundation@auafoundation.org
Internet: www.UrologyHealth.org

Centers for Disease Control and Prevention

National Center for Chronic Disease Prevention and Health Promotion Division of
Diabetes Translation
4770 Buford Highway NE, Mail Stop K–10
Atlanta, GA 30341–3717
Phone: 1–800–CDC–INFO (232–4636) or 770–488–5000

Email: cdcinfo@cdc.gov

Internet: www.cdc.gov/diabetes

Juvenile Diabetes Research Foundation International

26 Broadway, 14th Floor

New York, NY 10004

Phone: 1-800-533-CURE (2873)

Fax: 212-785-9595

Email: info@jdrf.org

Internet: www.jdrf.org

Lower Extremity Amputation Prevention Program

Health Resources and Services Administration

5600 Fishers Lane

Rockville, MD 20857

Phone: 1-888-ASK-HRSA (275-4772)

Internet: www.hrsa.gov/leap

National Diabetes Education Program

1 Diabetes Way

Bethesda, MD 20814-9692

Phone: 1-888-693-NDEP (6337)

TTY: 1-866-569-1162

Fax: 703-738-4929

Email: ndep@mail.nih.gov

Internet: www.ndep.nih.gov

National Digestive Diseases Information Clearinghouse

2 Information Way

Bethesda, MD 20892-3570

Phone: 1-800-891-5389

TTY: 1-866-569-1162

Fax: 703-738-4929

Email: nddic@info.niddk.nih.gov

Internet: www.digestive.niddk.nih.gov

National Heart, Lung, and Blood Institute Information Center

P.O. Box 30105

Bethesda, MD 20824–0105

Phone: 301–592–8573

Fax: 240–629–3246

Email: nhlbiinfo@nhlbi.nih.gov

Internet: www.nhlbi.nih.gov

National Institute of Neurological Disorders and Stroke

P.O. Box 5801

Bethesda, MD 20824

Phone: 1–800–352–9424 or 301–496–5751

Internet: www.ninds.nih.gov

National Kidney and Urologic Diseases Information Clearinghouse

3 Information Way

Bethesda, MD 20892–3580

Phone: 1–800–891–5390

TTY: 1–866–569–1162

Fax: 703–738–4929

Email: nkudic@info.niddk.nih.gov

Internet: www.kidney.niddk.nih.gov

Pedorthic Footwear Association

2025 M Street NW, Suite 800

Washington, DC 20036

Phone: 1–800–673–8447 or 202–367–1145

Fax: 202–367–2145

Email: info@pedorthics.org

Internet: www.pedorthics.org

Acknowledgments

Publications produced by the Clearinghouse are carefully reviewed by both NIDDK scientists and outside experts. This publication was originally reviewed by Peter J.

Dyck, M.D., Peripheral Neuropathy Research Laboratory, Mayo Clinic Rochester, Rochester, MN; Eva L. Feldman, M.D., Ph.D., Department of Neurology, University of Michigan, Ann Arbor, MI; and Aaron I. Vinik, M.D., Ph.D., Strelitz Diabetes Research Institute, Eastern Virginia Medical School, Norfolk, VA. Dr. Feldman also reviewed the updated version of the publication.

You may also find additional information about this topic by visiting MedlinePlus at www.medlineplus.gov.

This publication may contain information about medications and, when taken as prescribed, the conditions they treat. When prepared, this publication included the most current information available. For updates or for questions about any medications, contact the U.S. Food and Drug Administration toll-free at 1-888-INFO-FDA (1-888-463-6332) or visit www.fda.gov. Consult your health care provider for more information.

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National Diabetes Information Clearinghouse

1 Information Way

Bethesda, MD 20892-3560

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Email: ndic@info.niddk.nih.gov

Internet: www.diabetes.niddk.nih.gov

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NIH Publication No. 09–3185

February 2009

Page last updated November 26, 2013