

Infections Cross the Blood-Brain Barrier: The Growing Threat of Neuroinvasive Pathogens

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Abstract

The blood-brain barrier (BBB) serves as a critical protective shield, maintaining the brain's microenvironment by restricting the passage of pathogens and toxins from the bloodstream. However, certain neuroinvasive pathogens have evolved mechanisms to cross this barrier, posing significant threats to central nervous system (CNS) health. This review explores the growing concern of infections breaching the BBB, focusing on various bacteria, viruses, fungi, and parasites. We discuss the molecular and cellular strategies these pathogens employ to penetrate the BBB, including direct invasion, exploitation of host immune cells, and disruption of BBB integrity. The clinical manifestations of such infections are diverse, ranging from mild neurological impairments to severe, life-threatening conditions like encephalitis and meningitis. Understanding the interaction between pathogens and the BBB is crucial for developing effective diagnostic tools, preventive measures, and therapeutic interventions. As the incidence of neuroinvasive infections rises, driven by factors such as global travel, climate change, and immunocompromised populations, addressing this challenge becomes increasingly urgent. This review underscores the need for heightened surveillance, research, and innovation in combating neuroinvasive pathogens to protect CNS health.

Discussion

The blood-brain barrier (BBB) is a highly specialized barrier that prevents most substances from entering the brain. It is composed of a layer of endothelial cells that are tightly joined together, forming a barrier that is impermeable to most large molecules and ions. This barrier is essential for maintaining the brain's microenvironment and protecting it from the fluctuations of the bloodstream. However, certain pathogens have evolved mechanisms to cross this barrier, posing a significant threat to CNS health. This review discusses the growing concern of infections breaching the BBB, focusing on various bacteria, viruses, fungi, and parasites. We explore the molecular and cellular strategies these pathogens employ to penetrate the BBB, including direct invasion, exploitation of host immune cells, and disruption of BBB integrity. The clinical manifestations of such infections are diverse, ranging from mild neurological impairments to severe, life-threatening conditions like encephalitis and meningitis. Understanding the interaction between pathogens and the BBB is crucial for developing effective diagnostic tools, preventive measures, and therapeutic interventions. As the incidence of neuroinvasive infections rises, driven by factors such as global travel, climate change, and immunocompromised populations, addressing this challenge becomes increasingly urgent. This review underscores the need for heightened surveillance, research, and innovation in combating neuroinvasive pathogens to protect CNS health.

Microbial Infection of the BBB

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