

### Introduction

Multiple sclerosis, or MS, is a disease of the brain and spinal cord. Most patients with multiple sclerosis are able to lead a very functional life. However, MS causes a handicap for some patients.

This reference summary will help you understand what multiple sclerosis is and how it can be treated. It also discusses symptoms and causes of MS.

### Anatomy

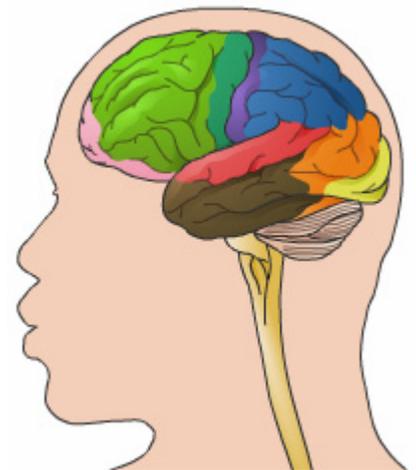
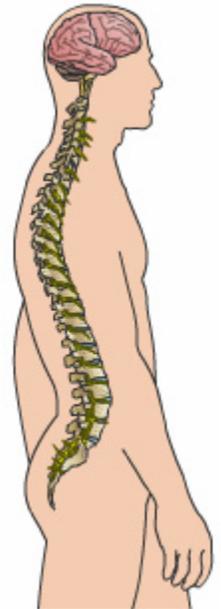
The brain is the command center of the body. In addition to thinking and feeling, it receives information and sends orders to different parts of the body. Orders from the brain travel through the spinal cord. From the spinal cord, orders travel to the rest of the body through peripheral nerves. Together, the brain and spinal cord are called the “central nervous system.” The nerves in the rest of the body are called the “peripheral nervous system.”

Different areas of the brain control different functions. For example, specific areas of the brain control vision, motions, touch, hearing, and thinking.

Like other tissue in the body, the brain is made of cells. The cells of the brain and nerves are called *neurons*. Each neuron has a body and an axon.

Axons are long fibers that are similar to electrical wires. Though neurons are microscopic, the axons can extend from the brain to the hand!

Neurons communicate with each other by sending electrical signals through the axons. For instance, a nerve in the finger may sense heat, and send the message to the brain through axons. The brain would then send



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orders to the muscles to move the finger. Voluntary muscles are directly controlled by nerves, which receive orders from the brain.

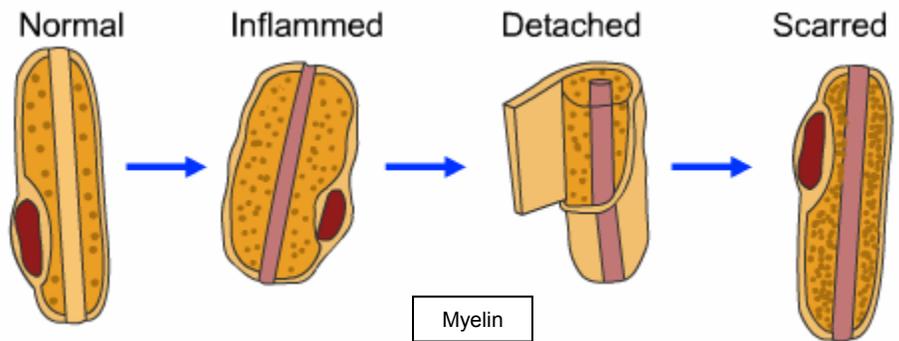
A special material called myelin covers axons. Myelin improves the conduction of the electric current and communication between neurons. In multiple sclerosis, the myelin in certain parts of the brain, spinal cord, or central nervous system is destroyed. Scientists currently do not know why this myelin is destroyed.

### Multiple Sclerosis

It is then destroyed, forming a scar over the axons.

*Sclerosis* means scar.

When myelin is destroyed, the neurons communicate less effectively, causing the symptoms of multiple sclerosis. For instance, if the myelin of vision neurons is destroyed, vision is affected. If the myelin of muscle neurons is destroyed, the muscle becomes weak.



Some myelin destruction repairs itself, which is why most people improve after an attack of MS. However, myelin can become inflamed again at different times and in different places.

There are two types of multiple sclerosis. The most common type is relapsing remitting MS, which affects 85% of patients with MS. It is characterized by periods of worsening symptoms followed by periods of improvement.

The other type is called progressive MS, meaning that the disease keeps on getting worse without any improvement. About 60% of the patients with the first type of relapsing remitting MS end up having the progressive type within 15 years if they are not treated.

Multiple sclerosis usually appears in Caucasian people between the ages of 15 and 60. Women are affected two to three times as often as men.

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People who live in temperate climates are more likely to develop MS than those living in tropical areas. Mild climates include the northern United States, Canada, and Europe.

## Causes

Scientists do not know what causes the destruction of myelin in multiple sclerosis. Some scientists believe that cells of the immune system attack the myelin in the central nervous system.

The immune system usually attacks germs and foreign bodies. Cells of the immune system may be attacking myelin in MS because they mistake it for a foreign, harmful material. This type of disease is called an autoimmune disease. Some researchers think that after certain types of viral infections, the immune system starts attacking the myelin of the central nervous system as if it were the virus.



There may also be genetic causes of MS because certain populations are more or less susceptible to it. For example, Native Americans have a very low incidence of it. This leads to the idea that MS may be partially hereditary.

In studies of identical twins, only about 30% of twins of patients with MS developed MS. This shows that even though there is a genetic component, this component is not the only reason for developing MS.

## Signs & Symptoms

Symptoms of MS depend on the area of the central nervous system that loses myelin. Early symptoms may include:

- numbness or tingling in parts of the body, usually the leg or arm
- unexplained weakness, dizziness, and fatigue
- double vision, blurry vision, or blindness



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During periods of remission, the patient may feel better, but the arm or leg may feel stiff.

Some weakness, numbness, and vision problems may remain.

As the symptoms come back, they may become more severe and include:

- muscle spasms
- bowel and bladder problems
- slurred speech
- blindness
- sexual problems
- paralysis
- confusion and forgetfulness

Pain can also be a symptom of MS, it can involve the face or one of the extremities.

In some patients, heat seems to make symptoms worse. Such patients should avoid long hot baths or being outside too long on hot days.

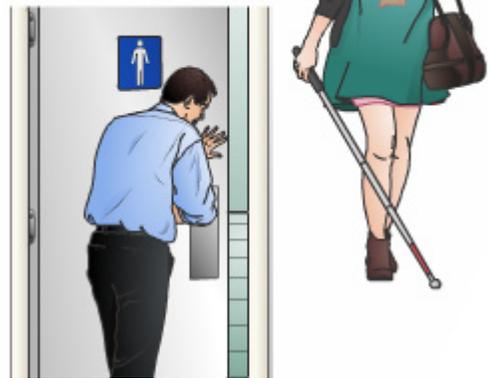
The symptoms of MS can be found in other diseases. This means that not all patients with the symptoms of MS have MS.

## Diagnosis

Physical examination and medical history are very important in diagnosing MS. Physical exams include a variety of tests to check the health of the nerves and muscles. A diagnosis of MS relies primarily on seeing patches of destroyed myelin on a magnetic resonance imaging (MRI) scan. As the doctor tracks the progress of the disease, multiple MRIs may need to be done.



MRIs also help make sure that the patient is not suffering from other diseases that have symptoms similar to MS, such as brain tumors and disk herniations in the neck or lower back.



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Spinal fluid may be taken from the back to test for abnormalities. Other tests aim at measuring the speed of the brain connections. For example, the Visual Evoked Response test measures the speed of the visual pathway. The Brain Stem Evoked Response test measures the speed of the auditory, or hearing, pathways.

Your doctor may ask for other tests to determine if diseases other than MS are causing symptoms similar to those of MS. For example, some vitamin deficiencies have early symptoms that resemble those of MS.

## Treatment

Scientists have not discovered a cure for MS yet. However, several medications are available to help control the disease. Doctors and scientists are constantly finding out new things about MS and about how to treat and manage it. The specific treatment recommendations for each patient with MS depend on the patient's condition, his or her type of MS, how debilitating it is and how progressive it is.

For patients who find out that they have MS unexpectedly after an MRI, when they've had no recent symptoms or active disease, treatment may not be necessary. However, these patients should be watched closely just in case the MS flares up. Patients with ongoing flare ups and symptoms may be prescribed a variety of medications to control the progress of MS. Such medications may reduce the severity of the symptoms or decrease how often they occur.



Special chemicals that help regulate the immune system can be used to treat MS. These are known as Beta interferons.

These formulations have been approved by the FDA:

- Betaseron<sup>®</sup>
- Avonex<sup>®</sup>
- Rebif<sup>®</sup>
- Extavia<sup>®</sup>
- Plegridy<sup>®</sup>

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Beta interferon has been shown to reduce the number of exacerbations and may slow the progression of physical disability. When attacks do occur, they tend to be shorter and less severe.

These medications are given by injection under the skin or into a large muscle. They are usually injected one or more times a week. Plegridy is injected every two weeks.

The side effects of these interferons include: symptoms of cold, depression, increase in spasticity, and possible abnormalities in liver function tests or blood counts.

Fingolimod (Gilenya®) is an immunosuppressive medication taken by mouth. It was shown to reduce MS attacks and decrease disability. However, it has some potentially dangerous side effects, such as a slow heart rate, vision and liver problems, among others. Strict follow up and supervision by a healthcare provider is a must.



Aubagio® (teriflunomide) and Tecfidera® (dimethyl fumarate) are medications taken by mouth that reduce inflammation and affect the activity of the immune system.

Ask your healthcare provider for more information about possible side effects and risks of these medications.

The FDA also has approved a synthetic form of myelin basic protein, called copolymer I (Copaxone® or Glatopa™), for the treatment of relapsing-remitting MS. Copolymer I has few side effects, and studies indicate that the agent can reduce the relapse rate by almost one third.

Novantrone® (mitoxantrone) is an anticancer drug that weakens the immune system. By weakening the immune system it decreases the symptoms of MS. It is given intravenously once every three months. It is very well tolerated except for some nausea and vomiting that can be treated at the time of the injection. One of its side effects is possible damage to the heart. This occurs after a certain dosage of the medication has been given. Most patients can take it safely for up to two years.



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Other anticancer medications have been tried. These include cyclosporine (Sandimmune<sup>®</sup>), cyclophosphamide (Cytoxan<sup>®</sup>), methotrexate and azathioprine (Imuran<sup>®</sup>). Bone marrow transplant is also being studied as a treatment for MS.

The FDA has also approved dalfampridine (Ampyra<sup>®</sup>) to improve walking in individuals with MS. One monoclonal antibody, natalizumab (Tysabri<sup>®</sup>), was shown in clinical trials to significantly reduce the frequency of attacks in people with relapsing forms of MS and was approved for marketing by the U.S. Food and Drug Administration (FDA) in 2004. However, in 2005 the drug's manufacturer voluntarily suspended marketing of the drug after several reports of significant adverse events. In 2006, the FDA again approved sale of the drug for MS but under strict treatment guidelines involving infusion centers where patients can be monitored by specially trained physicians.

Steroids, given either orally or intravenously, can help decrease the severity of an attack. It is not known whether they can help a patient have fewer attacks or not. Steroids sometimes used include methylprednisolone, prednisone and ACTH.

There are a lot of ways to treat MS and the treatment methods change all the time as we keep learning more. This is why it is very important to check with your physicians frequently about any new developments in this ever evolving and thankfully improving field. Many clinical trials are under way to help patients who need better control of their MS.



Researchers are currently studying stem cell therapies to slow disease activity and repair existing damage to the nervous system. Ask your healthcare provider for more information on stem cell research.

Other medications aim at improving neurological problems. For example, medication can be used to decrease the stiffness of the muscles. These include:

- Baclofen (Lioresal<sup>®</sup>)
- Tizanidine (Zanaflex<sup>®</sup>)
- Diazepam (Valium<sup>®</sup>)
- Clonazepam (Klonopin<sup>®</sup>)
- Dantrolene (Dantrium<sup>®</sup>)

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Physical therapy and exercise can help preserve remaining function, and patients may find that various aids -- such as foot braces, canes, and walkers -- can help them remain independent and mobile.

Avoiding excessive activity and avoiding heat are probably the most important measures patients can take to counter physiological fatigue. If psychological symptoms of fatigue such as depression or apathy are evident, antidepressant medications may help.



Other drugs that may reduce fatigue in some, but not all, patients include amantadine (Symmetrel<sup>®</sup>), pemoline (Cylert<sup>®</sup>).

Although improvement of optic symptoms usually occurs even without treatment, a short course of treatment with intravenous methylprednisolone (Solu-Medrol<sup>®</sup>) followed by treatment with oral steroids is sometimes used.

Adopting healthy life habits helps MS patients cope with fatigue and potential stress caused by MS. These habits include:

- getting enough rest
- exercising regularly
- eating a healthy, balanced diet with lots of fiber
- relaxation and reducing stress in your life



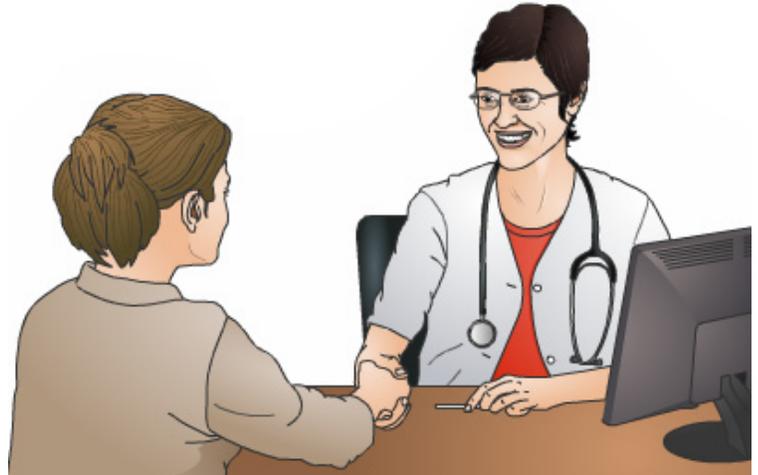
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## Summary

Multiple sclerosis is a disease of the brain and spinal cord. It can be debilitating, however, most people with MS are able to lead normal, active lives and pursue their hobbies. If you have symptoms of MS, such as numbness or tingling in any part of your body, check with your doctor.

Other symptoms of MS include double vision, blindness, muscle tremor, fatigue, and dizziness. MS can be treated with medication. Some cases of MS are benign and only need to be observed without any treatment. Keeping healthy life habits and staying connected with friends and family are great ways to cope with multiple sclerosis and limit the fatigue and stress it may place on the body.



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