

Meningitis

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REVIEW ARTICLE

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ABSTRACT

The term aseptic meningitis encompasses all types of inflammations of the brain meninges other than that caused by pus producing organisms. It is usually a mild illness. Etiology of aseptic meningitis is very wide and includes many infections - both viral and non viral, drugs, malignancy and systemic illness. The most common cause is viral infection and enteroviruses - Coxsackie and ECHO viruses account for more than half of all cases. Clinical manifestations include headache, fever, malaise, photophobia and meningeal signs. Convulsions, neurological deficits and severe obtundation are rare except with certain non viral infectious meningitis. Diagnostic work up includes blood and cerebrospinal fluid (CSF) examination and serology for infectious meningitis. The polymerase chain reaction is a rapid and accurate method for detection of microbial DNA in CSF. Treatment is mainly supportive, except for the nonviral infectious etiology.

Keywords: Meningitis, meninges, epidemiology, immunization

1. Introduction

Definition

Meningitis is the inflammation of the protective membranes covering the central nervous system, known collectively as the meninges.

Meningitis is an inflammation of the **meninges**, the membranes that cover the brain and spinal cord. The inflammation is usually caused by bacteria or viruses (viral meningitis is also called aseptic meningitis). Less common causes include fungi, protozoa, and other parasites. Sometimes certain medications, cancers, or other diseases can inflame the meninges.

Many of the bacteria or viruses that can cause meningitis are fairly common and are more often associated with other everyday illnesses. Sometimes, however, they spread to the meninges from an infection in another part of the body. The infection can start anywhere, including in the skin, gastrointestinal tract, or urinary system, but the most common source is the

respiratory tract. From there the microorganisms can enter the bloodstream, travel through the body, and enter the central nervous system. In some cases of bacterial meningitis, the bacteria spread directly to the meninges from a severe nearby infection, such as a serious ear infection (otitis media) or nasal sinus infection (sinusitis). Bacteria may also enter the central nervous system after severe head trauma or head surgery. (1)

History

Meningitis may have been described in the Middle Ages, but it was first accurately identified by the Swiss Vieusseux (a scientific-literary association), during an outbreak in Geneva, Switzerland in 1805.

In the 19th Century, meningitis was a scourge of the Japanese Imperial family, playing the largest role in the horrendous pre-maturity death rate the family endured. In the mid-1800s, only the Emperor Kōmei and two of his siblings reached maturity out of fifteen total children surviving birth. Kōmei's son, the Emperor Meiji, was one of two survivors out of Kōmei's six

children, including an elder brother of Meiji who would have taken the throne had he lived to maturity. Five of Meiji's fifteen children survived, including only his third son, Emperor Taishō, who was feeble-minded, perhaps as a result of having contracted meningitis himself. By Emperor Hirohito's generation the family was receiving modern medical attention. As the focal point of tradition in Japan, during the Tokugawa Shogunate the family was denied modern "Dutch" medical treatment then in use among the upper caste; despite extensive modernization during the Meiji Restoration the Emperor insisted on traditional medical care for his children.(2)

2. Treatment

Treatment for meningitis depends on the organism causing the infection, your

age, the extent of the infection, and the presence of other medical conditions or complications of meningitis.

Most people with viral meningitis usually start getting better within 3 days of feeling sick and recover within 2 weeks .However, it is important to see your health professional if symptoms of meningitis develop so that he or she can rule out bacterial meningitis, which is more serious. With mild cases of viral meningitis you may only need home treatment, including fluids to prevent dehydration and medication to control pain and fever. If you do not get better or if symptoms worsen, you may need further testing to check for other causes of illness.(3)

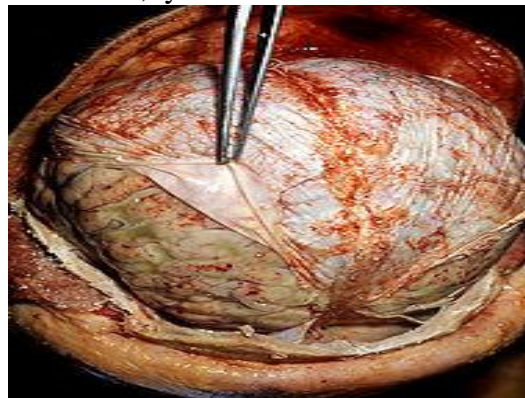


Figure 1. Acute infective meningitis

Anatomy of Brain

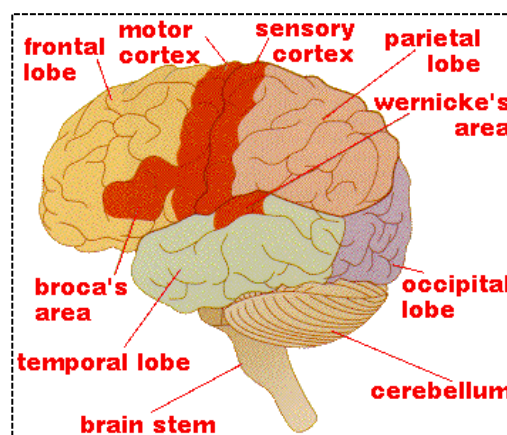


Figure 2. Anatomy of brain

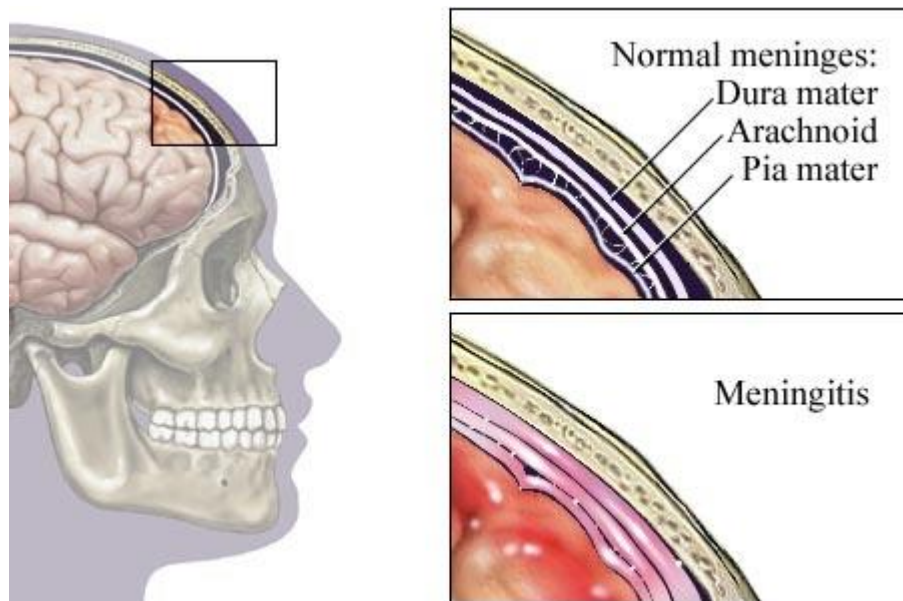


Figure 3. Meninges

3. Types of meningitis

The term meningitis does not refer to a specific disease but rather the symptom of inflammation of the tissues of the meninges. There are a number of different types of meningitis inflammation.

Aseptic meningitis: Aseptic meningitis is an illness characterized by serous inflammation of the linings of the brain (i.e., meninges), usually with an accompanying mononuclear pleocytosis. Clinical symptomatology is varied and includes predominantly headache and fever. The illness is usually mild and runs its course without treatment; however, some cases can be severe and life threatening.

Aseptic meningitis syndrome is not caused by pyogenic bacteria, but can be caused by multiple conditions including infectious viral and nonviral causes and many noninfectious etiologies. Hence, this term is no longer synonymous with viral meningitis, although the two often are used interchangeably. (4,5)

Bacterial meningitis: this is an inflammation of the meninges that is

caused by a bacterial infection. Dehydration is common as a result of vomiting. It is much more serious. It can cause severe disease that can result in brain damage and even death.

Cryptococcal meningitis: Cryptococcal meningitis is a brain infection caused by a fungus called *Cryptococcus neoformans*, which is found mainly in dirt and bird droppings. Many people have been exposed to the *Cryptococcus* fungus at some time during their lives, but the immune system usually stops the fungus from causing illness.

When the immune system is weakened by HIV, the fungus can cause illness. The most common illness caused by the *Cryptococcus* fungus is cryptococcal meningitis. Meningitis means swelling of the meninges. The meninges are membranes that cover the brain and spinal cord. Cryptococcal meningitis is a serious infection.

The symptoms can be similar to other conditions, but it is important to be aware of the possibility of cryptococcal meningitis. Watch for fever, vomiting,

headache, nausea, fatigue, loss of appetite, and a general feeling of not being well. Sometimes symptoms include a stiff neck and seizures. You may experience all or just a few of these symptoms

Infectious meningitis: this is a general term for meningitis. It is caused by infection by bacteria, viruses or protozoa. Most of the agents that cause meningitis are infectious but the majority of people are not susceptible. Those at greatest danger include people with AIDS, infants, transplant patients, and others whose immune systems may be compromised. For this reason, infectious meningitis patients are almost always isolated until the risk of spreading the illness to others has passed.

Neoplastic meningitis: Neoplastic meningitis is a condition in which cancer cells spread into the membranes surrounding the brain and the spinal cord (the meninges). Often, the condition is associated with cancer that has spread from tumors elsewhere in the body. Neoplastic meningitis is difficult to treat because chemotherapy drugs injected intravenously often do not reach high enough concentrations in the meninges to be effective. Consequently, chemotherapy for neoplastic meningitis is often given intrathecally, injected into the fluid-filled space between the meninges.

Viral meningitis: inflammation of the meninges caused by a virus, commonly one of the enteroviruses. This type of meningitis is highly contagious and occurs frequently in children. It can often be a complication of childhood diseases such as chickenpox. Viral meningitis is also called aseptic meningitis.

Tuberculous meningitis: inflammation of the meninges caused by tuberculosis infection. This is very dangerous and if left untreated may cause brain damage. Tuberculous meningitis begins insidiously with a gradual fluctuating fever, fatigue, weight loss, behavior changes, headache,

and vomiting. This early phase is followed by neurologic deficits, loss of consciousness, or convulsions. A dense gelatinous exudate (outpouring) forms and envelops the brain arteries and cranial nerves. It creates a bottleneck in the flow of the cerebrospinal fluid, which leads to hydrocephalus. The development of arteritis and infarctions of the brain can cause hemiplegia or quadriplegia.

Syphilitic meningitis: inflammation of the meninges due to infection with the bacterium that causes syphilis. Some people with untreated syphilis who are in the tertiary stage develop a chronic form of meningitis. The condition is marked by changes in mental status and problems with nerve function. (6-8)

4. Causes and Risk Factor

Causes

Meningitis is usually caused by a bacterial or viral infection that invades the cerebral spinal fluid (CSF). Cerebral spinal fluid (CSF) is the fluid within the open spaces of the brain that protect and cushion the brain and spinal cord. A fungus or parasite may also cause meningitis. The severity of a child's symptoms and prognosis depend on the specific organism that is causing the meningitis. Meningitis can occur in infants, children, and adults. Some bacteria and viruses are more common in certain age groups than others, including the following:

Bacteria that can cause meningitis (bacterial meningitis)

In newborns and young babies, possible bacteria include the following:

- *Group B streptococcus*
- *Escherichia coli (or E. coli)*
- *Listeria monocytogenes*

In older babies and children, possible bacteria include the following:

- *Streptococcus pneumoniae*

- *Neisseria meningitides* (meningococcal meningitis)
- *Haemophilus influenzae* type b or *H. influenzae*

Other bacteria that may cause meningitis include the following:

- syphilis
- tuberculosis (TB)

Viruses that can cause meningitis (viral meningitis)

- polioviruses
- mumps (paramyxovirus)
- herpes simplex virus (HSV)

Other microorganisms that can cause meningitis

- *Borrelia burgdorferi* (Lyme disease)
- fungi such as *Candida*, *Aspergillus*, or *Cryptococcus neoformans*

Meningitis caused by a virus is more common and usually less severe. Bacterial meningitis is usually more severe and may produce long-term complications or death. (9)

5. Risk factor

A few risk factors can make you or your child more likely to develop meningitis:

- **Age.** Children younger than 5 years, young people ages 15 to 24 and older

Table 1. Risk and/or Predisposing Factor

Risk and/or Predisposing Factor	Bacterial Pathogen
Age 0-4 weeks	<i>S agalactiae</i> (group B streptococci) <i>E coli</i> K1 <i>L monocytogenes</i>
Age 4-12 weeks	<i>S agalactiae</i> <i>E coli</i> <i>H influenzae</i> <i>S pneumoniae</i> <i>N meningitidis</i>
Age 3 months to 18 years	<i>N meningitidis</i> <i>S pneumoniae</i> <i>H influenzae</i>

adults are more likely to develop meningitis than is the rest of the population.

- **Living in a community setting.** College students living in dormitories, personnel on military bases and children in boarding schools and child care facilities are at increased risk of meningococcal meningitis, probably because infectious diseases tend to spread quickly wherever large groups of people congregate.
- **Pregnancy.** If you're pregnant, you're more likely to contract listeriosis — an infection caused by *Listeria* bacteria, which may also cause meningitis. If you have listeriosis, your unborn baby is at risk, too.
- **Working with animals.** People who work with domestic animals, including dairy farmers and ranchers, have a higher risk of contracting *Listeria*, which can lead to meningitis.
- **Compromised immune system.** Factors that may compromise your immune system — including AIDS, diabetes and use of immunosuppressant drugs — also make you more susceptible to meningitis. Removal of your spleen, an important part of your immune system, also may increase your risk. (10)

Age 18-50 years	<i>S pneumoniae</i> <i>N meningitidis</i> <i>H influenzae</i>
Age older than 50 years	<i>S pneumoniae</i> <i>N meningitidis</i> <i>L monocytogenes</i> Aerobic gram-negative bacilli
Immunocompromised state	<i>S pneumoniae</i> <i>N meningitidis</i> <i>L monocytogenes</i> Aerobic gram-negative bacilli
Intracranial manipulation, including neurosurgery	<i>Staphylococcus aureus</i> Coagulase-negative staphylococci Aerobic gram-negative bacilli, including <i>Pseudomonas aeruginosa</i>
Basilar skull fracture	<i>S pneumoniae</i> <i>H influenzae</i> Group A streptococci
CSF shunts	Coagulase-negative staphylococci <i>S aureus</i> Aerobic gram-negative bacilli <i>Propionibacterium acnes</i>

6. Epidemiology

Young adults are mainly affected by viruses (mainly enteroviruses) and meningococci. Adults usually are affected by pneumococci and meningococci. In elderly adults there is a larger role for pneumococcus as well as listeria. There is a lot of cross over for all these groups. Meningitis can be divided into community

acquired and nosocomial. Nosocomial episodes are primarily related to neurosurgical procedures and drug related immunosuppression. Community acquired meningitis almost always begins with colonization of the oropharynx. (11-13)

Table 2. Meningitis can affect anyone in any age group, from the newborn to the elderly

Age group	Causes
Neonates	<i>Streptococci Group B</i> , <i>E. Coli</i> , <i>Listeria</i>
Infants	<i>Neisseria meningococci</i> , <i>Haemophilus influenzae</i> , <i>Streptococci pneumonia</i>
Children	<i>Neisseria meningococci</i> , <i>Streptococci pneumonia</i>
Adults	<i>Streptococci pneumonia</i> , <i>Neisseria meningococci</i> , <i>Mycobacteria</i> , <i>Cryptococci</i>

Table 3. Changing Epidemiology of Acute Bacterial Meningitis in the United States

Bacteria	1978-1981	1986	1995
<i>H influenzae</i>	48%	45%	7%
<i>Listeria monocytogenes</i>	2%	3%	8%
<i>N meningitidis</i>	20%	14%	25%
<i>Streptococcus agalactiae</i>	3%	6%	12%
<i>S pneumoniae</i>	13%	18%	47%

Table 4. Infectious Agents Causing Aseptic Meningitis Syndrome

Category	Agent
Bacteria	Partially-treated bacterial meningitis <i>L monocytogenes</i> <i>Brucella species</i> <i>Rickettsia rickettsii</i> <i>Ehrlichia species</i> <i>Mycoplasma pneumoniae</i> <i>B burgdorferi</i> <i>Treponema pallidum</i> <i>Leptospira species</i> <i>Mycobacterium tuberculosis</i> <i>Nocardia species</i>
Parasites	<i>N fowleri</i> <i>Acanthamoeba species</i> <i>Balamuthia species</i> <i>Angiostrongylus cantonensis</i> <i>G spinigerum</i> <i>Baylisascaris procyonis</i> <i>S stercoralis</i> <i>Taenia solium</i> (cysticercosis)
Fungi	<i>Cryptococcus neoformans</i> <i>C immitis</i> <i>B dermatitidis</i> <i>H capsulatum</i> <i>Candida species</i> <i>Aspergillus species</i>
Viruses	Enterovirus <i>Poliovirus</i> <i>Echovirus</i> <i>Coxsackievirus A</i> <i>Coxsackievirus B</i> <i>Enterovirus 68-71</i>
	Herpesvirus <i>HSV-1 and HSV-2</i> <i>Varicella-zoster virus</i> <i>EBV</i> <i>CMV</i> <i>HHV*-6</i> <i>HHV-7</i>
	Paramyxovirus <i>Mumps virus</i> <i>Measles virus</i>
	Togavirus <i>Rubella virus</i>
	Flavivirus <i>Japanese encephalitis virus</i> <i>St. Louis encephalitis virus</i>

Bunyavirus <i>California encephalitis virus</i> <i>La Crosse encephalitis virus</i>
Alphavirus <i>Eastern equine encephalitis virus</i> <i>Western equine encephalitis virus</i> <i>Venezuelan encephalitis virus</i>
Reovirus <i>Colorado tick fever virus</i>
Arenavirus <i>LCM virus</i>
Rhabdovirus <i>Rabies virus</i>
Retrovirus <i>HIV</i>

7. Sign and symptoms

- In infants (symptoms may be difficult to pinpoint):
 - Irritability
 - Fever
 - Sleeping all the time
 - Poor feeding
 - High-pitched cry
 - Arching back
 - Cries when picked up or being held
 - Inconsolable crying
 - Bulging fontanelle (soft spot on an infant's head)
 - Noticeably different temperament
 - Seizures



Figure 4. Sign and symptoms in Babies & Toddlers

In children older than one year:

- Neck and/or back pain
- Headache
- Sleepiness
- Confusion
- Irritability
- Fever
- Refusing to eat
- Decreased level of consciousness
- Seizures
- Photophobia (sensitivity to light)
- Nausea and vomiting

- Neck stiffness

Complication

- Even with effective antimicrobial therapy, significant neurologic complications have been reported

to occur in as many as 30% of survivors following an episode of bacterial meningitis. Closely monitor for the development of these complications.

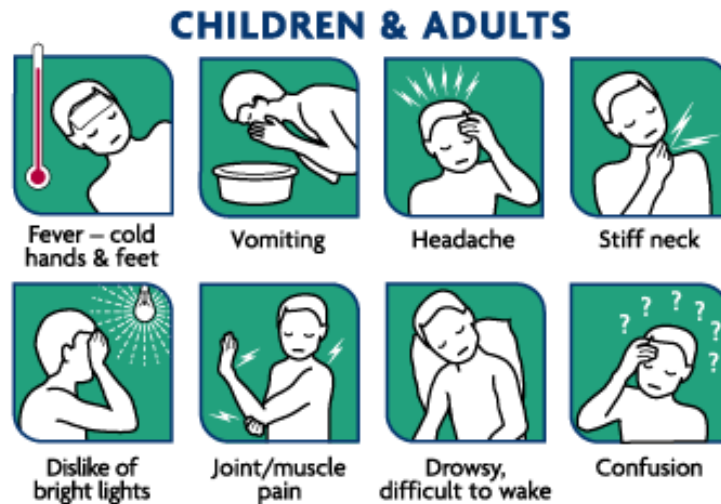


Figure 5. Sign and symptoms in Children and Adults

- Cranial nerve palsies and the effects of impaired cerebral blood flow, such as cerebral infarction, are caused by increased ICP.
- Other early complications include the development of venous sinus thrombosis, obstruction of CSF flow, or the formation of subdural empyema and brain abscess.
- The long-term neurologic sequelae can be grouped into 3 categories as follows:
 - Hearing impairment
 - Obstructive hydrocephalus
 - Brain parenchymal damage: This is the most important feared complication of bacterial meningitis. It could lead to sensory and motor deficits, cerebral palsy, learning disabilities, mental retardation, cortical blindness, and seizures. (14-16)
- Patients with viral meningitis usually have a good prognosis for recovery.
- The prognosis is worse for patients at the extremes of age (ie, <2 y, >60 y) and those with significant comorbidities and underlying immunodeficiency.
- Patients presenting with an impaired level of consciousness are at increased risk for developing neurologic sequelae or dying.
- Acute bacterial meningitis is a medical emergency and delays in instituting effective antimicrobial therapy result in increased morbidity and mortality.
- The presence of low-level pleocytosis (<20 cells) in patients with bacterial meningitis suggests a poorer outcome.
- Meningitis caused by *S pneumoniae*, *L monocytogenes*, and gram-negative bacilli has a higher case-fatality rate compared to

Prognosis

meningitis caused by other bacterial agents.

- The prognosis of meningitis caused by opportunistic pathogens also depends on the underlying immune function of the host. Many of the survivors require lifelong suppressive therapy (eg, long-term fluconazole for suppression in patients with HIV-associated cryptococcal meningitis). (17,18)

8. Screening and Diagnosis

Pediatrician can diagnose meningitis based on a medical history, a physical exam and certain diagnostic tests. During the exam, your doctor may check for signs of infection around the head, ears, throat and the skin along the spine. You or your child may undergo the following diagnostic tests:

- **Throat culture.** A throat culture can find and identify the bacteria causing throat pain, neck pain and headache, but can't determine what pathogens may be in your spinal fluid.
- **Imaging.** X-rays and computerized tomography (CT) scans of the chest, skull or sinuses may reveal swelling or inflammation. These tests can also help your doctor look for infection in other areas of the body or infections associated with meningitis.
- **Spinal tap (lumbar puncture).** The definitive diagnosis of meningitis is often made by analyzing a sample of your cerebrospinal fluid (CSF), which is collected during a procedure known as a spinal tap. In people with meningitis, the CSF fluid often shows a low sugar (glucose) level along with an increased white blood cell count and increased protein. CSF analysis may also help your doctor identify the exact bacterium that's causing the illness.

- **Polymerase chain reaction analysis.** If your doctor suspects meningitis, he or she may order a DNA-based test known as a polymerase chain reaction (PCR) amplification to check for the presence of certain causes of meningitis. (19-21)

9. Prevention

Breastfeeding is somewhat protective against meningitis.

Vaccines and preventive antibiotics when exposed are two powerful methods of prevention.

Meningitis typically results from contagious infections. Common bacteria or viruses that can cause meningitis can spread through coughing, sneezing, kissing or sharing eating utensils, a toothbrush or a cigarette. You're also at increased risk if you live or work with someone who has the disease. (22-24)

Careful hand washing is important to avoiding exposure to infectious agents. Teach your children to wash their hands often, especially before they eat and after using the toilet, spending time in a crowded public place or petting animals. Show them how to wash their hands vigorously, covering both the front and back of each hand with soap and rinsing thoroughly under running water. In addition, boost your immune system by getting enough rest, exercising regularly, and eating a healthy diet with plenty of fresh fruits, vegetables and whole grains.

If you're pregnant, reduce your risk of listeriosis by cooking meat thoroughly and avoiding cheeses made from unpasteurized milk. (25,26)

Vaccination

There are vaccines against Hib and against some strains of *N. meningitidis* and many types of *Streptococcus pneumoniae*. The vaccines against Hib are very safe and highly effective. There is also a vaccine that protects against four strains of *N.*

meningitidis, but it is not routinely used in the United States. The vaccine against *N. meningitidis* is sometimes used to control outbreaks of some types of meningococcal

meningitis in the United States. Meningitis cases should be reported to state or local health departments to assure follow-up of close contacts and recognize outbreaks.

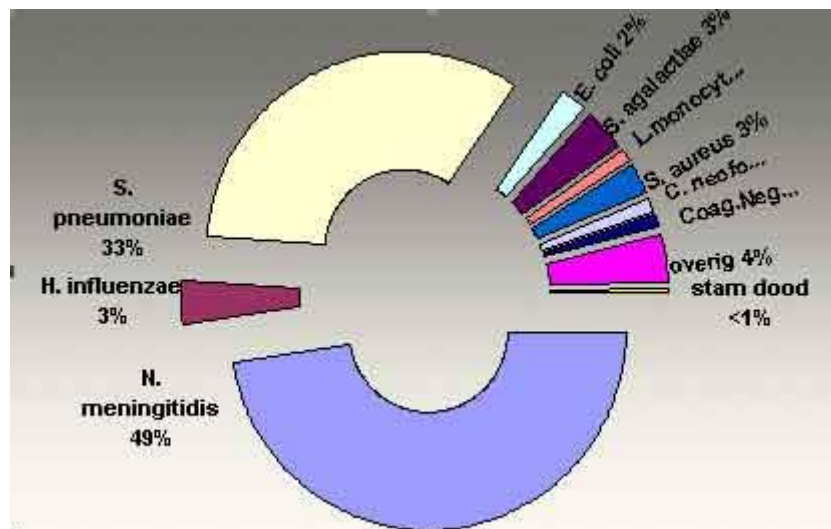


Figure 6. Vaccination

College freshman, especially those who live in dormitories are at higher risk for meningococcal disease and should be educated about the availability of a safe and effective vaccine, which can decrease their risk. There are vaccines to prevent meningitis due to *S. pneumoniae* (also called pneumococcal meningitis) which can also prevent other forms of infection due to *S. pneumoniae*. The pneumococcal polysaccharide vaccine is recommended for all persons over 65 years of age and younger persons at least 2 years old with certain chronic medical problems. There is a newly licensed vaccine (pneumococcal conjugate vaccine) that appears to be effective in infants for the prevention of pneumococcal infections and is routinely recommended for all children greater than 2 years of age. (27,28)

Immunization

Some forms of bacterial meningitis are preventable with the following vaccinations:

- **Haemophilus influenzae type b (Hib) vaccine.** Children in the

United States routinely receive this vaccine as part of the recommended schedule of vaccines, starting at about 2 months of age. The vaccine is also recommended for some adults, including those with sickle cell disease or AIDS.

- **Pneumococcal conjugate vaccine (PCV7).** This vaccine is also part of the regular immunization schedule for children younger than 2 years in the United States. In addition, it's recommended for children between the ages of 2 and 5 who are at high risk of pneumococcal disease, including children with chronic heart or lung disease or cancer.
- **Pneumococcal polysaccharide vaccine (PPV).** Older children and adults who need protection from pneumococcal bacteria may receive this vaccine. The Centers for Disease Control and Prevention recommends the PPV vaccine for all adults older than 65 and younger adults and children with compromised immune systems or

chronic illnesses such as heart disease, diabetes or sickle cell anemia.

Meningococcal conjugate vaccine (MCV4)

As of May 2005, the Centers for Disease Control and Prevention and the American Academy of Pediatrics recommend that this vaccine be routinely administered for the following previously unvaccinated groups: children 11 to 12 years old, adolescents at high school entry (about age 15), and college freshmen living in dormitories. (29, 30)

10. Treatment of Meningitis

Viral meningitis

General care: People with meningitis need careful attention and quiet, darkened, calm surroundings

- Headaches can be treated with painkillers
- Tepid sponging, electric fans and suitable drugs can be used to reduce high temperature
- Nausea and vomiting can be treated with anti-nausea drugs and by replacing fluids by mouth or vein (drip).

Antibiotics are of no use in viral meningitis because they only work against infections caused by bacteria. Most people with viral meningitis recover within one week.

Bacterial meningitis

General care

As in viral meningitis

Treatment and medication (drugs)

Antibiotics

- Intravenous antibiotics are started as soon as bacterial meningitis is suspected.

- Several antibiotics may have to be given at once to ensure that the bacteria are effectively treated.

- Once the bacteria have been identified, some antibiotics may be stopped.

- Antibiotics will usually be continued for seven to 10 days.

Anticonvulsants: As in viral encephalitis.

Brain swelling

- As in viral encephalitis.
- Surgery may be necessary to relieve the **hydrocephalus** or to drain an abscess.
- It is common to give **steroids** to children with bacterial meningitis, but they are usually only needed for a short period. They reduce inflammation and raised pressure in the head and reduce the likelihood of long-term hearing loss in haemophilus meningitis. (31)

Fungal meningitis

General care

As in viral meningitis.

Treatment and medication (drugs)

Anti-fungal agents

Intravenous anti-fungal treatment is given as soon as fungal meningitis is suspected.

Anticonvulsants

As in viral encephalitis.

Brain swelling

As in viral encephalitis. Surgery is sometimes needed to relieve the hydrocephalus or to drain an abscess.

Table 5. Antibiotic Dosages for Neonatal Bacterial Meningitis to be Adjusted by Weight and Age Dosage (mg/kg/dose or U/kg/dose for Highest Dose Within Dosage Range) and Intervals of Administration (32)

Antibiotic	Administration Route	Dose for birth weight <2000 g and age 0-7 days	Dose for birth weight >2000 g and age 0-7 days	Dose for birth weight <2000 g and age >7 days	Dose for birth weight >2000 g and age >7 days
Penicillins					
Ampicillin	IV, IM	50 mg q12h	50 mg q8h	50 mg q8h	50 mg q6h
Penicillin-G	IV	50,000 U q12h	50,000 U q8h	50,000 U q8h	50,000 U q6h
Oxacillin	IV, IM	50 mg q12h	50 mg q8h	50 mg q8h	50 mg q6h
Ticarcillin	IV, IM	75 mg q12h	75 mg q8h	75 mg q8h	75 mg q6h
Cephalosporins					
Cefotaxime	IV, IM	50 mg q12h	50 mg q8h	50 mg q8h	50 mg q6h
Ceftriaxone	IV, IM	50 mg once daily	50 mg once daily	50 mg once daily	75 mg once daily
Ceftazidime	IV, IM	50 mg q12h	50 mg q8h	50 mg q8h	50 mg q8h

Table 6. Dose Guidelines of Intravenous Antimicrobials in Infants and Children with Bacterial Meningitis

Antibiotic	Dose (mg/kg/day) IV	Maximum Daily Dose	Dosing Interval
Ampicillin	400	6-12 g	q6h
Vancomycin	60	2-4 g	q6h
Penicillin G	400,000 U	24 million	q6h
Cefotaxime	200-300	8-10 g	q6h
Ceftriaxone	100	4 g	q12h
Ceftazidime	150	6 g	q8h
Cefepime*	150	2-4 g	q8h
Imipenem†	60	2-4 g	q6h
Meropenem	120	4-6 g	q8h
Rifampin	20	600 mg	q12h

Table 7 Chemoprophylaxis for Contacts of Patients and IndexCase of *H influenzae* Type b and Contacts of Meningococcal Disease (33)

Drug Name	Age of Contact	Dosage
<i>H influenzae</i> disease		
Rifampin	Adults	600 mg PO qd for 4 d
	≥1 month	20 mg/kg PO qd for 4 d; not to exceed 600 mg/dose
	<1 month	10 mg/kg PO qd for 4 d
<i>N meningitidis</i> disease		
Rifampin	Adults	600 mg PO q12h for 2 d

	>1 month	10 mg/kg PO q12h for 2 d; not to exceed 600 mg/dose
	≤1 month	5 mg/kg PO q12h for 2 d
Ceftriaxone	>15 years	250 mg IM once
	≤15 years	125 mg IM once
Ciprofloxacin	≥18 years	500 mg PO once

11. Discussion and Conclusion

Meningitis is the inflammation of the meninges, the membranes that cover the brain and spinal cord. The inflammation is usually caused by bacteria or virus. Less common cause include fungi, protozoa and other parasites.

Treatment of meningitis depends on the organism causing the infection, your age, the extent of the infection and the presence of other medical condition or complication of meningitis.

In the future as our understanding of the disease process in meningitis improvement it may be possible to select treatment in relation to the pathogenesis of this disease. In the meantime patient with suspected diagnosis of meningitis should be referred promptly to a specialist center where their diagnosis can be confirmed and appropriate treatment started without delay.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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