Journal of Virology & Antiviral Research

Perspective A SCITECHNOL JOURNAL

Meningitis: Pathogenesis, Clinical Presentation, and Management

Woo-Jae Chung*

Department of Integrative Biotechnology, Sungkyunkwan University, Republic of Korea

***Corresponding author:** Woo-Jae Chung, Department of Integrative Biotechnology, Sungkyunkwan University, Republic of Korea; E-mail: wjchung@su.edu

Received date: 21 August, 2024, Manuscript No. JVA-24-145971;

Editor assigned date: 26 August, 2024, PreQC No. JVA-24-145971 (PQ);

Reviewed date: 10 September, 2024, QC No. JVA-24-145971;

Revised date: 13 April, 2025, Manuscript No. JVA-24-145971 (R);

Published date: 20 April, 2025, DOI: 10.4172/2324-8955.1000704.

Abstract

Meningitis is an inflammation of the protective membranes covering the brain and spinal cord, known as the meninges. It is a serious medical condition that can result from various infectious and non-infectious causes. This manuscript provides a comprehensive overview of meningitis, including its etiology, pathogenesis, clinical manifestations, diagnostic approaches, and treatment options. By highlighting recent advancements and ongoing challenges, this review aims to enhance understanding and management of this critical condition.

Keywords: Inflammation; Management; Viruses; Fungi; Parasites

Introduction

Meningitis is an acute or chronic inflammation of the meninges, often leading to a range of symptoms that can vary from mild to life-threatening. It can be caused by infectious agents, including bacteria, viruses, fungi, and parasites, or by non-infectious factors such as autoimmune diseases, medications, or malignancies. Prompt diagnosis and appropriate management are crucial to reduce morbidity and mortality associated with meningitis.

Etiology and pathogenesis

Infectious causes

Bacterial meningitis: Common bacterial pathogens include *Neisseria meningitidis* (meningococcus), *Streptococcus pneumoniae* (pneumococcus), *Haemophilus influenzae* type b (Hib), and *Listeria monocytogenes*. The bacteria typically reach the meninges *via* the bloodstream after causing an initial infection elsewhere in the body. The pathogen's virulence factors, such as capsule formation, endotoxins, and exotoxins, contribute to the inflammatory response and neuronal damage.

Viral meningitis: Viruses such as enteroviruses, mumps virus, herpes simplex virus, and Human Immunodeficiency Virus (HIV) are known causes. Viral meningitis is often less severe than bacterial meningitis and may resolve without specific antiviral treatment.

Fungal meningitis: Fungal infections are less common but can occur, particularly in immunocompromised individuals. Pathogens such as *Cryptococcus neoformans*, *Histoplasma capsulatum*, and *Coccidioides immitis* are notable causes.

Parasitic meningitis: Parasites like *Naegleria fowleri* (a free-living amoeba) can cause primary amoebic meningoencephalitis, which is often rapidly fatal.

Non-infectious causes

Autoimmune meningitis: Conditions such as Systemic Lupus Erythematosus (SLE) and Behçet's disease can lead to meningitis as part of their broader systemic effects.

Drug-induced meningitis: Certain medications, including Non-steroidal Anti-Inflammatory Drugs (NSAIDs) and antibiotics, can induce an aseptic meningitis-like syndrome.

Malignancy: Tumors, especially those with leptomeningeal spread, can cause secondary meningitis.

Clinical presentation

Acute bacterial meningitis

Classic symptoms: Patients typically present with a triad of symptoms: fever, headache, and neck stiffness. Additional signs include photophobia (sensitivity to light), nausea, vomiting, and altered mental status. In severe cases, seizures, coma, and signs of increased intracranial pressure may occur.

Infants and children: In infants, symptoms may be less specific and can include irritability, feeding difficulties, and bulging fontanelles. Older children may present with similar symptoms to adults but may also have more prominent gastrointestinal symptoms.

Viral meningitis

Symptoms: Often presents with less severe symptoms than bacterial meningitis, including fever, headache, and neck stiffness, but may also include a mild rash or gastrointestinal symptoms. The clinical course is typically self-limited.

Fungal and parasitic meningitis

Symptoms: These forms of meningitis can present with symptoms similar to bacterial or viral meningitis but are often chronic or subacute in onset. Symptoms may include persistent headache, fever, and signs of increased intracranial pressure.

Chronic meningitis

Symptoms: Chronic meningitis may present with a gradual onset of symptoms over weeks to months, including headache, personality changes, and cognitive decline. It can be caused by infections, malignancies, or autoimmune conditions.

Diagnostic approaches

Clinical evaluation: Initial assessment includes a thorough history and physical examination. Key diagnostic clues are based on the clinical presentation and risk factors for specific pathogens.

Laboratory testing

All articles published in Journal of Virology & Antiviral Research are the property of SciTechnol and is protected by copyright laws. Copyright © 2025, SciTechnol, All Rights Reserved.

Cerebrospinal Fluid (CSF) analysis: Lumbar puncture is the gold standard for diagnosing meningitis. CSF is analyzed for cell count, protein concentration, glucose levels, and the presence of microorganisms. A high white blood cell count with a predominance of neutrophils suggests bacterial meningitis, while lymphocytic predominance is more typical of viral meningitis.

Microbiological testing: CSF can be cultured to identify bacterial pathogens. PCR and antigen detection assays are useful for identifying viral, fungal, and parasitic causes.

Blood tests: Blood cultures, Complete Blood Count (CBC), and other markers of inflammation (e.g., C-reactive protein) provide supportive diagnostic information.

Imaging

Neuroimaging: CT or MRI scans of the brain may be performed to identify complications of meningitis, such as abscesses or cerebral edema, and to rule out other potential causes of symptoms.

Treatment strategies

Antibiotic therapy

Bacterial meningitis: Immediate empirical antibiotic therapy is crucial. Common regimens include a combination of ceftriaxone or cefotaxime with vancomycin to cover a broad range of pathogens. In cases of Listeria infection, ampicillin is added. Antibiotic choice may be adjusted based on CSF culture results and susceptibility testing.

Antiviral therapy

Viral meningitis: Specific antiviral agents may be used depending on the causative virus. For example, acyclovir is used for herpes simplex virus infections.

Antifungal therapy

Fungal meningitis: Treatment typically involves antifungal agents such as amphotericin B or fluconazole, depending on the pathogen.

Supportive care

Symptom management: Pain relief, fever control, and maintenance of hydration are important. Corticosteroids may be used in certain bacterial cases to reduce inflammation and prevent complications.

Management of complications

Severe cases: In severe cases with increased intracranial pressure or neurological complications, additional interventions may be necessary, including surgical decompression or management of hydrocephalus.

Prevention and vaccination

Vaccination

Routine vaccines: Vaccines against Haemophilus influenzae type b (Hib), S*treptococcus pneumoniae*, and *Neisseria meningitidis* are effective in preventing certain types of bacterial meningitis. The introduction of these vaccines has significantly reduced the incidence of these infections.

Targeted vaccination: For high-risk populations, such as those with chronic diseases or weakened immune systems, additional vaccines and prophylactic measures may be recommended.

Prophylactic antibiotics

Contacts of invasive meningococcal disease: Close contacts of individuals with invasive meningococcal disease may receive prophylactic antibiotics to prevent secondary cases.

Conclusion

Meningitis remains a significant medical condition with a range of etiologies and clinical presentations. Timely diagnosis and appropriate management are essential to improve outcomes and reduce complications. Advances in diagnostic methods, treatment options, and preventive measures continue to enhance our ability to manage this challenging disease. Ongoing research and global health initiatives will play a crucial role in addressing the burden of meningitis and improving patient care.