Brain Infections - Meningitis

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HSCI-840-DL

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Module 8 Assignment

October 31, 2021

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Pathophysiology

Meningitis is an infection of the brain that occurs when microbes impact the meninges of the central nervous system (CNS). Microbes gain access to the brain through the blood when they come in contact with tissue or wounds. Meningococcus can bind to cells in the nasopharynx and cross the mucosal barrier, thereby attaching to the choroid plexus and entering the cerebrospinal fluid (CSF). The body produces an inflammatory reaction to the infection, resulting in increased intracranial pressure (ICP) and swelling. The infection also causes purulent exudate to cover the brain's surface and to fill grooves in the cerebral cortex (sulci). This causes the surface of the brain to have a flat appearance. The blood vessels on the surface of the brain will also appear to be dilated and exudate is found in the CSF (VanMeter & Hubert, 2014).

Common Etiologies

Meningococcal disease has been declining in the United States since the late 1990s (CDC, 2019). While vaccines have provided some protection against the development of certain categories of meningitis, the risk of developing the disease has not been eliminated. Accordingly, the risk for developing meningitis based on exposure to certain organisms varies across age groups. *Neisseria meningitidis* or *meningococcus* is often carried asymptomatically in the nasopharynx. Transmission occurs via respiratory droplets and outbreaks normally occur in academic institutions where students are in close contact with each other. Infections resulting from this type of meningitis are more common in the late winter and early spring. *Escherichia coli* is the most common cause of meningitis in neonates, and usually occurs along with a neural tube defect, premature rupture of the amniotic membrane, or difficult/challenging child delivery. Young children often contract meningitis because of a bacterial infection caused by *Haemophilus influenzae*. Outbreaks are common in the fall or winter of the year. *Streptococcus pneumoniae* is a primary cause of meningitis in elderly individuals and young children.

Across all age groups, meningitis may develop as a secondary infection to other infections, including ear infections (otitis) or sinusitis. It can also result from an abscess, develop after an injury to the head, or following a surgical procedure due to the possible exposure to microorganisms (VanMeter &Hubert, 2014). Overall, the prevalence of meningitis is highest in children younger than one year's old, peaking a second time in adolescence. Among adolescents and young adults, individuals between 16 and 23 years old have the highest rates of infection. People with certain medical conditions including HIV, persistent complement component deficiencies (e.g., C3, C5-9, properdin, factor H, factor D), and functional or anatomic asplenia, are at increased risk for developing meningitis (CDC, 2019).

Signs and symptoms

Meningitis can occur suddenly. Common signs and symptoms may include severe headache, back pain, photophobia, neck stiffness, pyrexia, chills, elevated blood leukocytes, Kernig's sign and Brudzinski's sign. Buildup of ICP can cause vomiting, irritability, and weakness that may progress to more severe symptoms such as unresponsiveness or seizures. Meningococcal infections can cause a rose-colored rash or ecchymoses over the body. In newborns, difficulty feeding, weakness, irritability, high-pitched crying, and bulges in fontanelles may occur (VanMeter & Hubert, 2014).

Most common treatment protocols

The treatment protocol for meningitis includes aggressive use of antimicrobial therapy, as well as specific treatments to address ICP and seizures if necessary. Glucocorticoids may be prescribed to minimize cerebral swelling and inflammation (VanMeter & Hubert, 2014). Treatments to reduce ICP may include medication, draining of excess CSF, or craniotomy to relieve brain swelling, although this is rarely performed (John Hopkins Medicine, 2021). A craniotomy involves the temporary removal of a portion of the bone flap from the skull with the use of specialized tools. In some cases, computer technology and imaging tools like magnetic resonance imaging (MRI) and computerized tomography (CT) scans may be utilized to ensure that the most accurate location within the brain is treated. General complications can occur based on the location of the brain impacted by the surgical procedure, and may include infection, bleeding, blood clots, pneumonia, blood pressure instability, seizures, muscle weakness, cerebral edema, leakage of CSF, and general risks associated with anesthesia. Rare treatment complications may include difficulty with memory, speaking, paralysis, balance or coordination abnormalities, and coma (John Hopkins Medicine, 2021).

Long term implications for patient

If meningitis is diagnosed and treated in a timely manner, most patients will survive (VanMeter & Hubert, 2014). Approximately 10 to 15 in 100 people infected with meningococcal disease will die (CDC, 2019). Mortality rates for bacterial meningitis in neonates fall between 20% and 60% (Bundy & Noor, 2021). In general, about 1 in 5 patients will experience prolonged and disabling complications such as neurological deficits (10% to 20% of patients), nervous system problems, loss of limbs, and deafness (CDC, 2019; VanMeter & Hubert, 2014).

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