



Meningitis and Encephalitis

U.S. DEPARTMENT OF HEALTH
AND HUMAN SERVICES
National Institutes of Health

Meningitis and Encephalitis

What is meningitis?

What is encephalitis?

Infections and other disorders affecting the brain and spinal cord can activate the immune system, which leads to inflammation. These diseases, and the resulting inflammation, can produce a wide range of symptoms, including fever, headache, seizures, and changes in behavior or confusion. In extreme cases, these can cause brain damage, stroke, or even death.

Inflammation of the meninges, the membranes that surround the brain and spinal cord, is called *meningitis*; inflammation of the brain itself is called *encephalitis*. *Myelitis* refers to inflammation of the spinal cord. When both the brain and the spinal cord are involved, the condition is called *encephalomyelitis*.

What are the signs and symptoms?

The hallmark signs of meningitis include some or all of the following: sudden fever, severe headache, nausea or vomiting, double vision, drowsiness, sensitivity to bright light, and a stiff neck.

Meningitis often appears with flu-like symptoms that develop over 1-2 days. Distinctive rashes are typically seen in some forms of the disease. Meningococcal meningitis may be associated with bleeding into the skin (called purpura and seen when the bacteria spread through the bloodstream), or kidney and adrenal gland failure and shock.

Encephalitis can be characterized by fever, seizures, change in behavior, and confusion and disorientation. Related neurological signs depend on which part of the brain is affected by the encephalitic process as some of these are quite localized while others are more widespread. Individuals with encephalitis often show mild flu-like symptoms. In more severe cases, people may experience problems with speech or hearing, double vision, hallucinations, personality changes, and loss of consciousness. Other severe complications include loss of sensation in some parts of the body, muscle weakness, partial paralysis in the arms and legs, impaired judgment, seizures, and memory loss.

Important signs of meningitis or encephalitis to watch for in an infant include fever, lethargy, not waking for feedings, vomiting, body stiffness, unexplained/unusual irritability, and a full or bulging fontanel (the soft spot on the top of the head).

What causes meningitis and encephalitis?

Infectious causes of meningitis and encephalitis include bacteria, viruses, fungi, and parasites. For some individuals, environmental exposure (such as a parasite), recent travel, or immunocompromised state (such as HIV, diabetes, steroids, chemotherapy treatment) are important risk factors. There are also non-infectious causes such as autoimmune/rheumatological diseases and certain medications.

Some forms of bacterial meningitis and encephalitis are contagious and can be spread through contact with saliva, nasal discharge, feces, or respiratory and throat secretions (often spread through kissing, coughing, or sharing drinking glasses, eating utensils, or such personal items as toothbrushes, lipstick, or cigarettes). For example, people sharing a household, at a day care center, in a classroom, or those residing in a dormitory with an infected person can become infected. Children who have not been given routine vaccines are at increased risk of developing certain types of bacterial meningitis.

Because these diseases can occur suddenly and progress rapidly, anyone who is suspected of having either meningitis or encephalitis should immediately contact a doctor or go to the hospital.

Meningitis

Bacterial meningitis is a rare but potentially fatal disease. Several types of bacteria can first cause an upper respiratory tract infection and then travel through the bloodstream to the brain. The disease also can occur when certain bacteria invade the meninges directly. Bacterial meningitis can cause stroke, hearing loss, and permanent brain damage.

- Pneumococcal meningitis is the most common form of meningitis and is the most serious form of bacterial meningitis. Some 6,000 cases of pneumococcal meningitis are reported in the United States each year. The disease is caused by the bacterium *Streptococcus pneumoniae*, which also causes pneumonia, blood poisoning (septicemia), and ear and sinus infections. At particular risk are children under age 12 and adults with a weakened immune system. People who have had pneumococcal meningitis often suffer neurological damage ranging from deafness to severe brain damage.
- Meningococcal meningitis is caused by the bacterium *Neisseria meningitidis*. Each year in the United States about 2,600 people get this highly contagious disease. High-risk groups include infants under the age of 1 year, people with suppressed immune systems, travelers to foreign countries where the disease is endemic, and military recruits and others who reside in dormitories. Between 10-15 percent of cases are fatal, with another 10-15 percent causing brain damage and other serious side effects.

- *Haemophilus influenzae meningitis* was at one time the most common form of bacterial meningitis. Fortunately, the *Haemophilus influenzae b* vaccine has greatly reduced the number of cases in the United States (see Treatment section). Those most at risk of getting this disease are children in child-care settings and children who do not have access to this vaccine.

Other forms of bacterial meningitis include *Listeria monocytogenes meningitis* (in which certain foods such as unpasteurized dairy or deli meats are sometimes implicated); *Escherichia coli meningitis*, which is most common in elderly adults and newborns and may be transmitted to a baby through the birth canal; and *Mycobacterium tuberculosis meningitis*, a rare disease that occurs when the bacterium that causes tuberculosis attacks the meninges.

Viral, or aseptic, meningitis is usually caused by enteroviruses—common viruses that enter the body through the mouth and travel to the brain and surrounding tissues where they multiply. Enteroviruses are present in mucus, saliva, and feces, and can be transmitted through direct contact with an infected person or an infected object or surface. Other viruses that cause meningitis include *Varicella zoster* (the virus that causes chicken pox and can appear decades later as shingles), influenza, mumps, HIV, and *Herpes simplex type 2* (genital herpes).

Fungal infections can affect the brain. The most common form of fungal meningitis is caused by the fungus *Cryptococcus neoformans* (found mainly in dirt and bird droppings).

It can be slow to develop and smolder for weeks. Although treatable, fungal meningitis often recurs in nearly half of affected persons.

Parasitic causes include cysticercosis (a tapeworm infection in the brain), which is common in other parts of the world, as well as cerebral malaria.

There are rare cases of amoebic meningitis, sometimes related to fresh water swimming, which can be rapidly fatal.

Encephalitis

Encephalitis, usually viral, can be caused by some of the same infections listed above. However, up to 60 percent of cases remain undiagnosed. Several thousand cases of encephalitis are reported each year, but many more may occur since the symptoms may be mild to non-existent in most individuals.

Most diagnosed cases of encephalitis in the United States are caused by *Herpes simplex* virus types 1 and 2, arboviruses (such as West Nile Virus), which are transmitted from infected animals to humans through the bite of an infected tick, mosquito, or other blood-sucking insect, or enteroviruses. Lyme disease, a bacterial infection spread by tick bite, occasionally causes meningitis, and very rarely encephalitis. Rabies virus, which is transmitted by bites of rabid animals, is an extremely rare cause of human encephalitis.

Herpes simplex encephalitis (HSE) is responsible for about 10 percent of all encephalitis cases, with a frequency of about

2 cases per million persons per year. More than half of untreated cases are fatal. About 30 percent of cases result from the initial infection with the *Herpes simplex* virus; the majority of cases are caused by reactivation of an earlier infection. Most people acquire *Herpes simplex* virus type 1 (the cause of cold sores or fever blisters) in childhood.

HSE due to *Herpes simplex* virus type 1 can affect any age group but is most often seen in persons under age 20 or over age 40. This rapidly progressing disease is the single most important cause of fatal sporadic encephalitis in the United States. Symptoms can include headache and fever for up to 5 days, followed by personality and behavioral changes, seizures, hallucinations, and altered levels of consciousness. Brain damage in adults and in children beyond the first month of life is usually seen in the frontal lobes (leading to behavioral and personality changes) and temporal lobes (leading to memory and speech problems) and can be severe.

Four common forms of mosquito-transmitted viral encephalitis are seen in the United States:

- **Equine encephalitis** affects horses and humans.
 - *Eastern equine encephalitis* is extremely rare and has been seen in areas bordering the eastern U.S. coast and along the Gulf Coast. Symptoms are seen 4-10 days following transmission and include sudden fever, general flu-like muscle pains, and headache of increasing severity, followed by coma and death in severe cases.

- *Western equine encephalitis* is seen in farming areas in the western and central plains states. Symptoms begin 5-10 days following infection. Children, particularly those under 12 months of age, are affected more severely than adults and may have permanent neurologic damage.
- **LaCrosse encephalitis** occurs most often in the upper midwestern states (Illinois, Wisconsin, Indiana, Ohio, Minnesota, and Iowa). Most cases are seen in children under age 16. Symptoms such as vomiting, headache, fever, and lethargy appear 5-10 days following infection. Severe complications include seizures, coma, and permanent neurologic damage.
- **St. Louis encephalitis** is most prevalent in temperate regions of the United States but can occur throughout most of the country. The disease is generally milder in children than in adults, with elderly adults at highest risk of severe disease or death. Symptoms typically appear 7-10 days following infection and include headache and fever. In more severe cases, confusion and disorientation, tremors, convulsions (especially in the very young), and coma may occur.
- **West Nile encephalitis** is usually transmitted by a bite from an infected mosquito but also can occur after transplantation of an infected organ or transfusions of infected blood or blood products. Symptoms are flu-like and include fever, headache, and joint pain. Some individuals may develop a skin rash

and swollen lymph glands, while others may not show any symptoms. At highest risk are older adults and people with weakened immune systems.

Powassan encephalitis is rare but is the only well-documented tick-borne arbovirus in the United States and Canada. Symptoms appear 7-10 days following the bite (most people do not notice tick bites) and may include headache, fever, nausea, confusion, partial paralysis, coma, and seizures.

It is also possible to develop encephalitis that has non-infectious or autoimmune causes. Some cases are caused by an autoimmune disorder that may in some instances be triggered by a recent infection that is no longer active (“post infectious”) or by a cancer—even one that is microscopic and cannot be found (so-called paraneoplastic neurological syndromes).

How are meningitis and encephalitis diagnosed?

Following a physical exam and medical history to review activities of the past several days or weeks (such as recent exposure to insects, ticks or animals, any contact with ill persons, or recent travel; preexisting medical conditions and medications), the doctor may order various diagnostic tests to confirm the presence of infection or inflammation. Early diagnosis is vital, as symptoms can appear suddenly and escalate to brain damage, hearing and/or speech loss, blindness, or even death.

Diagnostic tests include:

- *A neurological examination* to assess motor and sensory function, nerve function, hearing and speech, vision, coordination and balance, mental status, and changes in mood or behavior.
- *Laboratory screening of blood, urine, and body secretions* to detect and identify brain and/or spinal cord infection and determine the presence of antibodies and foreign proteins. Such tests can also rule out metabolic conditions that may have similar symptoms.
- *Analysis of the cerebrospinal fluid* that surrounds and protects the brain and spinal cord to detect infections, inflammation, and other diseases.
- *Brain imaging* using computed tomography and magnetic resonance imaging can reveal signs of brain inflammation, internal bleeding or hemorrhage, or other brain abnormalities.
- *Electroencephalography*, or EEG, which monitors electrical activity in the brain noninvasively through the skull, can help diagnose patterns that may suggest specific viral infections such as herpes virus and detect seizures.

How are these infections treated?

People who are suspected of having meningitis or encephalitis should receive immediate, aggressive medical treatment. Both diseases can progress quickly and have the potential to cause severe, irreversible neurological damage.

Meningitis

Effective vaccines are available to prevent *Haemophilus influenzae*, pneumococcal and meningococcal meningitis.

Two types of vaccines are available in the United States to help prevent meningococcal meningitis. The Centers for Disease Control and Prevention recommends vaccination with a meningococcal conjugate vaccine for all preteens and teens ages 11 to 12 years, with a booster dose at 16 years old. Teens and young adults (ages 16 through 23) also may be vaccinated with a serogroup B meningococcal vaccine. If meningococcal meningitis is diagnosed, people in close contact with an infected individual should be given preventative antibiotics.

Early treatment of bacterial meningitis involves antibiotics that can cross the blood-brain barrier (a lining of cells that keeps harmful micro-organisms and chemicals from entering the brain). Appropriate antibiotic treatment for most types of meningitis can greatly reduce the risk of dying from the disease. Anticonvulsants to prevent seizures and corticosteroids to reduce brain inflammation may be prescribed.

Infected sinuses may need to be drained. Corticosteroids such as prednisone may be ordered to relieve brain pressure and swelling and to prevent hearing loss that is common in some forms of meningitis. Lyme disease, a bacterial infection, is treated with antibiotics. meningitis is rarely life threatening and no specific treatment is needed. Fungal meningitis is treated with intravenous antifungal medications.

Encephalitis

Antiviral drugs used to treat viral encephalitis include acyclovir and ganciclovir. For most encephalitis-causing viruses, no specific treatment is available.

Autoimmune causes of encephalitis are treated with additional immunosuppressant drugs and screening for underlying tumors when appropriate. Acute disseminated encephalomyelitis, a non-infectious inflammatory brain disease mostly seen in children, is treated with steroids.

Anticonvulsants may be prescribed to stop or prevent seizures. Corticosteroids can reduce brain swelling. Affected individuals with breathing difficulties may require artificial respiration.

Once the acute illness is under control, comprehensive rehabilitation should include cognitive rehabilitation and physical, speech, and occupational therapy.

Can meningitis and encephalitis be prevented?

Effective vaccines are available to prevent some forms of meningitis.

People should avoid sharing food, utensils, glasses, and other objects with someone who may be exposed to or have the infection. People should wash their hands often with soap and rinse under running water.

People who live, work, or go to school with someone who has been diagnosed with bacterial meningitis may be asked to take antibiotics for a few days as a preventive measure.

Also, people should limit outdoor activities at night, wear long-sleeved clothing when outdoors, use insect repellents that are most effective for that particular region of the country, and rid lawn and outdoor areas of free-standing pools of water, in which mosquitoes breed.

What is the prognosis for these infections?

Outcome generally depends on the particular infectious agent involved, the severity of the illness, and how quickly treatment is given. In most cases, people with very mild encephalitis or meningitis can make a full recovery, although the process may be slow.

Individuals who experience only headache, fever, and stiff neck may recover in 2-4 weeks. Individuals with bacterial meningitis typically show some relief 48-72 hours following initial treatment but are more likely to experience complications caused by the disease. In more serious cases, these diseases can cause hearing and/or speech loss, blindness, permanent brain and nerve damage, behavioral changes, cognitive disabilities, lack of muscle control, seizures, and memory loss. These individuals may need long-term therapy, medication, and supportive care.

The recovery from encephalitis is variable depending on the cause of the disease and extent of brain inflammation.

What research is being done?

The mission of the National Institute of Neurological Disorders and Stroke (NINDS) is to seek fundamental knowledge about the brain and nervous system and to use that knowledge to reduce the burden of neurological disease. The NINDS is a component of the National Institutes of Health (NIH), the leading supporter of biomedical research in the world.

Current research efforts include basic studies of host immune responses, gaining a better understanding of how the central nervous system responds to inflammation, and the role of T cells (blood cells involved in immune system response) in suppressing infection in the brain. Scientists hope to better understand the molecular mechanisms involved in the protection and disruption of the blood-brain barrier, which could lead to the development of new treatments for several neuroinflammatory diseases such as meningitis and encephalitis. Other scientists hope to define, at a molecular level, how certain viruses overcome the body's defense mechanisms and interact with target host cells. A possible therapeutic approach under investigation involves testing neuroprotective compounds that block the damage that may follow infection and inflammation of meningitis and encephalitis and potentially lead to complications, including loss of cognitive function and dementia. Additional research focuses on autoimmune causes of encephalitis and the optimal treatments for them.

Where can I get more information?

For more information on neurological disorders or research programs funded by the National Institute of Neurological Disorders and Stroke, contact the Institute's Brain Resources and Information Network (BRAIN) at:

BRAIN

P.O. Box 5801
Bethesda, MD 20824
800-352-9424
www.ninds.nih.gov

Information also is available from the following organizations:

Meningitis Foundation of America, Inc.

P.O. Box 1818
El Mirage, AZ 85335
480-270-2652
800-668-1129
www.musa.org

National Meningitis Association

P.O. Box 60143
Ft. Myers, FL 33906
866-366-3662
www.nmaus.org

HHV-6 Foundation

1482 East Valley Road, Suite 619
Santa Barbara, CA 93108
888-530-6726
www.hhv-6foundation.org

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800-232-4636
www.cdc.gov

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