

Kerala emerging as arthropod and zoonotic virus hotspot

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ABSTRACT

Emerging and reemerging viruses of various magnitude are posing a burgeoning threat to the modern human as well as other higher vertebrates and capitulates the ever-increasing concern of terrestrial life sustenance. Biodiversity hotspots with dense population and greater human interactions form a bridge to such species barrier spill over. India being front runner in population density, Kerala with high human, animal and other species interactions with much favouring climatic conditions and style of living overrides the barrier much easily, potentiating more and more viral outbreaks. This review tries to address the major viral incidences reported with in Kerala over a span of few decades and also highlights the significance of awareness on such outbreaks with virus details.

KEYWORDS

Zoonosis, Nipah virus, Zika virus, SARS-CoV2, Chikungunya virus, Dengue virus

Introduction

Kerala from the historic period has been remarkable in its international trade and maritime business and ever since has been in a constant exchange, be it the increasing number of tourists arriving or the vast majority of Kerala expatriates. The exchange has also been reflective in case of viral outbreaks in Kerala notably during the recent outbreak of the global pandemic of SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) and presumably the Zika virus outbreak. High population density as well as humid climatic conditions, rich foliage, natural resource utilisation, deforestation and plantation cropping, increasing number of human-wildlife contact and conflict has led to emergence and re-emergence of various viruses in Kerala. Kerala had been a hotspot for cyclic seasonal Dengue outbreaks, a period of Chikungunya infections, alarming cases of Nipah and Zika viral infections and owing to the highest number of SARS CoV-2 infections in the country over a period of 2-3 months through the pandemic outbreak. Although the state had been overburdened and embroiled by new emerging viral outbreaks, its leading age health sector, preparedness and public awareness has been well appreciated and ever active in identifying, treating and containing viruses of all magnitudes. A few viruses among the notable outbreaks that have shook the state and country during the short span of a few decades is discussed here.

Nipah virus

Named after region of its first outbreak, Nipah virus (NiV) was identified in Malaysia and is a single stranded negative sense RNA virus belonging to the *Henipaviridae* family (Goh et al., 2000; Soman

Pillai et al., 2020). NiV is considered as a classic zoonotic virus accounting to its case fatality rate and mode of transmission, as human happens to be the dead end host and higher vertebrates occur as intermediate or amplifying host, while bats particularly of fruit eating variety especially *Pteropus* are understood as the carrier host. The disease manifests as respiratory distress with altered sensorium and disorientation often leading to death due to encephalitis as well as respiratory failure (Goh et al., 2000). NiV strains are classified as Malaysian and Bangladesh strains on the basis of regions of its most prevalence and difference in symptoms demonstrated in patients as well as incubation period (Rahman and Chakraborty, 2012).

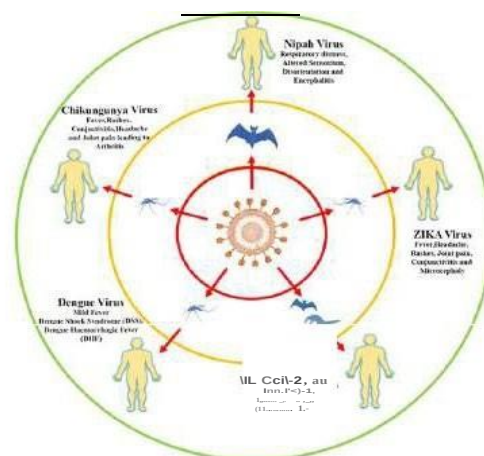


Figure 1: Schematic representation of the viruses, their vector/ host and symptoms

Although India had earlier outbreaks of NiV in Siliguri and Nadia districts of West Bengal, while Kerala witnessed the first outbreak of NiV during May 2018 in Perambra taluk in the northern district of Kozhikode and later nosocomial spread leading to more infections. Almost 23 patients were infected due to fatal outbreak accounting to 18 confirmed deaths and the undetermined index patient with symptoms. NiV resurged in the central district Ernakulam during June 2019, accounting to infection in a single patient and later recovery (Soman Pillai et al., 2020). Although unchecked, NiV cases were not reported in 2020, possibly owing to the precautions in place due to SARS CoV-2 outbreak both within and out of Kerala. The most recent case report of NiV happened on September 5th 2021 accounting to the death of the assumed index patient, a 12 year old boy, believed to have consumed virus infested fruit which the bats would have bitten (Sampath, 2021). Although the viral infection leads to death of the terminal host, NiV can be contained if proper precautions and containment measures are timely in place.

Zika virus

Zika virus (ZIKV) is an arthropod-borne single stranded RNA virus belonging to the family Flaviviridae. It has been reported to be prevailing in non-human primates and *Aedes* mosquito species (White et al., 2016). ZIKV is commonly transmitted by the bite of an infected mosquito, however other transmission routes like monkey bites, laboratory infections, sexual contact and blood transfusions are also reported. In humans, Zika virus disease is not fatal but ZIKV can be transferred from pregnant woman to her fetus causing microcephaly in new-borns (Petersen et al., 2016). Estimated incubation period for ZIKV disease is 3-14 days (Krow-Lucal et al., 2017). Common symptoms associated with ZIKV are fever, rashes, headache, joint pain, conjunctivitis and muscle pain (Petersen et al., 2016).

ZIKV was detected in Kerala for the first time on 8th July, 2021 in a 24 year old pregnant woman from Thiruvananthapuram who was admitted with fever, headache and rashes all over the body. The total number of cases in the state rose to 44 by 22nd July, 2021 and all the cases were from Thiruvananthapuram district making it an epicentre of the ZIKV outbreak. By August 15, 2021 Kerala government had declared the outbreak under control with a total of 66 cases of infection. Out of 66 cases, 62 were from the capital Thiruvananthapuram, 2 from Ernakulam and one each from Kollam and Kottayam.

SARS-CoV-2

Corona viruses are single stranded, positive sense RNA viruses belonging to the family Coronaviridae (Chan et al., 2013). SARS-CoV-2 is a new evolutionary branch of corona virus which have navigated their host barrier to cause lethal diseases in humans (Krishna et al., 2020). The phylogenetic similarity of SARS-CoV-2 to SARS-like bat CoVs suggest bat to human transmission of SARS-CoV-2 (Zhou et al., 2020). SARS-CoV-2 infection causes COVID-19 which is characterized by mild to severe respiratory distress.

Human to human transmission predominantly occurs via respiratory droplets. COVID-19 positive patients manifest asymptomatic, mild to moderate flu-like symptoms or even severe respiratory distress leading to multiple organ failure and death (Bai et al., 2020). Mean incubation period ranges from 1-14 days, most commonly around 5 days (He et al., 2020). The most common symptoms include fever, tiredness and dry cough while sore throat, diarrhoea, headache, loss of taste or smell and rashes are also seen (Fu et al., 2020; Huang et al., 2020).

India's first SARS-CoV-2 infection was confirmed in Thrissur, Kerala on 30th January 2020 in a student who travelled from Wuhan, China. At present, Kerala reports around 43 lakhs of total infections with about 22000 deaths. Kerala's success in containing COVID-19 was largely applauded throughout the world. However, a rise in new COVID-19 cases occurred post Onam festival especially in Ernakulam, Malappuram, Kozhikode and Thrissur districts. Moreover, the highest single day spike with 43,529 new cases was reported in Kerala on 12th May 2021. Nevertheless, compared to the national average Kerala has the lowest fatality rate of 0.51%, which is possibly the world's lowest fatality rate.

Dengue virus

Unlike the earlier mentioned viruses Dengue virus has been considered an endemic virus leading to cycles of infection every year and have been identified throughout Kerala during sero-prevalance studies as well as vector surveillance. Dengue belongs to the flaviviridae family and has four different known strains DEN-1, 2, 3, 4 (ICMR, 2006). Dengue is an arthropod vector borne disease and is spread by the bites of day biting mosquitoes of *Stegomyia* genus, while its spread in India and particularly Kerala was through *Aedes aegypti* and *Aedes albopictus*, otherwise commonly known as Asian tiger mosquito (Alunad et al., 1997; Gubler, 1998a). Although first reported cases of Dengue in Kerala date back only from 1997, surveillance studies have proven the presence of antibodies to the virus in populations dating back from 1979. Dengue presents mild fever to severe symptoms with life threatening manifestations including Dengue shock syndrome (DSS) and Dengue Haemorrhagic fever (DHF) (Gubler, 1998a,b; Rigau-Perez et al., 1998). Albeit the awareness and precautionary measures taken by the government, dengue infections have been reported in successive years after its first reports. Endemic nature of Dengue in Kerala may account to the climatic changes happening to the region as well as the increasing levels of annual rainfall and the rainforest nature with numerous rivers.

Chikungunya virus

Chikungunya virus (CHIKV) similar to Dengue is an arthropod borne disease and was reported in India and Kerala during 2006-2007, while in 2007 Kerala was the worst affected owing to a huge 56% of then reported cases in India (Mavalankar et al., 2007; Kumar et al., 2008). CHIKV belongs to the alphavirus of the Togaviridae family and is transmitted by *Aedes* mosquitoes (Pialoux et al., 2007). Both dengue and CHIKV spread in India and Kerala draws comparisons to the spread of malaria, though not much

commonalities could be seen in their disease manifestations. CHIKV commonly leads to high fever, joint pain, rashes and at times conjunctivitis and headache. The debilitating effect of CHIKV in Kerala particularly is understood to be muscular and joint pain leading to immobility and assumed to lead to arthritis. The Mid-highlands of Kerala known for Rubber plantations, where both the plantations and its decaying foliage as well as vessels and containers used for the rubber sap collections are understood to be the major promoters of the mosquito growth (Kumar et al., 2011). Studies identified A226V mutation in the E1 gene of the virus spread throughout Kerala and the high presence of *Aedes albopictus* mosquito in the region may have collectively contributed to the alarming CHIKV infections in Kerala (Kumar et al., 2008).

Conclusion

Being a biodiversity hotspot, Kerala has all essential components from climate to vegetation, high impacting population density to surplus water all favouring the growth and emergence of new virus strains and acquiring favourable mutations. This conditioning along with anthropogenic infiltration into the wildlife and within accelerates the possibility of novel virus and vector outbreaks. The human to human exchange and exposure scenario also holds true via tourism as well as the working migrant inflow and outflow. Government, public and health sector should compensate to check any anomalies in such trade and also be prepared to handle outbreaks of unknown origin. India and Kerala in particular has undergone such unchecked exposures and should strengthen the available resources, improve to modern and advanced avenues of research concerning such threats. It is imperative to avail most promising containment strategies to cope with any future virus outbreaks of unknown magnitudes.

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