



respiratory tract, outbreaks of meningitis due to *N. meningitidis* may occur in persons living in close quarters, such as among household members, in daycare, in college dormitories, and among the incarcerated. One outbreak of serogroup C disease was reported in New York City among men who have sex with men, and outbreaks caused by serogroup B were reported on the campuses of Princeton University and University of California, Santa Barbara. Patients with deficiencies in the terminal complement components (C5-C8 and perhaps C9) and properdin are at increased risk for meningococcal infections.

The incidence of meningitis due to *H. influenzae* has declined more than 90% with the widespread use of routine vaccination with the *H. influenzae* type b conjugate vaccine. Isolation of this microorganism in older children and adults suggests certain underlying conditions, such as sinusitis, otitis media, epiglottitis, pneumonia, diabetes mellitus, alcoholism, splenectomy or asplenic states, head trauma with CSF leak, and immune deficiency.

Meningitis caused by *L. monocytogenes* is most common in neonates, adults older than 50 years, alcoholics, immunosuppressed adults, and in patients with chronic conditions such as diabetes mellitus and renal disease. Given the likely gastrointestinal portal of entry for this microorganism, outbreaks of listerial infection have been associated with ingestion of contaminated coleslaw, raw vegetables, milk, and cheese. Sporadic cases have been linked to contaminated turkey franks, alfalfa tablets, cantaloupe, diced celery, hog's head cheese, and processed meats.

Gram-negative meningitis is rare; it usually affects debilitated persons and those with a breach in the meninges as a result of trauma or neurosurgical procedures. *Staphylococcus aureus* meningitis is usually found in the early period after neurosurgery or trauma, in those with CSF shunts, or in patients with underlying conditions such as diabetes mellitus, alcoholism, chronic kidney disease requiring hemodialysis, injection-drug use, and malignancies. *Staphylococcus epidermidis* is the most common cause of meningitis in patients with CSF shunts.

Viral Meningitis

Enteroviruses are the leading identifiable cause of the *aseptic meningitis syndrome*, a term used to define any meningitis (particularly with lymphocytic pleocytosis) for which a cause is not apparent after initial evaluation, routine CSF stains, and cultures. The Centers for Disease Control and Prevention (CDC) estimate that 10 to 15 million symptomatic enteroviral infections occur annually in the United States; of these, 30,000 to 75,000 are meningitis cases.

Many other viruses can cause the aseptic meningitis syndrome, including mumps virus (in unimmunized populations), human immunodeficiency virus (HIV), several arboviruses (e.g., St. Louis encephalitis virus, the California encephalitis group of viruses, Colorado tick fever virus, West Nile virus), and herpesviruses. The syndrome of herpes simplex virus (HSV) meningitis is most commonly associated with primary genital infection. The DNA of HSV has been detected in the CSF of patients with the syndrome of recurrent benign lymphocytic meningitis (previously known as Mollaret's meningitis), with almost all cases caused by herpes simplex virus type 2 (HSV-2).

Spirochetal Meningitis

The most common spirochetes associated with meningitis are *Treponema pallidum* (the etiologic agent of syphilis) and *Borrelia burgdorferi* (the etiologic agent of Lyme disease). The incidence of syphilitic meningitis is greatest in the first 2 years after initial infection, occurring in 0.3% to 2.4% of untreated cases. The overall incidence of neurosyphilis has increased, with many cases reported in patients with HIV infection. The nervous system is involved in at least 10% to 20% of patients with Lyme disease while erythema migrans is apparent or 1 to 6 months later.

Tuberculous Meningitis

Tuberculous meningitis accounts for approximately 15% of cases of extrapulmonary tuberculosis in the United States. CNS disease is much more common in less developed areas of the world. Factors associated with reactivation of latent foci and progression to the syndrome of late generalized tuberculosis include advanced age, immunosuppressive drug therapy, gastrectomy, pregnancy, and chronic medical conditions. The epidemiology of tuberculosis has been influenced by the advent of HIV infection, in which extrapulmonary disease (including CNS disease) occurs in more than 70% of cases.

Fungal Meningitis

The incidence of fungal meningitis has increased dramatically in recent years because of the increased numbers of immunosuppressed patients. *Cryptococcus neoformans* is the most common fungal cause of clinically recognized meningitis, occurring most commonly in persons who are immunosuppressed or have chronic medical conditions. HIV-infected patients are in the highest-risk group. Cases have also been documented in apparently healthy individuals.

Coccidioides immitis is a thermal dimorphic fungus that is endemic in the semiarid regions of the Americas and desert areas of the southwestern United States (e.g., California, Arizona, New Mexico, Texas), where about one third of the population is infected. Less than 1% of patients develop disseminated infection, and one third to one half of those have meningeal involvement.

Other fungi less commonly cause CNS infection. *Histoplasma capsulatum* is endemic to fertile river valleys, principally the Mississippi and Ohio River basins. *Candida* meningitis is uncommon.

Clinical Presentation

Acute Meningitis

Adult patients with acute meningitis typically seek medical attention within hours to days of illness. Patients with bacterial meningitis classically exhibit fever, headache, meningismus, and signs of cerebral dysfunction (i.e., confusion, delirium, or a declining level of consciousness ranging from lethargy to coma). All signs may not be seen in a given patient. The meningismus may be subtle, marked, or accompanied by Kernig's sign or Brudzinski's sign, although the sensitivity of these signs is only 5% in adults. Cranial nerve palsies (especially involving cranial nerves III, IV, VI, and VII) and focal cerebral signs are seen in 10% to 20% of cases. Seizures occur in about 30% of patients. Older adult patients with bacterial meningitis, especially those with