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Perspective

Epidemics and Evolution: The Role of Vaccines and Antivirals in Controlling Hemorrhagic Fever

Jason Posta*

Department of Medicine, Wayne State University School of Medicine, Detroit, United States of America

DESCRIPTION

Viral Hemorrhagic Fevers (VHFs) are a group of diseases characterized by severe and often deadly symptoms, including fever, bleeding and organ failure. These illnesses, which include ebola, marburg, lassa fever and orimean-congo hemorrhagic fever are caused by viruses that disrupt blood vessel integrity and immune function leading to hemorrhaging and high mortality rates. VHFs are most commonly found in tropical regions, where conditions often facilitate transmission and they pose a serious global health risk due to their high fatality rates and potential for outbreaks. Over the years, epidemics of VHFs have spurred international research efforts to develop effective vaccines and antiviral treatments. The severity of VHFs lies in the unique way these viruses attack the human body. Viruses such as ebola and marburg are known for causing extensive blood vessel damage and immune suppression. These viruses enter human cells, replicate rapidly and evade immune responses, resulting in widespread inflammation and tissue damage. In the case of ebola, infection often leads to hemorrhaging, where patients experience internal bleeding, gastrointestinal distress and ultimately multi-organ failure. With fatality rates ranging from 25% to as high as 90% in certain strains, VHFs place a significant strain on healthcare systems, particularly in resource-limited areas.

The transmission of VHFs varies depending on the virus. For example, ebola and marburg viruses are transmitted through direct contact with bodily fluids of infected individuals or animals, while lassa fever is typically transmitted through exposure to infected rodents. Furthermore, the highly infectious nature of these viruses and their ability to spread through direct or indirect contact contribute to rapid outbreaks in densely populated or healthcare-challenged areas. One of the most promising responses to VHFs has been the development of vaccines. Vaccine research gained momentum after the 2014-2016 Ebola outbreaks, which claimed more than 11,000 lives. In addition to vaccines, antiviral drugs are emerging as a vital tool for treating VHFs. While vaccines are essential for preventing infection, antivirals are essential in reducing disease severity and mortality once an individual has been infected. One notable development is the approval of remdesivir, an antiviral that inhibits viral replication. Originally developed for treating ebola, remdesivir gained prominence during the COVID-19 pandemic but has also shown efficacy in reducing viral loads and improving outcomes in VHF patients. Similarly, favipiravir, a broad-spectrum antiviral, is being investigated for its potential effectiveness against a range of VHFs.

Beyond existing treatments, scientists are working to develop monoclonal antibodies specifically targeting VHF viruses. For Ebola, the antibody treatment Inmazeb, approved by the U.S. Food and Drug Administration (USFDA), has proven effective in neutralizing the virus and providing immediate immunity. These antibodies bind to viral proteins and prevent the virus from entering cells, offering a therapeutic option for patients already infected. Given their high efficacy, monoclonal antibodies have become an essential part of the therapeutic arsenal in managing VHF outbreaks.

The development of vaccines and antivirals for VHFs is not without challenges. One major hurdle is the limited infrastructure in regions where VHFs are most prevalent. In resource-limited areas, access to vaccines and antiviral treatments remains challenging due to logistical issues and lack of cold chain facilities. Furthermore, the cost of developing and deploying these treatments is high, often limiting the ability of low-income countries to benefit from advancements. Another challenge is the rapid mutation of some viruses, such as lassa and ebola, which can affect the efficacy of vaccines and antivirals. Researchers are thus focused on developing treatments that target conserved viral components, increasing the likelihood of effectiveness across different strains.

Despite these challenges, the global response to VHFs has fostered international collaboration and innovation. Initiatives such as the Coalition for Epidemic Preparedness Innovations

Correspondence to: Jason Posta, Department of Medicine, Wayne State University School of Medicine, Detroit, United States of America, E-mail: jason@pt.edu

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(CEPI) are working to accelerate vaccine research for diseases with epidemic potential, including VHFs. In collaboration with WHO and various governments, CEPI has funded research into vaccine platforms that can quickly be adapted to emerging threats. Similarly, the World Health Organization has implemented preparedness and response strategies, such as training healthcare workers and deploying rapid diagnostic tools in high-risk regions, to stop the spread of VHFs.