Infectious Disease Epidemiology Section
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MENINGITIS

Revised 6/9/2011

Meningitis is an inflammation of the meninges with increased intracranial pressure, increased WBCs in CSF (pleocytosis) usually secondary to infection in the pia-subarachnoid space and ventricles, leading to neurologic sequelae and abnormalities.

The incidence is about 15 cases per 100,000 population per year (3 for bacterial, 11 for viral and one for others). It affects all ages, from neonate to geriatric.

Clinical Presentation

• Fever
• Headache
• Neck stiffness, nuchal rigidity, meningismus
• Photophobia
•Altered mental status, lethargy, stupor, coma
• Vomiting, nausea
• Rash: petechial associated with meningococcal infection
• Myalgia
• Cranial nerve abnormality (unilateral)
• Papilledema, dilated, nonreactive pupil(s)
• Seizures, posturing: decorticate/decerebrate

• Physical examination findings of Kernig's sign and Brudzinski's sign in adults with meningitis are often not helpful in determining meningeal inflammation

Etiology

Most meningitis are due to bacteria or viruses. Other causes are rare such as carcinomatous meningitis, intracranial tumors, medications (some antibiotics and Nonsteroidal anti-inflammatory agents), systemic illnesses (lupus).

The most common causes of **bacterial** meningitis depend on the age of the patients.:
• Neonates (0-1 month): group B streptococci, *Escherichia coli*, Klebsiella sp., *Listeria monocytogenes*
• Infants (1-3 months): group B streptococci, *Escherichia coli*, *Listeria monocytogenes*, *Streptococcus pneumoniae, Neisseria meningitidis, Hemophilus influenzae,*
• Infants through adolescence (3 months-18 years): *Neisseria meningitidis, Hemophilus influenzae, Streptococcus pneumoniae*
• Adults: *Neisseria meningitidis, Streptococcus pneumoniae*
• Elderly: *Streptococcus pneumoniae*, *Neisseria meningitidis*, *Listeria monocytogenes*, Gram-negative bacilli.
Other rare causes of bacterial meningitis include anthrax, enterobacteria, enterococci, leptospira, Lyme disease, rickettsial diseases, staphylococci, syphilis and tuberculosis.

The viral causes of **viral** meningitis: Enterovirus; mumps; measles; arboviruses, herpes (simplex and zoster); HIV; lymphocytic choriomeningitis virus; adenovirus; CMV; parainfluenza virus types 2 and 3; influenza virus.

Diagnosis

When bacterial meningitis is suspected, blood cultures are indicated. The diagnosis of bacterial meningitis is made by examination of the CSF. The need to obtain neuroimaging studies (CT or MRI) prior to LP requires clinical judgment. In an immunocompetent patient with no known history of recent head trauma, a normal level of consciousness, and no evidence of papilledema or focal neurologic deficits, it is safe to perform LP without prior neuroimaging studies. If LP is delayed in order to obtain neuroimaging studies, empirical antibiotic therapy should be initiated after blood cultures are obtained. Antibiotic therapy initiated a few hours prior to LP will not significantly alter the CSF WBC count or glucose concentration, nor is it likely to prevent visualization of organisms by Gram's stain.

CSF bacterial cultures are positive in greater than 80% of patients, and CSF Gram's stain demonstrates organisms in more than 60%.

Use of the CSF/serum glucose ratio corrects for hyperglycemia that may mask a relative decrease in the CSF glucose concentration. The CSF glucose concentration is low when the CSF/serum glucose ratio is < 0.6. A CSF/serum glucose ratio < 0.4 is highly suggestive of bacterial meningitis but may also be seen in other conditions, including fungal, tuberculous, and carcinomatous meningitis. It takes from 30 minutes to several hours for CSF glucose concentration to reach equilibrium with blood glucose concentrations; therefore, administration of 50 mL of 50% glucose (D50) prior to LP, as commonly occurs in emergency room settings, is unlikely to alter CSF glucose concentration significantly unless more than a few hours have elapsed between glucose administration and LP.

CSF Examination

CSF	Normal	Bacterial Meningitis	Viral Meningitis
Opening Pressure	70-180 mm H_2O	Normal to increased	Usually normal
Protein	15-45 mg/dL	Increased	Normal to increased
Glucose	45-80 mg/dL	Decreased	Normal to decreased
WBC Count	0-10 /mm^3	100 to 10,000	100 to 1,000
Predominant Cells	Mononuclear	Polymorphonuclear Neutrophiles 80%	Lymphocytes
Bacteria on Gram stain	Negative	Positive 60%-90%	Negative
Bacterial culture	Negative	Positive 65%-90%	Negative bacterial culture
CSF bacterial antigen		50% to 100% sensitivity	Negative

Surveillance

Only some specific meningitis are reportable:
- All viral meningitis (enteroviral, arboviral, meningitis presumed of viral etiology or aseptic meningitis)
- Meningococcal meningitis
- Hemophilus influenzae meningitis
- Meningitis due to a reportable disease: anthrax, enterobacteria (vancomycin resistant), listeria, Lyme disease, methicillin resistant *Staphylococcus aureus*, rickettsial diseases, syphilis, tuberculosis.

The latex agglutination (LA) test for the detection of bacterial antigens of *S. pneumoniae*, *N. meningitidis*, *H. influenzae* type b, group B streptococcus, and *Escherichia coli* K1 strains in the CSF is very useful for making a rapid diagnosis of bacterial meningitis, especially in patients who have been pretreated with antibiotics and in whom CSF Gram's stain and culture are negative. The CSF LA test has

a *specificity* of 95 to 100% for *S. pneumoniae* and *N. meningitidis*, so a positive test is virtually diagnostic of bacterial meningitis caused by these organisms. However, the *sensitivity* of the CSF LA test is only 70% to 100% for detection of *S. pneumoniae* and 33% to 70% for detection of *N. meningitidis* antigens, so a negative test does not exclude infection by these organisms. The Limulus amebocyte lysate assay is a rapid diagnostic test for the detection of gram-negative endotoxin in CSF, and thus for making a diagnosis of gram-negative bacterial meningitis. The test has a specificity of 85% to 100% with a sensitivity approaching 100%. Thus, a positive Limulus amebocyte lysate assay occurs in virtually all patients with gram-negative bacterial meningitis, but false-positives may occur. CSF polymerase chain reaction (PCR) tests are not as useful in the diagnosis of bacterial meningitis as they are in the diagnosis of viral CNS infections. A CSF PCR test has been developed for detecting DNA from bacteria in CSF, but its sensitivity and specificity need to be better characterized before its role in diagnosis can be defined.

Almost all patients with bacterial meningitis will have **neuroimaging** studies performed during the course of their illness. MRI is preferred over CT because of its superiority in demonstrating areas of cerebral edema and ischemia. In patients with bacterial meningitis, diffuse meningeal enhancement is often seen after the administration of gadolinium. Meningeal enhancement is not diagnostic of meningitis but occurs in any CNS disease associated with increased blood-brain barrier permeability.

Petechial skin lesions, if present, should be biopsied. The rash of meningococcemia results from the dermal seeding of organisms with vascular endothelial damage, and biopsy may reveal the organism on Gram's stain.

Differential Diagnosis

Viral meningoencephalitis, and particularly herpes simplex virus (HSV) encephalitis, can mimic the clinical presentation of bacterial meningitis (see "Encephalitis," below). HSV encephalitis typically presents with headache, fever, altered consciousness, focal neurologic deficits (e.g., dysphasia, hemiparesis), and focal or generalized seizures. The findings on CSF studies, neuroimaging and electroencephalogram (EEG) distinguish HSV encephalitis from bacterial meningitis. The typical CSF profile with viral CNS infections is a lymphocytic pleocytosis with a normal glucose concentration, in contrast to PMN pleocytosis and hypoglycorrhachia characteristic of bacterial meningitis. MRI abnormalities (other than meningeal enhancement) are not seen in uncomplicated bacterial meningitis. By contrast, in HSV encephalitis parenchymal changes, especially in orbitofrontal and medial temporal lobes, are usually found. Some patients with HSV encephalitis have a distinctive periodic pattern on EEG (see below).

Rickettsial disease can resemble bacterial meningitis. Rocky Mountain spotted fever (RMSF) is transmitted by a tick bite and caused by the bacteria Rickettsia rickettsii. The disease may present acutely with high fever, prostration, myalgia, headache, and nausea and vomiting. Most patients develop a characteristic rash within 96 hours of the onset of symptoms. The rash is initially a diffuse erythematous maculopapular rash that may be difficult to distinguish from that of meningococcemia. It progresses to a petechial rash, then to a purpuric rash, and, if untreated, to skin necrosis or gangrene. The color of the lesions changes from bright red to very dark red, then yellowish-green to black. The rash typically begins in the wrist and ankles, and then spreads distally and proximally within a matter of a few hours and involves the palms and soles. Diagnosis is made by immunofluorescent staining of skin biopsy specimens.

Focal suppurative CNS infections (see below), including subdural and epidural empyema and brain abscess, should also be considered, especially when focal neurologic findings are present. MRI should be performed promptly in all patients with suspected meningitis who have focal features, both to detect the intracranial infection and to search for associated areas of infection in the sinuses or mastoid bones.

A number of noninfectious CNS disorders can mimic bacterial meningitis. Subarachnoid hemorrhage is generally the major consideration. Other possibilities include chemical meningitis due to rupture of tumor contents into the CSF (e.g., from a cystic glioma, craniopharyngioma epidermoid or dermoid cyst); drug-induced hypersensitivity meningitis; carcinomatous or lymphomatous meningitis; meningitis associated with inflammatory disorders such as sarcoid, systemic lupus erythematosus (SLE), and Behçet disease;

pituitary apoplexy; and uveomeningitic syndromes (Vogt-Koyanagi-Harada syndrome).

The following is an **Example of a Letter concerning Bacterial meningitis in school:**

It is NOT necessary, but maybe useful

If a case of bacterial meningitis (NOT meningococcal) has been diagnosed in a school, **it is not necessary to send letters to parents since there is no preventive measures to be taken. However, if the word went around that there was a case of meningitis, it may be useful to send out a letter to parents in order to prevent rumors and panic**. The school authorities are responsible for making this decision.

____/____/____

Dear Parents and Students:

We have received word that a senior at the school has been diagnosed with bacterial meningitis. He is currently receiving treatment. Health personnel have identified those persons whom they consider to be close contacts, have notified them of the situation, and have treated those who were in need of treatment.

The bacteria that cause meningitis are spread by direct close contact with the discharges from the nose or throat of an infected person. Fortunately, **none of the bacteria that cause meningitis are very contagious**, and they are not spread by casual contact or by simply breathing the air where a person with meningitis has been.

The symptoms of meningitis are high fever, headache, and stiff neck which can develop over several hours or which may take one to two days. Other symptoms include nausea, vomiting, discomfort looking into bright lights, confusion, and/or sleepiness.

Should any parent have concern regarding their child, or if they begin to exhibit symptoms of the disease they should contact their primary care physician.

Once again, **none of the bacteria that cause meningitis are very contagious**, and they are **not** spread by casual contact or by simply breathing the air where a person with meningitis has been.

If you have any questions or concerns regarding this matter, please contact _____ at the school.

Sincerely,

_____
Principal