

# Infection of Nervous System:

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An infection of the central nervous system (CNS) must be regarded as potentially **life-threatening** until a definitive diagnosis is determined.

One specialized **defense mechanism** of the CNS is the **blood–brain barrier**, which serves to minimize passage of infectious agents and potentially toxic metabolites into the cerebrospinal fluid (CSF) and tissues, as well as to regulate the rate of transport of plasma proteins, glucose, and electrolytes. When CNS infection develops, however, this barrier also poses difficulties in control; some antimicrobial agents and host immune factors, such as immunoglobulins and complement, do not pass as readily from the blood to the site of infection as they do to other tissues.

## ROUTES OF INFECTION

Most CNS infections appear to result from blood-borne spread; for example, bacteremia results from infection of tissue at a site remote from the CNS may result in penetration of the blood–brain barrier. Examples of infectious agents that commonly infect the CNS by this route are *Haemophilus influenzae*, *Neisseria meningitidis*, *Streptococcus pneumoniae*, *Mycobacterium tuberculosis*.

Direct spread occurs from adjacent infected focus such as middle ear  
Traumatic, surgical, or congenital lesions may give direct access  
Implanted foreign bodies such as shunts increase risk

## COMMON ETIOLOGIC AGENTS

The most frequent CNS infections are meningitis, encephalitis, and abscess. Intoxication caused by tetanus and botulinum toxins can affect the CNS, causing spastic or flaccid paralysis, but these diseases are quite rare in the developed world.

Pyogenic meningitis is typically caused by bacteria, often those that have an antiphagocytic capsule, and is acute in onset. The cerebrospinal fluid (CSF) is usually cloudy, with over 1,000 white blood cells per  $\mu\text{l}$  with neutrophils predominating; increased protein levels due to inflammation; and decreased glucose due in part to metabolism by white blood cells. Without appropriate antibiotic therapy—as defined by the selection of antibiotics that not only are active against the bacterial cause of the infection, but also achieve antibacterial levels in the CNS—the infection may quickly be fatal.

Other causes of pyogenic meningitis include a number of potential bioterrorism agents such as *Yersinia pestis* and *Bacillus anthracis*.

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Other causes of meningitis include viruses, fungi, and such slowly growing bacteria as *Mycobacterium tuberculosis*. In these cases, the CSF is more likely to be grossly “clear” due to a lower white blood cell count, typically in the range of 100 to 500/ $\mu$ l. Except for very early in the disease course, the predominant cell type is mononuclear, primarily lymphocytes. CSF glucose levels are frequently normal, but may be decreased in over half of the patients with fungal or mycobacterial infections. CSF protein levels are frequently normal except with *M. tuberculosis*, where they are typically quite elevated.

Bacterial meningitis is most common in the very young, the very old, and the immunocompromised.

Group B streptococci are the most common cause of neonatal meningitis (newborns to 2 months). *Listeria monocytogenes* is another organism that causes neonatal disease. It also is an important agent of meningitis in those individuals who are immunosuppressed due to defects in cell-mediated immunity.

Gram-negative enteric bacilli, including *Escherichia coli*, *Klebsiella pneumoniae*, and *Citrobacter* spp., may also cause neonatal meningitis.

Congenital syphilis, which may manifest itself during the neonatal period, frequently will have a CNS component, neurosyphilis.

Bacterial meningitis is most commonly seen in children 2 months to 5 years of age. Until recently, *Haemophilus influenzae* type b was the most common cause of bacterial meningitis in this age group in developed countries. The widespread use of conjugated *H. influenzae* type b vaccine has resulted in a dramatic decline in the incidence of this disease.

*Streptococcus pneumoniae* and *Neisseria meningitidis* are now the leading causes of meningitis in this age group and in the elderly.

Individuals with head trauma, including a breach in the integrity of the skull or the meninges following neurosurgery, are also at risk for developing bacterial meningitis. The organisms most frequently associated with this type of bacterial meningitis are coagulase-negative staphylococci, *Propionibacterium*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*.

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## Common Causes of Purulent Central Nervous System Infections

| AGE GROUP   | AGENT  |
|---|--|
| Newborns (<1 mo old)  | Group B streptococci (most common), <i>Escherichia coli</i> , <i>Listeria monocytogenes</i> , <i>Klebsiella</i> species, other enteric Gram-negative bacteria            |
| Infants and children  | <i>Streptococcus pneumoniae</i> , <i>Neisseria meningitidis</i> , <i>Haemophilus influenzae</i>  |
| Adults  | <i>S. pneumoniae</i> , <i>Neisseria meningitidis</i>   |
| <b>SPECIAL CIRCUMSTANCES</b>  |  |
| Meningitis or intracranial abscesses associated with trauma, neurosurgery, or intracranial foreign bodies | <i>Staphylococcus aureus</i> , <i>Staphylococcus epidermidis</i> , <i>S. pneumoniae</i> ; anaerobic Gram-negative and Gram-positive bacteria; <i>Pseudomonas</i> species |
| Intracranial abscesses not associated with trauma or surgery  | Microaerophilic or anaerobic streptococci, anaerobic Gram-negative bacteria (often mixed aerobic and anaerobic flora of upper respiratory tract origin)                  |