

Meningitis and Encephalitis

Causes and Treatment

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The contents of this course are taken from the National Institute of Neurological Disorders and Stroke. Learning objectives and post test have been prepared by Dr. Ratnakar P. Kini.

Upon completion of this course, the learner will be able to:

1. Define what meningitis is
2. Define what encephalitis is?
3. Enumerate and explain the causes of meningitis and encephalitis
4. Discuss their risk factors and mode of transmission for each of the disease
5. Explain their signs and symptoms
6. Discuss their diagnosis, treatment, outcome and prevention
7. Discuss the research done in meningitis and encephalitis

What is meningitis? What is encephalitis?

Infections in the brain and spinal cord can cause dangerous inflammation. This inflammation can produce a wide range of symptoms, including fever, headache, or confusion and, in extreme cases, can cause brain damage, stroke, seizures, or even death.

Infection of the meninges, the membranes that surround the brain and spinal cord, is called meningitis and inflammation of the brain itself is called *encephalitis*. *Myelitis* is an infection of the spinal cord. When both the brain and the spinal cord become inflamed, the condition is called *encephalomyelitis*.

What causes meningitis and encephalitis?

Meningitis and encephalitis are usually caused by viruses or bacteria. Most often, the body's immune system is able to contain and defeat an infection. But if the infection passes into the blood stream and then into the cerebrospinal fluid that surrounds the brain and spinal cord, it can affect the nerves and travel to the brain and/or surrounding membranes, causing inflammation. This swelling can harm or destroy nerve cells and cause bleeding in the brain.

Meningitis

Meningitis is most often caused by a bacterial or viral infection. It also may be caused by a fungal infection, a reaction to certain medications or medical treatments, an inflammatory disease such as lupus, some types of cancer, or a traumatic injury to the head or spine.

Bacterial meningitis is a rare but potentially fatal disease. It can be caused by several types of bacteria that first cause an upper respiratory tract infection and then travel through the blood stream to the brain. The disease can also occur when certain bacteria invade the meninges directly. The disease can block blood vessels in the brain, causing stroke 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 2 and adults with a weakened or depressed immune system. Persons who have had pneumococcal meningitis often suffer neurological damage ranging from deafness to severe brain damage.

Meningococcal meningitis, which is caused by the bacterium *Neisseria meningitides*, is common in children ages 2-18. 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 college students (freshmen in particular) who reside in dormitories. Between 10 and 15 percent of cases are fatal, with another 10-15 percent causing brain damage and other serious side effects.

Haemophilus 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. Those most at risk of getting this disease are children in child-care settings and children who do not have access to the vaccine.

Other forms of bacterial meningitis include *Listeria monocytogenes meningitis*, which can cross the placental barrier and cause a baby to be stillborn or die shortly after birth; *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 the most common form of meningitis in the United States. This typically mild and non-lethal disease 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).

Many 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). Cryptococcal meningitis is common in AIDS patients. Although treatable, fungal meningitis often recurs in nearly half of affected persons.

Encephalitis

Encephalitis can be caused by bacterial infection and, most often, viral infections. Several thousand cases of encephalitis are reported each year, but many more may actually occur since the symptoms may be mild to non-existent in most patients.

There are two types of encephalitis. *Primary encephalitis* (also called acute viral encephalitis) is caused by a direct viral infection of the spinal cord and brain. The infection may be focal (located in only one area) or diffuse (located in many different areas). *Secondary encephalitis*, also known as post-infective encephalitis, can result from complications of a current viral infection. Secondary encephalitis that results from an immunization or earlier viral infection is known as acute disseminated encephalitis. This illness often occurs 2 to 3 weeks following the initial infection.

Most cases of encephalitis in the United States are caused by enteroviruses, herpes simplex virus types 1 and 2, a bite from a rabid animal (rabies virus), or arboviruses, which are transmitted from infected animals to humans through the bite of an infected tick, mosquito, or other blood-sucking insect. Lyme disease, a bacterial infection spread by tick bite, can cause 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.

HSE due to herpes simplex virus type 1 (which causes cold sores or blisters around the mouth or eyes) 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 U.S. The virus is transmitted through contact with an infected person. Symptoms include headache and fever for up to 5 days, followed by personality and behavioral changes, seizures, partial paralysis, hallucinations, and altered levels of consciousness. Brain damage in adults and in children beyond the neonatal period is usually seen in the frontal and temporal lobes and can be severe.

Type 2 virus (genital herpes) is most often transmitted through sexual contact. An infected mother can transmit the disease to her child at birth, through contact with genital

secretions, but this is uncommon. In newborns, symptoms such as lethargy, irritability, tremors, seizures, and poor feeding generally develop between 4 and 11 days after delivery.

Powassan encephalitis is the only well-documented tick-borne arbovirus in the United States and Canada. Symptoms are noticed 7-10 days following the bite and may include headache, fever, nausea, confusion, partial paralysis, and coma. Permanent neurologic damage occurs in about half of all cases and death in about 10-15 percent of all cases.

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

- **Equine encephalitis** affects horses and humans. *Eastern equine encephalitis* also infects birds that live in freshwater swamps of the eastern U.S. seaboard and along the Gulf Coast. In humans, 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. About half of infected patients die from the disorder. Fewer than 10 human cases are seen annually in the United States. *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. Death occurs in about 3 percent of cases. *Venezuelan equine encephalitis* is very rare in this country. Children are at greatest risk of developing severe complications, while adults generally develop flu-like symptoms. Epidemics in South and Central America have killed thousands of persons and left others with permanent, severe neurologic damage.
- **LaCrosse encephalitis** occurs most often in the upper midwestern states (Illinois, Wisconsin, Indiana, Ohio, Minnesota, and Iowa) but also has been reported in the southeastern and mid-Atlantic regions of the country. 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 seizure, coma, and permanent neurologic damage. About 100 cases of LaCrosse encephalitis are reported each year.
- **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** was first clinically diagnosed in the United States in 1999; 284 people are known to have died of the virus the following year. There were 9,862 reported cases of human West Nile disease in calendar year 2003, with a total of 560 deaths from this disorder over 5 years. The disease is usually transmitted by a bite from an infected mosquito, but can also 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 patients may develop a skin rash and swollen lymph glands, while others may not show any symptoms. At highest risk are elderly adults and people with weakened immune systems.

Who is at risk for encephalitis and meningitis?

Anyone can get encephalitis or meningitis. People with weakened immune systems, including those persons with HIV or those taking immunosuppressant drugs, are at the highest risk of contracting the diseases.

How are these disorders transmitted?

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, or in a classroom with an infected person can become infected. College students living in dormitories—in particular, college freshmen—have a higher risk of contracting meningococcal meningitis than college students overall. Children who do not have access to childhood vaccines are at increased risk of developing certain types of bacterial meningitis.

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

What are the signs and symptoms?

The hallmark signs of meningitis are sudden fever, severe headache, and a stiff neck; encephalitis is characterized by seizures, stupor, coma, and related neurological signs. In more severe cases, neurological symptoms may include nausea and vomiting, confusion and disorientation, drowsiness, sensitivity to bright light, and poor appetite.

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 kidney and adrenal gland failure and shock.

Patients with encephalitis often show mild flu-like symptoms. In more severe cases, patients may experience problems with speech or hearing, double vision, hallucinations, personality changes, loss of consciousness, loss of sensation in some parts of the body, muscle weakness, partial paralysis in the arms and legs, sudden severe dementia, impaired judgment, seizures, and memory loss.

Important signs of encephalitis to watch for in an infant include vomiting, body stiffness, constant crying that may become worse when the child is picked up, and a full or bulging fontanel (the soft spot on the top of the head).

How are meningitis and encephalitis diagnosed?

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

A neurological examination involves a series of tests designed to assess motor and sensory function, nerve function, hearing and speech, vision, coordination and balance, mental status, and changes in mood or behavior. Doctors may test the function of the nervous system through tests of strength and sensation, with the aid of items including a tuning fork, small light, reflex hammer, and pins.

Laboratory screening of blood, urine, and body secretions can help 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 have similar symptoms. For example, a *throat culture* may be taken to check for viral or bacterial organisms that cause meningitis or encephalitis. In this procedure, the back of the throat is wiped with a sterile cotton swab, which is then placed on a culture medium. Viruses and bacteria are then allowed to grow on the medium. Samples are usually taken in the physician's office or in a laboratory setting and sent out for analysis to state laboratories or to the U.S. Centers for Disease Control and Prevention. Results are usually available in 2 to 3 days.

Analysis of the cerebrospinal fluid that surrounds and protects the brain and spinal cord can detect infections in the brain and/or spinal cord, acute and chronic inflammation, and other diseases. In a procedure known as a spinal tap (or lumbar puncture), a small amount of cerebrospinal fluid is removed by a special needle that is inserted into the lower back. The skin is anesthetized with a local anesthetic prior to the sampling. The fluid, which is completely clear in healthy people, is tested to detect the presence of bacteria or blood, as well as to measure glucose levels (a low glucose level is a sign of bacterial or fungal meningitis) and white blood cells (elevated white blood cell counts are also a sign of infection). The procedure is usually done in a hospital and takes about 45 minutes.

Computer-assisted imaging can reveal signs of brain inflammation, internal bleeding or hemorrhage, or other brain abnormalities. Two painless, noninvasive imaging procedures are routinely used to diagnose meningitis and encephalitis.

- *Computed tomography*, also known as a CT scan, combines x-rays and computer technology to produce rapid, clear, two-dimensional images of organs, bones, and tissues. Occasionally a contrast dye is injected into the bloodstream to highlight the different tissues in the brain and to detect signs of encephalitis or inflammation of the meninges. CT scans can also detect bone and blood vessel irregularities, certain brain tumors and cysts, herniated discs, spinal stenosis (narrowing of the spinal canal), blood clots or intracranial bleeding in patients with stroke, brain damage from a head injury, and other disorders.

- *Magnetic resonance imaging (MRI)* uses computer-generated radio waves and a strong magnet to produce detailed images of body structures, including tissues, organs, bones, and nerves. The pictures, which are clearer than those produced by CT, can help identify brain and spinal cord inflammation, infection, tumors, eye disease, and blood vessel irregularities that may lead to stroke. A contrast dye may be injected prior to the test to reveal more detail.

Electroencephalography, or EEG, can identify abnormal brain waves by monitoring electrical activity in the brain through the skull. Among its many functions, EEG is used to help diagnose certain seizure disorders, brain damage from head injuries, specific viral infections such as herpes virus, and inflammation of the brain and/or spinal cord. This painless, risk-free test can be performed in a doctor's office or at a hospital or testing facility.

How are these infections treated?

Persons 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

Early treatment of bacterial meningitis is important to its outcome. Strong doses of general antibiotics may be prescribed first, followed by intravenous antibiotics in more severe cases. Antibiotics may also be given to prevent other bacterial infections. Appropriate antibiotic treatment for most types of meningitis can reduce the risk of dying from the disease to below 15 percent.

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 patients with *Haemophilus influenzae* meningitis. Pain medicine and sedatives may be given to make patients more comfortable. Lyme disease is treated with intravenous antibiotics.

Unlike bacteria, viruses cannot be killed by antibiotics (an exception is the herpes virus, which can be treated with the antiviral drug acyclovir). Patients with mild viral meningitis may be allowed to stay at home, while those who have a more serious infection may be hospitalized for supportive care. Patients with mild cases, which often cause only flu-like symptoms, may be treated with fluids, bed rest (preferably in a quiet, dark room), and analgesics for pain and fever. The physician may prescribe anticonvulsants such as dilantin or phenytoin to prevent seizures and corticosteroids to reduce brain inflammation. If inflammation is severe, pain medicine and sedatives may be prescribed to make the patient more comfortable.

Acute disseminated encephalomyelitis is treated with steroids. Fungal meningitis is treated with intravenous antifungal medications.

Encephalitis

Antiviral drugs used to treat viral encephalitis include acyclovir and ganciclovir.

Very mild cases of encephalitis may be monitored at home by the physician and a caregiver. Supportive care includes fluids, bed rest, and over-the-counter analgesics to reduce fever and headache. More severe cases may require hospitalization.

Anticonvulsants may be prescribed to stop or prevent seizures, along with sedatives to calm more severely infected persons and drugs to counter nausea and vomiting. Corticosteroids and intravenous administration of carbohydrate solutions can reduce brain swelling. Patients with breathing difficulties may require artificial respiration.

Patients who experience severe brain inflammation may need physical, speech, and occupational therapy once the acute illness is under control.

Can meningitis and encephalitis be prevented?

Good personal hygiene can reduce the risk of getting the disease from an infected person. Avoid sharing food, utensils, glasses, and other objects with a person who may be exposed to or have the infection. Wash hands often with soap and rinse under running water.

Effective vaccines are available to prevent pneumonia, H. influenza, pneumococcal meningitis, and infection with other bacteria that can cause meningococcal meningitis.

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.

To lessen the risk of being bitten by an infected mosquito or other insect, 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. Do not over-apply repellants, particularly on young children and especially infants, as chemicals may be absorbed through the skin.

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.

Patients who experience only headache, fever, and stiff neck may recover in 2-4 weeks. Patients receiving treatment for viral meningitis and encephalitis usually see some relief in 24-48 hours and recovery in about a month. Patients 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 patients may need long-term therapy, medication, and supportive care.

What research is being done?

The National Institute of Neurological Disorders and Stroke (NINDS), a component of the National Institutes of Health (NIH) within the U.S. Department of Health and Human Services, conducts and supports a wide range of research on neurological disorders, including meningitis and encephalitis. Current research efforts include investigating new chemotherapy-based treatment for neoplastic meningitis (caused by cancer) and 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 mechanism and interact with target host cells. A possible therapeutic approach under investigation involves testing neuroprotective compounds that block the damage that accumulates after the infection and inflammation of meningitis and encephalitis and can lead to potential complications including loss of cognitive function and dementia.

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
<http://www.ninds.nih.gov>

Information also is available from the following organizations:

Meningitis Foundation of America, Inc.
6610 Shadeland Station
Suite 200
Indianapolis, IN 46220
support@musa.org
<http://www.musa.org>
Tel: 800-668-1129 317-595-6395

National Meningitis Association
738 Robinson Farms Drive
Marietta, GA 30068
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<http://www.nmaus.org>
Tel: 866-FONE-NMA (366-3662)

Fax: 317-595-6370

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