Short Communication

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Upsurge of Powassan virus disease in northeastern United States: a public health concern—a short communication

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Abstract

Powassan virus (POWV) is a tick-borne *Flavivirus* primarily transmitted through ticks in North America which is a significant public health threat in the northeastern United States. POWV infection spans from Ontario to the Mid-Atlantic, Northeast, and Midwest regions in the USA. Climate change, ecological factors, and human-related changes, including shifts in migration and agriculture, contribute to the dissemination of POWV. Symptoms include sore throat, fatigue, headache, and severe neuroinvasive conditions. Specialized attention is required for diagnosing and managing. MRI scans detect central nervous system abnormalities, while neuromonitoring identifies metabolic distress. Severe cases may necessitate ICU hospitalisation with continuous monitoring. Prevention measures, such as awareness, controlling mammals, and protecting pets, reduce POWV infection risk. The recent outbreak of POWV in Maine, USA, highlights the importance of worldwide collaboration for prevention. With the global prevalence of POWV increasing due to climate and socioeconomic changes, implementing preventative measures and promoting awareness are crucial in reducing infection risk.

Keywords: deer tick virus, encephalitis, Powassan virus(POW)

Introduction

The persistent emergence and resurgence of zoonotic viruses withhold a growing concern for both human and animal well-being. This phenomenon demands scientific scrutiny and immediate attention toward comprehensively assessing the factors driving these pathogens.The proliferation of disease-carrying ticks, accounting for 95% of US arthropod-borne illnesses, is fuelled by climate change, human encroachment, and habitat fragmentation.The empirical study conducted in Maine reveals the presence of zoonotic virus cases in both the New England and great lake regions, with no discernible sex disparity observed[1,2]. Powassan virus (POWV), a neuroinvasive *Flavivirus*, infects humans exclusively through ticks, making it North America's endemic tick-borne flavivirus. Encephalitis or meningoencephalitis occurs with a fatality rate of 10–15% in neurologically affected individuals. POWV primarily resides in rodents, transmitted by expanding tick populations. Despite the escalating incidence of tick-borne pathogens, the United States currently lacks any available vaccine specifically targeting these pathogens. Effective tick prevention and reporting are crucial in combating POWV[3]. The recent emergence of Powassan encephalitis is likely due to the transmission of the deer tick virus (DTV) lineage by the black-legged tick, also responsible for Lyme disease. The rising incidence of DTV and zoonotic risk parallels the growing prevalence of Lyme disease and other tick-borne illnesses, posing a growing threat[4].

Epidemiology and clinical presentation

POWV is the only North American member of the family Flaviviridae (+ssRNA viruses), genus Flavivirus. It is transmitted by the Ixodes tick species and causes tick-borne encephalitis. The POWV is primarily transmitted to humans through the bite of an infected tick. In recent decades, reported cases of POWV infection have expanded from Ontario to the Mid-Atlantic, Northeast, and Midwest regions of the USA. Prior to 2005, there was one case of POWV infection per year. After 2005, the number of cases increased to 10 per year. Between 2011 and 2020, there were 194 documented cases of POWV disease reported in the USA. POWV cases are primarily reported during the season of high tick activity, which is from May to September. During the period between 2010 and 2019, there were 181 reported cases, out of which 166 cases developed neuroinvasive disease. This spread is attributed to various factors, including climatic, ecological, and human-related changes, such as shifts in movement and

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agricultural patterns. Similar to other vector-borne illnesses, there has been a dramatic increase in the number of POWV cases. Considering the impact of climate on the occurrence and distribution of vector tick species, global warming, and its negative consequences may contribute to the future expansion of the geographical distribution of this tick species[5].

Non-neuroinvasive patients may experience sore throat, fatigue, headache, disorientation, and occasionally fever. Unlike other tick-borne illnesses, POWV infections are primarily neuroinvasive, with signs of encephalitis, meningoencephalitis, or aseptic meningitis. Some POWV encephalitis cases report ophthalmoplegia and nystagmus. Neuroinvasive cases have a 10% mortality rate, and 50% of survivors face long-term neurological sequelae like hemiplegia, muscle atrophy, severe headaches, and memory impairments[6]. The Major clinical features of POWV disease have been summarised in (Fig. 1).

Emergence in Maine, USA

POWV mostly spreads to humans by tick bites; infected deer ticks (*Ixodes scapularis*) or woodchuck ticks (*Ixodes cookei*), both of which are prevalent in the eastern United States and warrant significant consideration. Rare incidences of transmission via blood transfusions have been observed. Since 2013, the Maine Center for disease control and prevention has routinely documented POWV cases[7]. Tick survival is dependent on ideal conditions, which are determined by soil type, moisture retention, and host availability. The weather conditions for incubation are unclear. POWV and other tick-borne diseases are spread by adaptable hosts such as white-footed mice and voles. Precautions and global collaboration are critical in reducing tick-borne illness risks amidst environmental changes[1]. A Maine study reveals DTV infection in adult *I.scapularis*ticks, 2016–2017, with rates ranging from 0 to 3.5%. Similar rates in Wisconsin, Connecticut, and New York suggest consistent DTV infection patterns. The study also reveals genetic similarity among DTV isolates in the northeastern United States[8].

Diagnosis and management

POWV is a fatal disease that causes diffuse meningoencephalitis in laboratory animals and is transmitted by vertebrate hosts. After inoculation, the virus replicates and spreads through dendritic skin cells to lymph nodes, infecting lymphocytes and disseminating systemically. It then crosses the blood-brain barrier via the bloodstream, affecting various regions of the central nervous system.MRI reveals increased signal intensity on T2-weighted and fluid-attenuated inversion recovery) images, indicating frequent abnormalities in the thalamus, basal ganglia, cerebellum, and brainstem. Among these, thalamic lesions, whether unilateral, bilateral, multifocal, or diffuse, are the most common findings[9]. For patients with severe neurological or systemic symptoms, immediate admission to a (neuro) ICU is crucial. Approximately 12% of hospitalised POWV patients require ICU treatment, and around 7% may need artificial ventilation. Continuous invasive monitoring of intracranial pressure and cerebral perfusion pressure is recommended, particularly for conditions like meningitis and encephalitis that can cause brain oedema[10].

Invasive multimodal neuromonitoring is effective in detecting metabolic distress in severe brain oedema. Additionally, electroencephalogram plays a vital role in diagnosing epileptic seizures in entral nervous system infections and should be included in critical care monitoring[11].

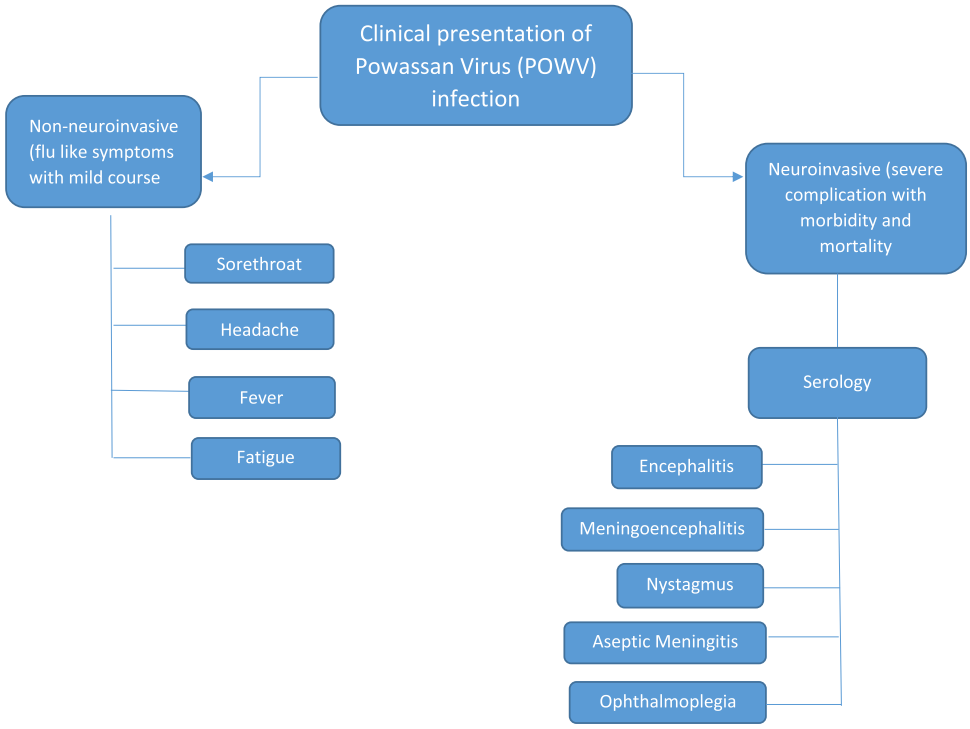

Figure 1. Clinical presentation of Powassan virus (POWV) disease.

Recommendations

POWV causes clinical disease in thousands of individuals annually in Europe and Asia. Its incidence has notably increased in Europe due to climate and socioeconomic changes. The endemic regions of the POWV are also shifting northward[12].

POWV is a tick-borne disease for which there are currently no specific treatments or vaccines available. Therefore, prevention becomes a critical aspect of avoiding infection. To minimise the risk of tick bites and subsequent transmission of the virus, it is advisable to take certain precautions. When venturing into tick-prone areas, wearing protective clothing, such as long-sleeved shirts, long pants, and closed-toe shoes, can act as a physical barrier against ticks. Additionally, using insect repellents containing N,N-diethyl-m-toluamide can effectively deter ticks from latching onto the skin. After engaging in outdoor activities, it is essential to conduct thorough checks on the body, paying close attention to hidden areas like the armpits, groyne, and scalp, as ticks tend to favour these regions. In the event of discovering a tick attached to the skin, it is crucial to promptly remove it using fine-tipped tweezers, ensuring to grasp it as close to the skin's surface as possible and pulling upward with a steady, even pressure[13]. Also, it is important to protect pets (dogs and cats) from tick bites and regularly check them to prevent ticks from entering their living spaces[14]. By adhering to these preventive measures, individuals can reduce their susceptibility to POWV and safeguard their well-being.

Discussion

POWV is an emerging arboviral infection that can cause encephalitis and meningoencephalitis. It is a neuroinvasive, single-stranded, positive sense RNA tick-borne flavivirus. POWV is the only tick-borne flavivirus recognised in North America, where it may cause sporadic cases of encephalitis, meningoencephalitis, aseptic meningitis, and other neurological diseases. Recent studies have shown an upsurge in POWV virus cases in the United States. This increment in the number of reported cases may be due to increased exposure to infected ticks. The elusive tick-borne nature of the virus renders control challenging, with the current absence of a vaccine or targeted treatment for POWV infection. Given the severity of POWV infection and the lack of effective treatments, it is crucial to continue studying the ecology and epidemiology of the virus to develop effective prevention and control strategies. POWV is also nationally notifiable, requiring prompt notification of all cases to regional public health agencies for prompt action. This allows for monitoring and tracking of the virus's spread and helps identify areas at high risk of infection. Since there is currently no vaccine or specific treatment for POWV, prevention heavily relies on personal protective measures to decrease exposure to infected ticks. The dissemination of information regarding POWV and its modes of transmission holds pivotal significance in preventive efforts. Public health authorities have a crucial role in providing informative resources and organising campaigns to raise awareness among the public regarding the dangers of tick bites and the importance of taking personal precautions. By strategically applying tick control measures in endemic areas, we hold the potential to reduce the tick population, thereby mitigating the risk of POWV transmission. The current trends can be enhanced by implementing different layers of control measures effectively running in synchrony and parallel to each other. Continued research on POWV is also crucial for bridging the gap by developing a better understanding of transmission dynamics, tick vectors, and potential reservoirs. This knowledge can inform the development of vaccines and targeted interventions to prevent and control the virus.

Conclusion

POWV is an emerging tick-borne flavivirus endemic to North America and Far Eastern Russia. The northeastern United States has witnessed a concerning upsurge in POWV cases, along with other tick-borne diseases. Our study confirms the expanding infection and tick-borne diseases in the region, emphasising the urgency of proactive measures.

POWV presents with mild to severe neuroinvasive conditions, leading to a 10% mortality rate and long-term neurological issues. This highlights the urgency of prompt diagnosis, specialised management, and prevention efforts.

Climate change, human activities, and habitat fragmentation contribute to POWV spread through tick population expansion. To combat POWV, educating communities, healthcare professionals, and policymakers is crucial for early detection and management. An extensive tick surveillance program is needed to monitor ticks carrying POWV.

Physicians in endemic regions should consider tick-borne diseases in their diagnosis and report diseases in remote areas to local health departments. The lack of specific treatment or prevention strategies underlines the necessity for an effective vaccine.

Public education on preventive measures, such as avoiding contact with sick animals, can be beneficial. Reporting dead or sick animals can act as an early warning. Unnecessary visits to tick-endemic areas should be avoided, and if necessary, individuals should wear long-sleeved nylon clothing.

Fostering global collaboration and adopting comprehensive approaches will strengthen the fight against POWV and other tick-borne diseases.

Ethics approval

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References

[1] Hassett EM, Thangamani S. Ecology of Powassan virus in the United States. Microorganisms 2021;9:2317.
[2] Uwishema O, Masunga DS, Naisikye KM, *et al*. Impacts of environmental and climatic changes on future infectious diseases. Int J Surg 2023; 109:167–70.
[3] Kapoor AK, Zash RPowa In: Stat Pearls. Treasure Island (FL): StatPearls Publishing; March 27, 2023.
[4] Goethert HK, Mather TN, Johnson RW, *et al*. Telford SR 3rd. Incrimination of shrews as a reservoir for Powassan virus. Commun Biol 2021;4:1319 Published 2021 Nov 22.
[5] Rupani A, Elshabrawy HA, Bechelli J. Dermatological manifestations of tick-borne viral infections found in the United States. Virol J 2022; 19:199.
[6] Campbell O, Krause PJ. The emergence of human Powassan virus infection in North America. Ticks Tick-Borne Dis 2020;11:101540.
[7] Division of Disease Surveillance Powassan Virus - Infectious Disease Epidemiology Program - MeCDC; DHHS Maine. Accessed: 29 May 2023. Available at: https://www.maine.gov/dhhs/mecdc/infectious-disease/epi/vector-borne/powassan/index.shtml
[8] Robich RM, Cosenza DS, Elias SP, *et al*. Prevalence and genetic characterization of Deer Tick Virus (Powassan Virus, Lineage II) in Ixodes scapularis Ticks collected in Maine. Am J Trop Med Hyg 2019;101: 467–71.
[9] Stone ET, Hassert M, Geerling E, *et al*. Balanced T and B cell responses are required for immune protection against Powassan virus in virus-like particle vaccination. Cell Rep 2022;38:110388.
[10] Piantadosi A, Solomon IH. Powassan virus encephalitis. Infect Dis Clin North Am 2022;36:671–88.
[11] Taba P, Schmutzhard E, Forsberg P, *et al*. EAN consensus review on prevention, diagnosis and management of tick-borne encephalitis. Eur J Neurol 2017;24:1214–e61.
[12] Madison-Antenucci S, Kramer LD, Gebhardt LL, *et al*. Emerging Tick-borne diseases. Clin Microbiol Rev 2020;33:e00083–18.
[13] B ogaty C, Drebot M. Powassan virus—an emerging public health concern. CMAJ : Can Med Assoc J 2018;190:E472.
[14] Kemenesi G, Bányai K. Tick-borne Flaviviruses, with a focus on Powassan virus. Clin Microbiol Rev 2018;32:e00106–17.