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Zika virus outbreak, epidemiology, transmission and infection dynamics: a review article

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ABSTRACT

Zika virus (ZIKV) infection has recently attracted the attention of medical community. While clinical manifestations of the infection in adult cases are not severe and disease is not associated with high mortality rates, Zika virus infection can have an impact on fetal development and lead to severe neurodevelopmental abnormalities. Zika virus s a newly emergent relative of the Flaviviridae family and linked to dengue (DENV) and Chikungunya (CHIVKV). ZIKV infection was characterized by mild disease with fever, headache, rash, arthralgia and conjunctivitis, with exceptional reports of an association with GuillainBarre syndrome (GBS) and microcephaly. However, since the end of 2015, an increase in the number of GBS associated cases and an astonishing number of microcephaly in fetus and new-borns in Brazil have been related to ZIKV infection, raising serious worldwide public health concerns. ZIKV is transmitted by the bite of infected female mosquitoes of Aedes species. Here, we extensively described the current understanding of the efects of ZIKV on heath, transmission, clinical manifestation, diagnosis and treatment options based on modern, alternative and complementary medicines regarding the disease.

INTRODUCTION

Mosquito-transmitted Zika virus (ZIKV) is a member of the Flavivirus genus in the Flaviviridae family. Similar to other flaviviruses, ZIKV is transmitted by several mosquito species including Aedes africanus, Ae. Aegypti, Ae. Albopictus, and Ae. Hensilli [1]. Among the family of viruses, Zika virus (ZIKV) is an Emerging evolving virus on the western hemisphere, Though it was initially reported from Uganda in 1940s [1, 2]. Transmission of ZIKV is related to the two other Imperative arboviruses including dengue virus (DENV) And chikungunya virus (CHIVKV) [3]. In a quest to solve the dilemma of yellow fever, a study conducted in 1947 Isolated the first novel virus from the blood of a sentinel rhesus macaque placed in the Zika Forest of Uganda [4, 5]. ZIKV stayed relatively silent for almost 70 years And all of a sudden emerged all over the America after Pacifc Islands to Brazil [6]. Recently it was identifed that The ZIKV strain found in the Americas had escalated to Angola and was linked with a cluster of microcephaly [7]. Hill et al. also reported similar results based on full Virus genome analysis [8]. All the above mentioned studies endorse overview of mosquito-borne transmission Of the ZIKV strain from the Americas into continental Africa. World Health Organization (WHO) declared it As emergency of public health with international concern. As a result of global alarm created by ZIKV by becoming first foremost infectious disease coupled with defects of Human birth revealed in more than a half of century. There are currently 86 countries, territories, or subnational areas with evidence of ZIKV transmission [9,10]. The recurrence of ZIKV around the world may have several causes including the generation of more virulent strains, new routes of transmission, and novel modifiers of the disease [10].

HISTORY AND EPIDEMIOLOGY OF ZIKV

At the earliest during a study on yellow fever virus, ZIKV was isolated from the blood of a febrile sentinel Rhesus monkey in Zika jungle of Uganda in 1947. In 1948, ZIKV was isolated from Aedes africanus mosquitoes indicating that the virus might be mosquito-borne [11]. Zika virus has been quickly emerging in the

western hemisphere over the past few months. It was first detected in Brazil, in the northeast and was subsequently recognized in other states and several South American countries including Colombia, Ecuador, Suriname, Venezuela, French Guyana and Paraguay. Transmission has been known in Central America (Panama, El Salvador, Honduras and Guatemala), the Caribbean (Martinique, Puerto Rico, Dominican Republic and Haiti) and Mexico. Transmission also occurred in travelers returning from the infected regions to non-endemic countries including United States, Canada, Japan and Western Europe[12]. Since January 2016, a sum of 20 countries in the Americas has reported ZIKV infections. Several Aedes species have been reported to be probable vectors of ZIKV including Aedes hensilli in Yap, Ae. Aegypti and Aedes polynesiensis in French Polynesia. Ae. Aegypti and Aedes albopictus are present in much of the Americas including many parts of the Southeastern and South Central United States as well as Hawaii [13,14]. In early 2015, an outbreak of ZIKV occurred in the state of Rio Grande do Norte, Brazil. Results of analysis revealed a high likeness of the sequences with Asian lineage. One theory regarding the introduction of ZIKV in Brazil is the arrival of the new emergent virus in 2014, during FIFA World Cup. In March 2015, another outbreak of ZIKV was occurred in the state of Bahia. The results of investigation on this outbreak showed that the obtained ZIKV sequences belonged to the Asian lineage with 99% identity with a sequence from a ZIKV isolate from French Polynesia and extend to other Pacific Islands. Since no endemic ZIKV endangered any of the Pacific countries during the FIFA World Cup, it has been hypothesized that the virus invaded Brazil through another occurrence that was held in Rio de Janeiro in August 2014, the "Va'a World Sprint Championship canoe race" where countries including French Polynesia, New Caledonia, Cook Islands and Easter Islands attended [15,16]. The African lineage split in East and West African clusters . Asian lineage presents expanded geographical distribution , since it emerged in the Pacifc Ocean and South America [16,17]. The 201516 epidemic occurred in the America was due to strain of the Asian lineage generally known as the American strain [17]. However, some consider the American outbreak strain as its own lineage. Epidemiology studies revealed distribution of ZIKV in half of the north African continent, Vietnam, Malaysia, Indonesia, Philip-pines, India, Tailand and Pakistan (Fig. 1) . The frst human case was detected in Uganda in 1952 during a study indicating the presence of neutralizing antibodies to ZIKV in sera . Only few cases of infection in human were reported before 2007 when outbreak of ZIKV infection in humans occurred in Yap, Federated States of Micronesia, in the Pacifc region [18,19]. In French Polynesia the largest epidemic of ZIKV occurred during 2013 to 2014 and extended to New Caledonia, Cook Islands, Vanuatu, Easter Island, Solomon Islands and other Pacifc Islands [19]. ZIKV transmission is known in 55 countries and territories. However, only in 2015 to 2016, indigenous transmission have been reported for 41 of them, with indirect confrmation regarding circulation of virus in six countries, terminated outbreaks reported in fve countries while three countries were afected with local infection [20].

TRANSMISSION OF ZIKV

ZIKV vector-borne transmission

Aedes aegypti, Aedes polynesiensis and Aedes albopictus are the potential vectors responsible for the transmission of ZIKV infection by biting. Aedes aegypti is the foremost vector of DENV and CHIKV. Aedes polynesiensis is the main vector responsible for dissemination of lymphatic flariasis in French Polynesia. After the epidemic in French Polynesia these species of mosquitoes were collected and tested for ZIKV infection by RT-PCR and only one Aedes aegypti mosquito was confrmed having ZIKV RNA; experimental investigations showed the French Polynesian strain of Aedes aegypti can replicate the French Polynesian ZIKV strain (Additional fle 1: Fig-ure S1) [20].Altogether, 61 countries and territories in six WHO regions have confrmation of conventional competent Aedes aegypti vectors but have not yet documented ZIKV transmission . Tus, risk of ZIKV spread to other countries is still likely. Might be due to lack of detection fewer countries did not report transmission. The re-emergence or re-introduction was also reported in all areas with prior reports of ZIKV transmission.Altogether in the African lineage eight mosquitoes were isolated, while P6-740 was the only mosquito isolated in the Asian lineage (Malaysia/1966). In 2007, ZIKV was identifed in patients infected with Aedes aldopictus mosquitoes from West Africa [20,21]. However, the Aedes (stregomyia) hensilli identifed as the probable principal vector that cause Micronesia outbreak [38]. Later on, in 2013, the ZIKV spread out to French Polynesia, with consequent extent to Oceanian islands (New Caledonia, Cook islands, and Easter island), was mostly related with Aedes aegypti and Aedes aldopictus species [22].

Non-vector-borne transmission

Non-vector-borne transmission of ZIKV infection can be caused during labor (mother to child), organ transplantation, blood transfusions and through sexual contact (Fig. 3).Antibodies against ZIKV were detected by Serosurvey studies in goats, rodents (Meriones hurrianae and Tatera indica), sheep and bats. These studies suggest that there is no clear association between ZIKV and a specifc species of animal [23]. In humans, it spreads through the bite of infected Aedes aegypti mosquitoes that are usually found in tropical and sub-tropical regions in domestic waterholding containers near dwellings [24]. Consequently, when a mosquito bites a person already infected with ZIKV, the virus infected blood goes into the midgut and prevailed into the circulatory system. Another similar mosquito, Aedes albopictus can also transmit ZIKV. Among humans, transmission of this viral infection may also refer to sexual contact. High ZIKV RNA load has detected in breast milk, so transmission is possible by breast feeding and ZIKV can also be transmitted by blood transfusions as reported on December 2015 in Brazil, the frst case of ZIKV blood transfusion transmission. ZIKV is adopted to transmit by enzootic and sub Urban cycle in enzootic setting this involves mosquitoes of Aedes species and non-human primates, however transmission in Urban setting involves human and mosquitoes of Aedes species demonstrate vector and non-vector borne transmission of ZIKV [24,25].

ZIKV SYMPTOMS AND DIAGNOSIS

Zika fever (also known as Zika virus disease) is an illness caused by the Zika virus. Most cases have no symptoms, but when present they are usually mild and can resemble dengue fever. Symptoms may include fever, red eyes, joint pain, headache, and a maculopapular rash. Infection during pregnancy causes microcephaly (shortened head than expected) and other brain malformations in some babies. Infection in adults has been linked to GuillainBarre syndrome (GBS) which is an uncommon sickness of the nervous system in which a person's own immune system damages the nerves, causing muscle weakness, and sometimes, paralysis. Other non-vector modes of Zika virus transmission include sexual contact or blood transfusions

[26].Diagnosis is done by testing the blood, urine, or saliva for the presence of Zika virus RNA when the person is sick [26,27].

ZIKV BIRTH DEFECTS

Zika virus displays a different behavior toward fetuses. When infected during gestation, fetuses have their immature neural cells killed by the viruses and consequently have devastating findings at birth [27]. In the past year the drastic effects of Zika virus infection in new borns include neurological, opthalmological, audiological and skeletal abnormalities. These findings represent new entities called congenital Zika Syndrome [27,28]. Intrauterine transmission is supported by the finding of Zika virus RNA by reverse transcription PCR (RT-PCR) in amniotic fluid of 2 mothers with symptoms of Zika virus infection during pregnancy; both delivered babies with microcephaly. ZIKV had also been detected within the brain of a microcephalic fetus and recently, direct evidence has emerged that ZIKV is able to infect and cause the death of neural stem cells. Viral RNA, but not culturable virus, has been detected in breast milk, but transmission by breast feeding has not been reported [28]

TREATMENT OF ZIKV

There are no specifc medications or vaccine Available to treat or prevent ZIKV infections until now. To help relieve symptoms, get plenty of rest and drink plenty of fluids to prevent dehydration. Only medications for symptomatic relief can be considered such as paracetamol to relieve pain and fever Associated with this infection . Nonsteroidal anti-Infammatory drugs (NSAIDs) should be avoided and Individuals should seek medical advice before taking Additional medication if they are already taking medicines for another medical condition [29]. Homeopathy is a worthy treatment option in ZIKV infection as it proved to be efective in Japanese encephalitis virus which is included in the same genus like Zika virus. The symptoms of Zika virus infection are similar to other mosquito-borne illnesses, such as dengue fever. If you're feeling ill after recent travel to an area where mosquito borne illness is common, see your doctor. Don't take ibuprofen (Advil, Motrin IB, others), naproxen sodium (Aleve) or aspirin until your doctor has ruled out dengue fever. These medications can increase the risk of serious complications from dengue fever [29,30].

PREVENTION AND CONTROL OF ZIKV

Most precarious threats for ZIKV infection are mosquitoes including their reproducing localities. Their encounter with humans must be reduced in order to control and prevent their outspread. This can be employed by using mosquito repellents, mosquito nettings and closing the entrances and openings. Insect killing sprays recommended by the WHO Pesticide Evaluation Scheme should be used as larvicides [30]. Insect repellents should not be used for babies under two months, mosquito nets should be used to protect babies from insect bite. Centre of disease control recommends mosquito repellents with active ingredients picaridin, DEET, eucalyptus oil, IR3535, oil of lemon and para-menthane-diol. These are safe for pregnant and lactating mothers . Repellants containing eucalyptus oil, lemon oil and paramenthane-diol should be avoided for children below 3 years of age. Mosquitoes should be killed using indoor mosquito killing sprays which contain active ingredient imidacloprid and β-Cyfuthrin available in market . Flying insect fogger can also be used against the mosquitoes containing active ingredients Tetramethrin and Cypermethrin [30,31]. Tests against ZIKV infection should be performed before blood transfusions to prevent transfusion related transmission. Pregnancy must be avoided in the high risk ZIKV infection prone areas before complete eradication or extra care must be exercised as microcephaly is associated with ZIKV infection [31]. Besides, diferent vector control strategies for averting Zika virus spread can be employed. Subjugation of mosquito population can be accomplished by a bacterium that can infect mosquitoes. Other strategies include the use of intracellular bacteria Wolbachia, which acts as a biopesticide to control mosquito population. Larvae of Toxorhynchites splendens mosquito species does not feed on blood. Tey feed on the larvae of other mosquito species, while the adults feed on honeydew, fruit, and nectar [32]. Hence, the spread of ZIKV can be encountered by utilizing these species. Aedes species mosquitoes populations can also be suppressed by the strategy of using sterile males to induce sterility in wild fertile females [32,33].

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