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Review Article

Epidemiology, Clinical Manifestations, Treatment Approaches and Future Perspectives of Rift Valley Fever

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ABSTRACT

Rift Valley fever (RVF) is a mosquito borne viral disease that had been firstly revealed in Kenya in 1930. It has now become an endemic in all over multiple African states as well as in Arabian Peninsula. In the early days, RVF was assumed to be geologically restricted to only sub-Saharan Africa, thus, RVF generally had not been considered in the diagnosis of disease epidemics outside of the Africa. The loss of livestock had furthermore threatened the livelihood of people who were dependent on the animals for their food and income. Weakness, chills, headache, fever are considered to be the most common symptoms that arise in the patients suffering from RVF. Nevertheless, the choices for control of the RVF outbreaks have been restricted by the lack of approved human vaccines or other medications. Ribavirin, Favipiravir and various other anti-viral drugs had shown to be effective against the rift valley fever. However, only supportive care had been used for the treatment of the RVF. For that purpose, Rift Valley Fever had now been prioritized by the World Health Organization (WHO) for urgent research and development of countermeasures for the control and prevention of future outbreak. In this review, we had highlighted the outbreak of Rift Valley Fever in various countries, its epidemiology, clinical manifestations, various medications that had been used for the treatment of this infectious disease and also the future prospectives regarding the RVF based on up-to-date data extracted from reputed journals and official websites.

INTRODUCTION

An evolving arboviral disease Rift Valley fever (RVF), had affected humans as well as the livestock in the Middle East, western Indian Ocean and Africa. In Kenya, This disease was very firstly defined in 1930 after abrupt mortality in the lambs that arose on a farm in the region of Rift Valley [1]. Substantial rise in the adjacent regions arose in initial 2000s when this outbreak was reported in Yemen and Saudi Arabia. To this day, many of the Egypt region and Sub-Saharan Africa is now considered to be endemic for Rift Valley fever virus (RVFV) or had been affected by infrequent outbreaks [2-7]. RVFV is adherent to the Bunyavirales order, Phenuiviridae family, of negative-sense RNA viruses. It consists of 3 genome segments: small (S) segment that had encoded nucleoprotein N as well as non-structural proteins, large (L) segment that encodes viral RNA-dependent RNA polymerase (RdRp) and medium (M)

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segment that encodes surface glycoproteins Gc and Gn accompanied by nonstructural protein NSm. Humans could be exposed by the bite of mosquito or may be by the contact with the tissues and infected fluids. Numerous studies had suggested the transmission of vector-borne to be likely for humans [8]. Exposures of Zoonotic may be determined by much of homestead and occupational behaviors that have been performed with consistency. Occupational exposures had been exposed to provoke a larger occurrence than the individuals that have close contact with or caring for the animals at homestead, as well as is expected to be related to contact with some larger volume of animals and their fluids [9]. Another possibility is the Aerosolization, though it is very not likely route of transmission, as well as had been very much associated with a larger probability of the unembellished disease in the laboratory experiments [10]. About 1–2% of the cases had experienced symptoms of hemorrhagic fever, whereas approx. up to 50% of the hemorrhagic cases are very deadly [11]. Many In-vitro studies had previously proposed that, the hemorrhage that results by the Rift Valley Fever Virus infection caused by the rift valley fever virus (Figure 1) might be related to the expression levels of transcription factor IIH (TFIIH) [12]. It had been recommended that hemorrhagic cases of Rift valley fever virus infection might enhance risk of the nosocomial transmission for the healthcare workers as well as many other individuals providing care [13], so far human-to-human passage transmission via the nosocomial routes of contact had up till now to be documented. This review describes the epidemiology of the disease, clinical manifestations that were observed of Rift valley fever, a brief treatment and prevention approaches for the rift valley fever and also the future prospectives of this infectious disease built on the most current literature report since the outbreak.

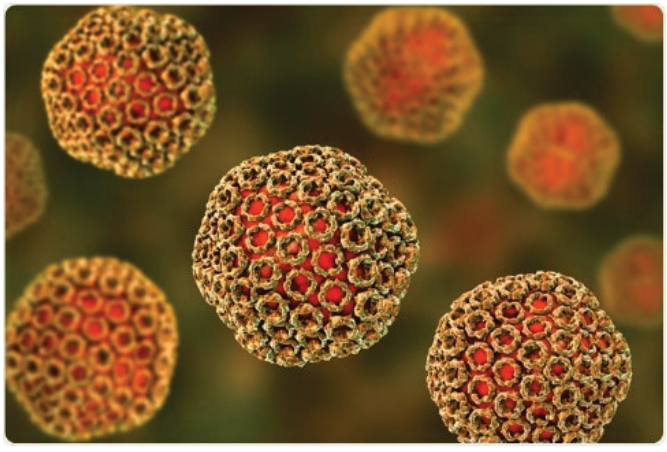

Figure 1: Rift Valley Fever Virus (RVFV)

Epidemiology

Very recently, RVFV had appeared to be recurring much more often, by approximately many areas of the Eastern Africa going through the eruptions of Rift valley fever after each four years [2, 14]. Systemic investigations of seroprevalence studies and case reports had founded, Rift Valley Fever Virus been familiar in all the 5 African regions encircling 80% of all the countries belonging to African region [2]. The appearance of Rift Valley Fever in Arabian Peninsula in initial 2000s was expected to be occurred because of import of the disease-ridden mosquitos or may be livestock during the trade crosswise the Red Sea [15]. Livestock investigations had shown a very extensive range of Rift Valley Fever Virus seroprevalence, with less than one percent to approximately 50% in the cattle, camels and goats as well as equal to 90% of sheep, contingent on season, vicinity, age of animal, bioclimatic region and animal breed [16-20]. This virus had continued to blowout to many other portions of Africa that had not been formerly detected as well as introduction of the disease hooked on the other countries leftovers a very potential threat [2, 21, 22]. Many human cases succeeding epizootic eruptions could array from thousands to hundreds, along with many of the case fatalities amid to be found between 1% and 30% in the symptomatic individuals reporting to authorities of healthcare system [23, 24]. Incidence of Rift Valley Fever Virus infection might be misdiagnosed and underrated or lest adjacent to a known livestock eruption because of non-specific symptoms of disease as well as similarity to cocirculating pathogens [25, 26]. RVFV overlays with the other endemic viral diseases and with some identical disease manifestations, including West Nile virus (WNV) and Lassa fever possibly complicating treatment and diagnoses of the cases.

Clinical manifestations

Majorly, the cases of RVF are very self-restrictive as well as could be recognized by slight frequently sub-clinical febrile sickness and also by means of incubation time of characteristically up to 4 to 6 days [27]. Symptoms mainly comprises of severe chills, malaise, dizziness, weakness, and headache [28]. Typically, many patients had suffered from a two phasic febrile phase, that had been recognized along with an unembellished headache. Some individuals alternatively, who had developed the very unembellished forms of Rift valley fever had been at very increased risk of the fatality. Liver infection is mostly characterized by the increase in lactate dehydrogenase, aspartate aminotransferase, alanine aminotransferase as well as decreased hemoglobin and count of platelet are significant [29]. Demise could happen mostly in about 3–17 days afterwards the initiation of these signs as well as deadly cases of Rift Valley Fever had showed diffuse gastrointestinal as well as hepatic necrosis. Many individuals had presented a reduced level of consciousness

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that are suffering from RVF-induced encephalitis. In many cases, patients with RVF could grow a maculo or retinopathy (0.5 to 2%), that could affect in either one or both the eyes as well as could occur in either very initial or months afterward infection. Many studies had described that some patients could have loss of vision or also may have a blurry vision. Though, in many scenarios a fractional development in visualization over time had been recognized [30], yet, numerous individuals would experience complete or might be partial blindness [31].

Various medications for Rift Valley Fever Virus

Mostly, antiviral treatments either be targeting the processes intrinsic to viruses, for example, binding of host cell and also the viral genome replication, or can moderate the host cellular progressions that are very significant for virus lifecycle.

Table 1: Summary of antiviral medications for treatment of Rift Valley Fever

Therapeutics	Mechanism	In-Vitro Results	Reference
Ribavirin ± poly(ICLC)	Nucleoside analog ± immunostimulant	78 µg/ml (Vero)	[32]
Suramin	Interaction of vRNA/N	22.3 µM (HEK 293T)	[33]
Favipiravir (T-705, AviganR) ± ribavirin	Nucleotide analog ± nucleoside analog	31 µM (Vero 76)	[34]
Sorafanib	RNA synthesis	6.4 µM (Vero)	[35]
Rapamycin	Inhibition of mTOR	11 µM (H2.35)	[36]
Bortezomib	Inhibition of Ubiquitin proteasome	0.01 µM (HSAEC)	[37]
GYY4137 (H2S-donor)	Reactive species scavenger	5 mM (Vero)	[38]

Existing approaches for the treatment of patients suffering with RVF as shown in Table 1 mainly focus on providing symptomatic care. RVFV ZH501, a pathogenic strain that had been isolated from a deadly human case during the first outbreak of Egyptian Rift Valley Virus in 1977 to 1978. This strain had been recognized as a select agent, as well as could be utilized at BSL4 or BSL3E containment. MP-12 strain had been established via the consecutive plaque channels of strain of Egyptian ZH548, that is 12 times more in the presence of a chemical mutagen, 5-fluorouracil. RVFV ZH548 had also been isolated from a febrile patient when it was Egyptian outbreak in 1977 to 1978 [39].

Ribavirin

Ribavirin, a nucleoside analogue, had been considered as one of the few drugs that have been permitted for the therapy of particular viral hemorrhagic fevers [40]. Subsequently, the progress in 1980s, this had been considered to be very foremost anti-viral that had been investigated in the models suffering from infection with phlebovirus. In early investigations, it had presented a very high efficiency in vitro utilizing the preserved cell lines that had been separated by the African green monkey, many investigations had been rapidly extended towards a model of infection in mice with the tightly linked phlebovirus and the Punta Toro virus. At this time, therapy of ribavirin had very much decreased copying of the virus as well as the harshness of symptoms along with the 100% persistence at daily administration of 18.8 mg/kg subcutaneously, by primary therapy of 4 hours just before the subcutaneous infection. Inappropriately, side effect ribavirin profile, most commonly hemolytic anemia and inflammation, had been restricted its usage in the clinical settings. Encapsulation of the lipid had been very much effectively utilized in decreasing side effects via the administration of lesser but more of the targeted doses, that results in the enhanced persistence of the mice that are infected [41].

Favipiravir

Favipiravir, formerly developed by the Toyama Chemical (Japan), had been considered as a non-nucleoside inhibitor in influenza polymerase as well as had also received the support for using in contrast to the viruses of influenza in Japan as well as Phase-III clinical investigations had been finished in United states of America [42]. Prominently, favipiravir had been verified to be as effective as a broad spectrum anti-viral that is against a very broad spectrum of the RNA-viruses that includes yet had not been restricted to paramyxo-, arena-, filo-, as well as bunyaviruses. In preliminary, in-vitro studies had shown that the favipiravir is very extremely active against the bunyaviruses from diverse genera, that includes Rift Valley Fever Virus along with an EC50 of about 32 µM. Afterwards, the efficiency of favipiravir had been investigated in a model of hamster for Rift Valley Fever Virus ZH501. The treatment started 1-hour post-infection (HPI) along with a 200 mg/kg/day twice daily (BID) orally (PO) for 10 days protected 80% of SC infected animals along with 30 pfu RVFV ZH501. Ribavirin (75 mg/kg/day, BID, PO) had been a part of as a positive control as well as only bring about in the 20% of survival. In another investigation, by the use of an aerosol exposed model of Wistar–Furth rat, Caroline as well as his various colleagues had demonstrated that the animals that have received favipiravir inside the 1 HPI at 100 mg/kg/day BID per oral for 14 days had been completely covered from the deadly Rift Valley Fever Virus infection together with 50 pfu. Once the treatment had been started 48 HPI, the persistence rate was mainly considered to be 92% [43].

Vaccines

At present, no vaccine is there for the prevention of Rift valley fever infection that had been permitted for use in the

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animal in Europe or North America. Subsequently, initial isolation of the Rift valley fever virus, multiple vaccines against the RVF virus had been established, that includes the vaccines that had been produced via inactivation of formalin [44]; by attenuation via the in vivo serialized passage and can be via the in vitro chemical mutagenesis [39]; through the use of naturally founded attenuated mutant virus, recombinant virus vectors, viral subunits or by viral cDNA; as well as by using the recombinant live attenuated Rift valley fever virus that contains whole removals of the already recognized virulence genes. In the last 50 years, each of these methods had been leading to the extra refinements in safety and efficacy of the vaccines as well as had enhanced the understanding of RVF virus vaccinology. Vaccines that are Formalin-inactivated have been considered as safe, yet they also have problems for use in field because of characteristic requirement for three early inoculations over a period of one to two months that have been then followed by the annual booster inoculations [45]. Though, for use in human, a formalin-inactivated product had been formed in the middle of the 1970s further down a new innovative license of drug from the Food Drug Authority. The usage of this vaccine had been very firstly been beset at laboratory as well as on the other service personnel by large occupational hazard of contact to the virus. Though, now, no further produced as well is also in the restricted supply, TSI-GSD-200 had been verified as an effective, immunogenic, and safe in reducing the laboratory acquired infections between 598 human vaccines. The strain of live-attenuated Smith-burn Rift Valley Fever virus had been efficacious as well as immunogenic in the adult cattle and sheep, yet this had too caused teratologic effects in the fetuses or abortion in approximately 25% of the pregnant animals [46]. Therefore, this vaccine is very much probably inappropriate for the use in the areas that are separate of endemic zone of Rift Valley Fever virus activity.

Future perspectives

During the past years, further research had focused on the emergent pathogens with the goal of enhancing our preparation for any of the future outbreaks. RVFV had a complex ecological cycle that involves a very large range of livestock, vectors as well as wildlife species. Unfortunately, present surveillance is sub-optimal in several at-risk countries with numerous eruptions that remains unreported [47]. Preferably, proper surveillance measures would enable farmers to report unexplained disease in their livestock, which can be investigated and allow suitable measures to be implemented to reduce spread [48]. The development of specific therapeutics and vaccines is also of major importance. Disadvantages of current livestock vaccines and the absence of a licensed human vaccine have limited our ability to effectively respond to outbreaks. More research is essential for a better understanding of viral maintenance during IEPs; the part of vertical transmission in mosquitoes and flow in wildlife in numerous ecological surroundings. Information of how diverse ways of human exposure, for example via mosquito bite or via contact with the infected animal products, affect the immune response as well as disease results are still missing. Moreover, the role cellular immunity plays in livestock as well as in humans is still uncertain. Lastly, a better understanding of the causes of the various manifestations of RVF disease might be helpful to rationalize why an infection is asymptomatic or connected with the clinical, sometimes fatal, illness. As a single serotype of RVFV causes disease in multiple species, opportunities exist to look more broadly at immunological differences between species as well as how they are affecting the disease results. Currently, the absence of a licensed human vaccine has limited our ability to effectively respond to outbreaks. More research is essential for a better understanding of viral maintenance during the emergency outbreak. A better understanding of the causes of the various manifestations of Rift Valley Fever disease might be helpful to rationalize why an infection is asymptomatic or connected with the clinical, sometimes fatal, illness. This review recommends various treatment and prevention approaches of the RVF and in future what measures should be adopted for this outbreak as well as also describes the clinical symptoms that appears in the individuals that suffer from the Rift valley fever, built on the most current literature report since the outbreak.

CONCLUSIONS

Rift Valley Fever was first recognized as an outbreak in 1930. Symptoms of this infection arises usually from 4 to 5 days. Anti-viral such as ribavirin are thought to be an effective medication for the treatment of the rift valley fever. Although there had been a decent development in characterizing the virological, clinical and pathological features of RVFV infection, RVFV still causes outbreaks in African countries or in the Arabian Peninsula. The advances of safe, effective, highly immunogenic and economic vaccines for humans and animals would prevent RVF in endemic countries and further investigations are to be done to get the best possible treatment of the Rift valley fever.

Authors Contribution

Conceptualization: MAW
Methodology: MS, AA
Formal analysis: AQ, SS, HZ, AA
Writing-review and editing: MAW, AA, AR, MS, AA, TP, DI

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Conflicts of Interest

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REFERENCES

[1] Musa TH, Akintunde TY, Musa IH, Mohammed LA, Tassang AE, Musa HH. Rift valley fever: thematic analysis of documents indexed in the Web of Science Core Collection database. Ann. Infect. 2022; 6: 1. doi: 10.21037/aoi-21-9

[2] Bron GM, Strimbu K, Cecilia H, Lerch A, Moore SM, Tran Q, et al. Over 100 years of Rift Valley fever: a patchwork of data on pathogen spread and spillover. Pathogens. 2021 Jun; 10(6). doi: 10.3390/pathogens10060708

[3] Velu RM, Kwenda G, Libonda L, Chisenga CC, Flavien BN, Chilyabanyama ON, et al. Mosquito-Borne Viral Pathogens Detected in Zambia: A Systematic Review. Pathogens. 2021 Aug; 10(8): 1007. doi: 10.3390/pathogens10081007

[4] Anyamba A, Damoah R, Kemp A, Small JL, Rostal MK, Bagge W, et al. Climate Conditions During a Rift Valley Fever Post-epizootic Period in Free State, South Africa, 2014-2019. Frontiers in veterinary science. 2022 Jan; 8: 730424. doi: 10.3389/fvets.2021.730424

[5] Hassan A, Muturi M, Mwatondo A, Omolo J, Bett B, Gikundi S, et al. Epidemiological investigation of a Rift Valley fever outbreak in humans and livestock in Kenya, 2018. The American journal of tropical medicine and hygiene. 2020 Oct; 103(4): 1649-55. doi: 10.4269/ajtmh.20-0387

[6] Gear JH. Rift Valley fever. InCRC Handbook of Viral and Rickettsial Hemorrhagic Fevers . CRC Press. 2019 Jun: 101-118. doi: 10.1201/9780429276736-8

[7] Barry Y, Elbara A, Bollahi MA, El Mamy AB, Fall M, Beyit AD, et al. Rift Valley fever, Mauritania, 2020: Lessons from a one health approach. One Health. 2022 Dec; 15: 100413. doi: 10.1016/j.onehlt.2022.100413

[8] Tong C, Javelle E, Grard G, Dia A, Lacrosse C, Fourié T, et al. Tracking Rift Valley fever: from Mali to Europe and other countries, 2016. Eurosurveillance. 2019 Feb; 24(8): 1800213. doi: 10.2807/1560-7917.ES.2019.24.8.1800213

[9] Cook EA, Grossi-Soyster EN, De Glanville WA, Thomas LF, Kariuki S, Bronsvoort BM, et al. The sero-epidemiology of Rift Valley fever in people in the Lake Victoria Basin of western Kenya. PLoS neglected tropical diseases. 2017 Jul; 11(7): e0005731. doi: 10.1371/journal.pntd.0005731

[10] Hartman AL, Powell DS, Bethel LM, Caroline AL, Schmid RJ, Oury T, et al. Aerosolized rift valley fever virus causes fatal encephalitis in african green monkeys and common marmosets. Journal of virology. 2014 Feb; 88(4): 2235-45. doi: 10.1128/JVI.02341-13

[11] Nguku PM, Sharif SK, Mutonga D, Amwayi S, Omolo J, Mohammed O, et al. An investigation of a major outbreak of Rift Valley fever in Kenya: 2006-2007. The American journal of tropical medicine and hygiene. 2010 Aug; 83(2): 05-13 doi: 10.4269/ajtmh.2010.09-0288

[12] Le May N, Dubaele S, De Santis LP, Billecocq A, Bouloy M, Egly JM. TFIIH transcription factor, a target for the Rift Valley hemorrhagic fever virus. Cell. 2004 Feb; 116(4): 541-50. doi: 10.1016/S0092-8674(04)00132-1

[13] Al-Hamdan NA, Panackal AA, Al Bassam TH, Alrabea A, Al Hazmi M, Al Mazroa Y, et al. The risk of nosocomial transmission of Rift Valley fever. PLoS neglected tropical diseases. 2015 Dec; 9(12): e0004314. doi: 10.1371/journal.pntd.0004314

[14] Brès P. Impact of arboviruses on human and animal health. InThe arboviruses: epidemiology and ecology. CRC Press; 2020 Mar: 1-18. doi: 10.1201/9780429280221-1

[15] Cecilia H, Drouin A, Métras R, Balenghien T, Durand B, Chevalier V, Ezanno P. Mechanistic models of Rift Valley fever virus transmission dynamics: A systematic review. medRxiv. 2022 Mar: 2022. doi: 10.1101/2022.03.28.22272741

[16] Zouaghi K, Bouattour A, Aounallah H, Surtees R, Krause E, Michel J, et al. First serological evidence of crimean-congo hemorrhagic fever virus and rift valley fever virus in ruminants in tunisia. Pathogens. 2021 Jun; 10(6). doi: 10.3390/pathogens10060769

[17] Endale A, Michlmayr D, Abegaz WE, Geda B, Asebe G, Medhin G, et al. Sero-prevalence of West Nile virus and Rift Valley fever virus infections among cattle under extensive production system in South Omo area, southern Ethiopia. Tropical Animal Health and Production. 2021 Mar; 53: 1-8. doi: 10.1007/s11250-020-02506-0

[18] Cosseddu GM, Doumbia B, Scacchia M, Pinoni C, Di Provvido A, Polci A, et al. Sero-surveillance of emerging viral diseases in camels and cattle in Nouakchott, Mauritania: an abattoir study. Tropical Animal Health and Production. 2021 Jun; 53: 1-6. doi: 10.1007/s11250-021-02636-z

[19] Halawi AA, Saasa N, Pongombo BL, Kajihara M, Chambaro HM, Hity M, et al. Seroprevalence of Rift Valley fever in cattle of smallholder farmers in Kwilu Province in the Democratic Republic of Congo.

DOI: https://doi.org/10.54393/pjhs.v4i04.603

Tropical animal health and production. 2019 Nov; 51: 2619-27. doi: 10.1007/s11250-019-01978-z

[20] Rogier E, Plucinski M, Candrinho B, Moss DM, Gibbons A, Colborn J, et al. Adaptation to a Multiplex Bead Assay and Seroprevalence to Rift Valley Fever N Protein: Nampula Province, Mozambique, 2013-2014. Journal of Virology. 2022 Aug; 96(16): e00672-22. doi: 10.1128/jvi.00672-22

[21] Nielsen SS, Alvarez J, Bicout DJ, Calistri P, Depner K, Drewe JA, et al. Rift Valley Fever-epidemiological update and risk of introduction into Europe. EFSA Journal. 2020 Mar; 18(3): e06041. doi: 10.2903/j.efsa.2020.6041

[22] Muema C, Ngarega BK, Muturi E, Wei H, Yang H. Present and Future Ecological Niche Modeling of Rift Valley fever in East Africa in Response to Climate Change. bioRxiv. 2021 Mar. doi: 10.1101/2021.03.03.433832

[23] Tucker CJ, Melocik KA, Anyamba A, Linthicum KJ, Fagbo SF, Small JL. Reanalysis of the 2000 Rift Valley fever outbreak in Southwestern Arabia. Plos one. 2020 Dec; 15(12): e0233279. doi: 10.1371/journal.pone.0233279

[24] Sado FY, Tchetgna HS, Kamgang B, Djonabaye D, Nakouné E, McCall PJ, et al. Seroprevalence of Rift Valley fever virus in domestic ruminants of various origins in two markets of Yaoundé, Cameroon. PLoS Neglected Tropical Diseases. 2022 Aug; 16(8): e0010683. doi: 10.1371/journal.pntd.0010683

[25] Javelle E, Lesueur A, Pommier de Santi V, de Laval F, Lefebvre T, Holweck G, et al. The challenging management of Rift Valley Fever in humans: literature review of the clinical disease and algorithm proposal. Annals of Clinical Microbiology and Antimicrobials. 2020 Dec; 19(1): 1-8. doi: 10.1186/s12941-020-0346-5

[26] Uwishema O, Adanur I, Babatunde AO, Hasan MM, Elmahi OK, Olajumoke KB, et al. Viral infections amidst COVID-19 in Africa: implications and recommendations. Journal of medical virology. 2021 Dec; 93(12): 6798-802. doi: 10.1002/jmv.27211

[27] Daubney R and Hudson JR. Enzootic Hepatitis or Rift Valley Fever. An Un-described Virus Disease of Sheep, Cattle and Man from East Africa. Journal of pathology and bacteriology. 1931; 34: 545-79. doi: 10.1002/path.1700340418

[28] Findlay GM and Daubney R. The Virus of Rift Valley Fever or Enzob'tic Hepatitis. Lancet. 1931. doi: 10.1016/S0140-6736(00)99624-7

[29] Swanepoel, R, Manning, B, Watt J. Fatal Rift Valley fever of man in Rhodesia. Central African Journal of Medicine. 1979 Jan; 25(1): 1-8.

[30] El-Shinnawi BM, Sobhy F, El-Zawahry A. Laboratory findings in some cases of Rift Valley fever: histopathological haematological, and biochemical. The Journal of the Egyptian Public Health Association. 1978 Jan; 53(3-4): 187-9.

[31] Al-Hazmi A, Al-Rajhi AA, Abboud EB, Ayoola EA, Al-Hazmi M, Saadi R, et al. Ocular complications of Rift Valley fever outbreak in Saudi Arabia. Ophthalmology. 2005 Feb; 112(2): 313-8. doi: 10.1016/j.ophtha.2004.09.018

[32] Bird BH and Nichol ST. Breaking the chain: Rift Valley fever virus control via livestock vaccination. Current opinion in virology. 2012 Jun; 2(3): 315-23. doi: 10.1016/j.coviro.2012.02.017

[33] Ellenbecker M, Lanchy JM, Lodmell JS. Inhibition of Rift Valley fever virus replication and perturbation of nucleocapsid-RNA interactions by suramin. Antimicrobial Agents and Chemotherapy. 2014 Dec; 58(12): 7405-15. doi: 10.1128/AAC.03595-14

[34] Scharton D, Bailey KW, Vest Z, Westover JB, Kumaki Y, Van Wettere A, et al. Favipiravir (T-705) protects against peracute Rift Valley fever virus infection and reduces delayed-onset neurologic disease observed with ribavirin treatment. Antiviral research. 2014 Apr; 104: 84-92. doi: 10.1016/j.antiviral.2014.01.016

[35] Benedict A, Bansal N, Senina S, Hooper I, Lundberg L, de la Fuente C, et al. Repurposing FDA-approved drugs as therapeutics to treat Rift Valley fever virus infection. Frontiers in microbiology. 2015 Jul; 6. doi: 10.3389/fmicb.2015.00676

[36] Bell TM, Espina V, Senina S, Woodson C, Brahms A, Carey B, Let al. Rapamycin modulation of p70 S6 kinase signaling inhibits Rift Valley fever virus pathogenesis. Antiviral research. 2017 Jul; 143: 162-75. doi: 10.1016/j.antiviral.2017.04.011

[37] Keck F, Amaya M, Kehn-Hall K, Roberts B, Bailey C, Narayanan A. Characterizing the effect of Bortezomib on rift valley fever virus multiplication. Antiviral Research. 2015 Aug; 120: 48-56. doi: 10.1016/j.antiviral.2015.05.004

[38] Bazhanov N, Escaffre O, Freiberg AN, Garofalo RP, Casola A. Broad-range antiviral activity of hydrogen sulfide against highly pathogenic RNA viruses. Scientific reports. 2017 Jan; 7(1): 41029. doi: 10.1038/srep41029

[39] Caplen H, Peters CJ, Bishop DH. Mutagen-directed attenuation of Rift Valley fever virus as a method for vaccine development. Journal of General Virology. 1985 Oct; 66(10): 2271-7. doi: 10.1099/0022-1317-66-10-2271

[40] Monath TP. Treatment of yellow fever. Antiviral research. 2008 Apr; 78(1): 116-24. doi: 10.1016/j.

DOI: https://doi.org/10.54393/pjhs.v4i04.603

antiviral.2007.10.009

[41] Peters CJ, Reynolds JA, Slone TW, Jones DE, Stephen EL. Prophylaxis of Rift Valley fever with antiviral drugs, immune serum, an interferon inducer, and a macrophage activator. Antiviral research. 1986 Aug; 6(5): 285-97. doi: 10.1016/0166-3542(86)90024-0

[42] Furuta Y, Takahashi K, Kuno-Maekawa M, Sangawa H, Uehara S, Kozaki K, et al. Mechanism of action of T-705 against influenza virus. Antimicrobial agents and chemotherapy. 2005 Mar; 49(3): 981-6. doi:10.1128/AAC.49.3.981-986.2005

[43] Caroline AL, Powell DS, Bethel LM, Oury TD, Reed DS, Hartman AL. Broad spectrum antiviral activity of favipiravir (T-705): protection from highly lethal inhalational Rift Valley Fever. PLoS neglected tropical diseases. 2014 Apr; 8(4): e2790. doi: 10.1371/journal.pntd.0002790

[44] Pittman PR, Liu CT, Cannon TL, Makuch RS, Mangiafico JA, Gibbs PH, et al. Immunogenicity of an inactivated Rift Valley fever vaccine in humans: a 12-year experience. Vaccine. 1999 Aug; 18(1-2): 181-9. doi: 10.1016/S0264-410X(99)00218-2

[45] Barnard, BJH & Botha MJ. An inactivated rift valley fever vaccine. Journal of the South African Veterinary Association. 1977 Mar; 48(1): 45-8.

[46] Botros B, Omar A, Elian K, Mohamed G, Soliman A, Salib A, et al. Adverse response of non-indigenous cattle of European breeds to live attenuated Smithburn Rift Valley fever vaccine. Journal of medical virology. 2006 Jun; 78(6): 787-91. doi: 10.1002/jmv.20624

[47] Ahmed A, Mahmoud I, Eldigail M, Elhassan RM, Weaver SC. The emergence of Rift Valley Fever in gedaref state urges the need for a cross-border one health strategy and enforcement of the international health regulations. Pathogens. 2021 Jul; 10(7). doi: 10.3390/pathogens10070885

[48] Chambaro HM, Hirose K, Sasaki M, Libanda B, Sinkala Y, Fandamu P, et al. An unusually long Rift valley fever inter-epizootic period in Zambia: Evidence for enzootic virus circulation and risk for disease outbreak. PLoS neglected tropical diseases. 2022 Jun; 16(6): e0010420. doi: 10.1371/journal.pntd.0010420