Central Nervous System Infections

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KEYWORDS

• Meningitis • Encephalitis • Toxoplasmosis • Tuberculosis • Prions • Cryptococcus

KEY POINTS

- Prompt recognition and treatment of a central nervous system (CNS) infection is crucial for patient survival.
- Diagnosis of CNS infections is typically made by identifying clinical symptoms, evaluation of serology and cerebrospinal fluid studies, and neuroimaging. Specifically, cerebrospinal fluid is analyzed to look at the protein content, opening pressure, glucose levels, and cellular types.
- Prompt treatment of any CNS infection is important to prevent the patient from developing long-term sequelae as well as to decrease morbidity and mortality.
- Treatment is aimed at covering most common pathogens. As such, broad-spectrum antibiotics are preferred as well as antiviral medications.
- Immunodeficiency plays an important role in susceptibility in patients with opportunistic infections, such as toxoplasmosis, tuberculosis, and Cryptococcus.

INTRODUCTION

Infections of the nervous system are potentially life-threatening and are caused by pathogens, such as bacteria, viruses, and fungi. Prompt recognition and treatment of a central nervous system (CNS) infection is crucial for patient survival, as these infections have a high morbidity and mortality. CNS infections include meningitis, encephalitis, and brain abscesses. The CNS comprises the brain and spinal cord. The meninges along with cerebral spinal fluid surround the spinal cord and protect it. The meninges are subdivided into 3 layers from the outside to the inside: the dura, arachnoid, and pia matter.[1] The pia matter is a delicate structure that encases itself around the spinal cord. The arachnoid layer sits above the pia matter between the subarachnoid space that contains spinal fluid. Last, the dura matter is a tougher tissue that is attached to the skull and to the arachnoid layer. Infections occur when

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pathogens such as bacteria and viruses penetrate the subarachnoid space, eliciting an immune response. This is known as meningitis.[1] This immune response can lead to a release of inflammatory factors, such as cytokines, which leads to localized tissue damage, increased tissue permeability, and disruption of the blood brain barrier. Encephalitis occurs in a similar fashion; however, the inflammation is localized to the brain parenchyma. If not treated, both meningitis and encephalitis can lead to long-term sequalae, such as epilepsy, hydrocephalus, cognitive deficit, and death. Patients with meningitis and encephalitis typically present with the onset of symptoms from hours to days and have nausea, vomiting, headache, photophobia, confusion, fever, and, in some cases, loss of consciousness.

BACTERIAL

The pathogenesis of bacterial meningitis relies on the bacteria possessing pili or fimbriae, which assist on attaching on mucosal walls. Once the bacteria attaches to the epithelium, the bacteria expresses an immunoglobulin (Ig)A protease that cleaves host IgA, which facilitates bacterial colonization onto the epithelium.[2] Once this has occurred, the bacteria will eventually move into the bloodstream and directly infect the meninges and elicit an inflammatory response by the host immune system. This leads to localized inflammation and disruption of the blood brain barrier.

Bacterial meningitis can affect any age group, and the organisms that affect the patient vary by age, as summarized in **Table 1**.

Group B Streptococcus

Group B *Streptococcus* or GBS, is a bacterial infection common in neonates caused by *Streptococcus agalactiae*. Neonates are infected by this bacteria during their descent down the birth canal.[2,3] Risk factors for neonates developing GBS meningitis are infants born to GBS-positive (GBS+) mothers, prolonged rupture of membranes for more than 18 hours, or maternal fever.[3] Patients with suspected GBS meningitis are treated with ampicillin and cefoxtaxime. Of note, cefoxtaxime is favored over ceftriaxone due to ceftriaxone displacing bilirubin and increasing risk of jaundice in the neonate. To prevent GBS meningitis, all mothers are screened at 35 to 37 weeks while pregnant.[4] If the mother is known to be GBS+, she is given penicillin G or ampicillin as an alternative. If the mother has a mild penicillin allergy, then cefazolin can be used; however, an allergic reaction can still occur or clindamycin if the allergy is severe.[4]

Table 1
Common pathogens and treatment for meningitis

Age Group	Pathogen	Treatment
Neonates, infants	*Group B Streptococcus*	Cefoxtaxime
	Listeria monocytogenes	Vancomycin
	Escherichia coli	Ampicillin
Children (2–18)	*Streptococcus pneumoniae*	Ceftriaxone
	Neisseria meningitis	Vancomycin
	Haemophilus influenzae	
Adults	*Streptococcus pneumoniae*	Ceftriaxone
	Neisseria meningitis	Vancomycin
	Listeria monocytogenes	Ampicillin