

## Rift Valley Cholera: Science and the Study of Disease Transmission

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### Abstract

Rift Valley Fever (RVF) is a viral zoonosis spread by mosquitoes. It was first discovered in Kenya in 1930, and since then, it has spread to many African nations and the Arabian Peninsula. Human infection can result in a wide range of clinical outcomes, from self-limiting febrile illness to life-threatening hemorrhagic diatheses and miscarriage in pregnant women. The RVF virus primarily infects domestic livestock (sheep, goats, cattle) resulting in high rates of neonatal mortality and abortion. RVF has been responsible for numerous outbreaks in Africa and the Arabian Peninsula since its discovery, with significant effects on human and animal health. However, the lack of licensed human vaccines or therapeutics limits options for controlling RVF outbreaks. The World Health Organization places RVF at the top of its priority list for urgent research and development of measures to prevent and control future outbreaks. The current understanding of RVF, including its epidemiology, pathogenesis, clinical manifestations, and vaccine development status, are highlighted in this review.

**Keywords:** Zoonosis; Hemorrhagic; Miscarriage; Pathogenesis; Epidemiology

### Introduction

In 1930, Rift Valley Fever Virus (RVFV) was discovered to be the cause of an outbreak of "enzootic hepatitis" near Lake Naivasha in Kenya's Rift Valley. Blood from a diseased lamb was injected into an unaffected lamb, which reproduced the disease, through a Chamberland porcelain filter to determine whether it was caused by a bacterium or a virus. The outbreak occurred during a time of high mosquito activity, leading the researchers to believe that mosquitoes play a role in disease transmission. Healthy sheep were either relocated to a higher altitude where mosquitoes were absent or placed under mosquito netting in an effort to contain the outbreak. Both measures worked, and the lack of apparent direct animal-to-animal transmission supported the hypothesis that mosquitoes are involved in disease transmission. RVFV was later isolated from several naturally infected species of *Aedes* and *Culex* mosquitoes, confirming their role as vectors [1].

During and after the outbreak, inquiries revealed that nearly all herders had experienced severe pain and fever. It was believed that hundreds of human cases occurred without any fatalities. As a result, the infection was regarded as low-risk, and human susceptibility was demonstrated by injecting filtered blood from an infected lamb into a volunteer human. The majority of what we know about the natural course of RVF in humans and animals was informed by a number of animal infection studies that were carried out shortly after the outbreak and in the years that followed. These studies documented the susceptibility of a diverse range of animal species. We highlight recent advancements in our understanding of RVF, including its epidemiology, pathogenesis, clinical characteristics, and vaccine development status, in this review [2-5].

### Epidemiological impact

The ability to transmit the virus to its offspring has been demonstrated by a single species of *Aedes* that was incorrectly identified as *Aedes lineatopennis* prior to 1985 and later identified as *Aedes (Neomelanimon) mcintoshi*. During the dry season, RVFV may be able to remain viable in the eggs of this species before hatching when the rains return. Further research is needed to determine whether this is the only species capable of vertical transmission and to what extent it permits RVFV to circulate during IEPs. Seropositivity in sheep and goats that have not experienced an RVF outbreak suggests that the

virus can circulate at a low level in livestock. Wild ungulates can also be infected with RVFV by mosquitoes.

In point of fact, a wide variety of species, including African buffalo, giraffe, black rhino, impala, and African elephants, among others, have been found to have neutralizing antibodies that target RVFV. While some of these species, like buffalo and giraffe, appear to be immune to RVF, others, like elephants, appear to be.

RVF epizootics, in which a large number of livestock become infected, can occur when there are periods of exceptionally heavy rains that are followed by flooding that causes large increases in mosquito populations. Rainfall data and changes in vegetation have been used to predict RVF outbreaks because of the correlation between the weather and RVFV infection. However, models that predict RVF outbreaks frequently rely on inaccurate data on the variables. Because of this, these models' predictive value varies [5]. In Kenya, synchronous monitoring of livestock herds during times when conditions appear favorable for RVF outbreaks has also been utilized as an early warning system. Farmers may be more aware of RVF and more likely to get vaccinated as a result of these systems.

RVFV can be transmitted by a wide variety of mosquito species. The virus can infect other arthropods like midges, ticks, and sandflies, which could potentially serve as mechanical vectors. More than 53 species of mosquitoes caught in the field tested positive for RVFV, according to a study. Additionally, more than 65 species have been identified as potential vectors, most of which are *Aedes spp.* and *Culex spp.*. Depending on the species, some of these potential RVFV vectors may be able to successfully transmit the virus [6].

The majority of human infections, in contrast to those that affect

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**Received:** 01-April-2023, Manuscript No: awbd-23-95031; **Editor assigned:** 03-April-2023, PreQC No: awbd-23-95031(PQ); **Reviewed:** 17-April-2023, QC No: awbd-23-95031; **Revised:** 21-April-2023, Manuscript No: awbd-23-95031(R); **Published:** 28-April-2023, DOI: 10.4172/2167-7719.1000172

**Citation:** Wilson K (2023) Rift Valley Cholera: Science and the Study of Disease Transmission. Air Water Borne Dis 12: 172.

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animals, are caused by contact with infected tissues or fluids rather than by a mosquito bite. Various instances of human transmission during the 1930-1950s happened via unintentional lab contamination. In fact, these case reports were the source of much of our early understanding of the disease in humans.

Direct human-to-human transmission has not been recorded. There is no evidence of nosocomial transmission even during epidemics in hospitals with inadequate personal protective equipment. In one instance, viral RNA was isolated from an immunosuppressed patient's urine and sperm four months after the onset of symptoms. However, it is unknown whether RVFV can be transmitted sexually. Ex vivo experiments have shown that RVFV can directly infect human placental tissue, and vertical transmission from mother to child has been documented in human cases [7,9].

### Factors related to disease

Numerous studies on seroprevalence in human populations have provided insight into the populations most at risk for infection. Having contact with susceptible animals and participating in the slaughter process is the most significant risk factor. Adults are more likely than children to be seropositive, either because they are older and have had more time to come into contact with RVFV or because of the increased occupational risk.

However, it is unlikely that all of the larger outbreaks, like the one in Egypt in 1977, were caused by direct animal contact. *Culex pipiens* was mentioned for the first time in this instance. There are documented cases of human infections that were attributed to mosquito bites, despite having no direct connection to livestock [8-11].

It is currently unclear why some individuals develop more severe disease with long-term issues while others remain asymptomatic or experience only mild symptoms before recovering. Some evidence suggests that co-infection with other pathogens may make people more susceptible. For instance, RVF and HIV-1 co infection were found to increase the risk of severe illness and death, with 75% of cases resulting in death. Other studies have identified an association between severe disease and single nucleotide polymorphisms in genes involved in immunological pathways, indicating that host genetic factors play a role in susceptibility.

### Impact associated to disease

#### Hepatitis, Hemorrhagic disease

The liver suffers damage as the primary RVFV replication site, which can result in jaundice and hemorrhagic disease. Increases the level of aspartate transaminase and alanine transaminase. As the clotting time increases, platelet counts and hemoglobin levels decrease. Thrombosis is one possible additional symptom. The mortality rate for hemorrhagic fever patients is extremely high, and they typically die within a week or two of the onset of symptoms.

#### Encephalitis

Reduced consciousness, hallucinations, confusion, vertigo, excessive salivation, weakness, paralysis, decerebrate posture, hemiparesis, and pleocytosis are among the severe and persistent problems that can occur shortly after initial symptoms subside.

#### Miscarriage

Human abortion is less clearly linked to RVFV infection than ruminants. A concentrate on investigating the rate of early termination

during the 1977 episode in Egypt viewed as no increment over the ordinary recurrence of early terminations. However, a 2016 study demonstrated, for the first time, a significantly increased risk of miscarriage following a pregnancy with a laboratory confirmed RVFV infection. However, it appears that the risk of abortion in humans is lower than in livestock. It is necessary to conduct additional research on the underlying mechanisms of RVF caused pregnancy loss.

### Treatment strategy

As of now, immunization is viewed as the main technique to forestall RVFV diseases in animals. However, the current vaccines for livestock have a lot of room for improvement. The lack of licensed human vaccines also makes it difficult to use tools to control the spread to humans. Repeating the extensive security coming about because of normal openness is an alluring objective. In the United States, two vaccines for humans are currently considered investigational new drugs: MP-12 and TSI-GSD-200. The strain MP-12 was developed in the 1980s. It has 23 nucleotide mutations that are distributed across all three genome segments. One of the viral clones isolated from a human patient infected with the 74HB59 strain in the Central African Republic was another livestock vaccine, clone 13. The primary virulence factor, the NSs gene, was found to be naturally attenuated, and subsequent infection of mice demonstrated that it did not cause disease. In cattle, sheep, and goats, a single dose of clone 13 proved safe and immunogenic. However, clone 13 has been shown to be able to cross the placental barrier and cause teratogenic effects in overdose studies on pregnant ewes. A thermo stabilized rendition, chose from suitable clones after hatching at 56 °C, has been utilized to immunize animals in Senegal what's more, Mali.

### Conclusion

The creation of particular vaccines and therapeutics is also crucial. Impediments of current domesticated animal's immunizations and the shortfall of an authorized human antibody have restricted our capacity to answer flare-ups actually. To better comprehend viral maintenance during IEPs, more research is required; the significance of mosquito vertical transmission and wildlife circulation in various ecological settings. There is still a lack of understanding regarding the ways in which various methods of human exposure—such as being bitten by a mosquito or coming into contact with infected animal products—affect the immune system and the course of the disease. In addition, it is still unknown how cellular immunity affects humans and livestock. Last but not least, gaining a deeper comprehension of the factors that lead to the various manifestations of RVF disease may make it easier to explain why an infection may cause no symptoms or be associated with a clinical illness that can be fatal. Since multiple species are affected by a single RVFV serotype, it is possible to investigate how species-specific immunological differences affect disease outcome.

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