Advances in Science and Technology, Vol. 11, No. 1, March / April 2017, pp 1 - 6

Research Note

A Follow-up to: "Zika Virus: Origin, Transmission, Risk and Prevention"

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(Submitted: February 28, 2017; Accepted: March 10, 2017)

Abstract

Previously, we have presented the history, symptoms, pathological conditions, transmission, risk and prevention factors of Zika virus. The disease is transmitted not only via a mosquito vector but also through sexual contact. Zika virus has emerged as a devastating disease particularly to a developing fetus. Recent data suggest that the effects of the virus on an infected fetus are even more serious than first thought. It appears that infected infants born without any observable defects could encounter problems as they age. Furthermore, mosquito-borne Zika transmission has occurred in various parts of the United States with the highest incidence reported in Florida. Since the known vectors for the virus (*Aedes aegypti* and *Aedes albopictus*) are present in the southern part of the country, it continues to be a potential threat to the United States. Unfortuately, the costs for care and prevention have also exceeded previous estimations. It is hoped that sufficient funding will eventually be allocated for the development of vaccines, treatment for the disease and eradication of the mosquito vectors.

Keywords: Zika virus, *Aedes aegypti*, *Aedes albopictus*, microcephaly, Guillan-Barre' syndrome, Zika transmission and prevention.

1.0 Introduction

This is a follow-up to our paper titled "Zika Virus: Origin, Transmission, Risk and Prevention" – *Advances in Science and Technology* (Zaman and Sizemore, 2016).

In our previous paper, we reported that Zika virus was first discovered in monkeys in the Zika forest in Uganda in 1947 (Dick, 1952; Dick *et al*., 1952). The first human infections of this mosquito-borne disease were reported in Nigeria (MacNamara, 1954). Afterwards, serological tests indicated a wider distribution of human infection of Zika in African and Asian countries (Dick, 1953; Smithburn, 1954; Smithburn *et al*., 1954a; Smithburn et al., 1954b; MacNamara, 1954; Hammon et al., 1958; Pond, 1963; Petersen, 2016).

Zika virus did not draw the attention of public health officials until an outbreak occurred in French Polynesia in 2014, leading to an evaluation of over 3000 people for possible Zika infection (Cao-Lormeau *et al*., 2014; Petersen, 2016). Subsequent outbreaks were then reported in other Pacific islands (Dupont-Rouzeyrol *et al*., 2015) and Brazilian states that spread rapidly throughout Latin America (Fauci, 2016) and the continental USA.

In February 2016, the World Health Organization described Zika virus as a public health emergency (Gulland, 2016) and at present almost 60 countries have reported Zika infections (Jong, 2016; WHO, 2016a). As of late September 2016, a total of 3,625 Zika infections were reported in the U.S. and 21,988 in U.S. Territories (CDC, 2016e).

Zika is a silent enemy. Since symptoms of Zika infection are mostly mild in adults and do not require any specific treatment, most infections go unreported. Therefore, the actual number of infected cases could be much higher than what has been reported. Health officials estimate that for every person with symptoms, four more have undetected Zika infections (Belluck, 2016).

The two known mosquito species that serve as vectors for Zika transmission are *Aedes aegypti* and *Aedes albopictus* (Smith, 2016). Both of these species commonly occur in tropical and subtropical climates. So far, Zika transmissions have been linked mostly to *Aedes aegypti* which is believed to be a more potent vector than *Aedes albopictus* (Petersen *et al*., 2016).

Zaman and Sizemore (2016) presented the history, symptoms, pathological conditions, transmission, risk and prevention factors of Zika virus. In this paper, we will focus on updates and recent knowledge gained on Zika virus mostly throughout the summer months of 2016, the most active time for mosquito populations.

2.0 Mode of Zika Transmission

Transmission of Zika virus most commonly occurs through bites of mosquito vectors. Zika virus is not airborne and the literature does not indicate that it can spread through casual contact with infected patients. A pregnant woman infected with Zika can spread the virus to her fetus (CDC, 2016c). Several cases of Zika transmission through blood transfusion have been reported in Brazil (CDC, 2016c). The virus remains in blood for about a week or longer (CDC, 2016c). Four cases of laboratory acquired Zika infections have been reported, however, the route of virus transmission in these cases are not identified (CDC, 2016c).

Sexual transmission of Zika has been reported in several countries (WHO, 2016c) where men showed the symptoms of viral infection. Experts consider that other than mosquito bites, sexual transmission of the virus could be another significant mechanism of the Zika epidemic in the Americas (McNeil, 2016). The virus seems to survive longer in semen than in blood (CDC, 2016c).

Zika cases have been reported in countries such as France, Germany, Italy, Portugal and New Zealand where Zika infected mosquitoes could not be found (McNeil, 2016). In the U.S., most infections were found in those who had traveled to Zika infected areas (CDC, 2016a) and the Pentagon has recently confirmed Zika infections among U.S. service members and their families who had travelled to South America or the Caribbean (Zoroya and Szabo, 2016).

Those infected with the virus will most likely develop antibodies that will protect them from future Zika infections (CDC, 2016b). Researchers at the University of Massachusetts Medical School have found that a very small protein called interferon-induced transmembrane protein 3 (IFITM3), can significantly reduce the ability of Zeka to infect human and mouse cells, and as well as prevent the virus from destroying cells (DNA, 2016). IFITM3 has been previously shown to protect against several other viral pathogens (Chesarino, *et al*., 2014).

Currently, there is no vaccine against Zika virus, but researchers have made significant progress toward vaccine development. A USA-Brazilian team of scientists has reported development of two vaccines that provided powerful protection in mice from Zika infection (Healy, 2016). In June 2016, the Food and Drug Administration (FDA) approved a clinical trial for an experimental Zika vaccine (STAT, 2016), and in July, the National Institute of Allergy and Infectious Diseases (NIAID) also launched a clinical trial of a vaccine (NIAID, 2016).

3.0 Homegrown Zika

Zika cases reported to date within the continental U.S. and Hawaii had been traced to exposure while traveling abroad. However, on July 29, 2016 Florida health officials announced the first known cases of Zika infection that were thought to be the result of local mosquito bites in areas within Miami-Dade County. By September 28, 59 locally acquired Zika infections were reported (CDC, 2016e). So far, however, health officials have been unable to find local mosquitoes that tested positive for Zika virus (Mykhyalyshyn and Omri, 2016). If multiple Zika infections are reported in an area, as are the case in Florida, it would be prudent to test people in that locality to confirm if the infections are isolated cases or the result of active local virus transmission in the community.

4.0 Diagnosis, Symptoms, Risks, Complications and Preventions

A confirmed diagnosis of Zika infection can only be made through tests on body fluids (urine, saliva, semen, etc.). The symptoms of Zika infection include fever, headache, muscle and joint pain, skin rashes, conjunctivitis, etc. The symptoms are mostly mild and last for 2-7 days (WHO, 2016b).

In general, this viral disease is mild and does not require any specific treatment other than treating fever, headache and pain through common medications. However, complications from this virus such as microcephaly (children being born with unusually small heads) and Guillain-Barre syndromes (a neurological disorder that could lead to paralysis and death) are definitely severe consequences (WHO, 2016b).

According to the Center for Disease Control (CDC), fetuses infected with the Zika virus during the first three months of pregnancy have about a 1% to 13% chance of developing microcephaly with incomplete brain development (Zoroya and Szabo, 2016). Intense efforts are being made to study the association between Zika virus and these neurological disorders.

The key preventive measure against Zika infection is protection against mosquito bites. This can be achieved by wearing clothes that cover much of the body surface, sleeping under mosquito nets, using mosquito repellants, getting rid of potential mosquito breeding sites around houses and human habitats and limiting travels to Zika infected areas.

Since sexual transmission of Zika virus has been confirmed, practicing safer sex or abstinence from sexual activities could also help limit Zika infections (WHO, 2016b; 2016c). If men encounter Zika virus infections or symptoms, safer sexual practices or abstinence from sexual activities should be adopted for at least 6 months. When planning a pregnancy, the couple should remain free of Zika infection symptoms for at least eight weeks before trying to conceive, or wait for 6 months if one or both of the couple are symptomatic (WHO, 2016c).

5.0 Astounding Cost to Fight Zika

President Obama proposed an allocation of $1.8 billion to fight Zika virus (Fox, 2016). As the U.S. Congress continues to debate this proposal, experts fear that the economic cost of Zika could be staggering and the proposed amount may not be sufficient. We have recently seen the first child born with Zika infection in the U.S. diagnosed with microcephaly. According to a report published in June, 2016 the CDC has identified 341 confirmed cases of Zika among pregnant women in the U.S. (Leefeldt, 2016), and as of September, 2016, this number has climbed to 808 (CDC, 2016d). As previously noted, a total of 3,625 Zika infections were reported in the U.S. and 21,988 in U.S. Territories (CDC, 2016e).

According to the World Health Organization (WHO), Brazil alone expects about 2,500 cases of microcephaly this year (Leefeldt, 2016). The high cost to treat microcephaly cases is already stressing Brazil's delicate economy (Langlois, 2016). In Puerto Rico, it is estimated that about a million people could be infected with Zika virus this summer, but the number of microcephaly children born to pregnant women infected with Zika couldn't be predicted (Leefeldt, 2016).

The Center for American Progress (CAP) estimates that in the U.S., between Summer and Fall of 2016, about 2 million women will get pregnant and 50% of them live in areas potentially at risk for Zika (CAP, 2016). The CDC estimates that if 10% of these women get infected with Zika, and up to 13% of their babies have the potential to develop microcephaly, 13,000 babies will be born with this disease. It may cost between $13-130 billion to provide life-time care to these children (Leefeldt, 2016).

The true cost of treating microcephaly is hard to predict. But it could be as high as $1-10 million per individual (Leefeldt, 2016).

6.0 Discussion and Conclusion

In our previous article, we noted that *Aedes* mosquitoes are present in the United States and the

virus could become established and potentially more threatning than it is at present (Zaman and Sizemore, 2016). Here we note that mosquito-borne Zika transmission has occurred in parts of Florida (CDC, 2016 e). New fears are compounded by recent data that suggest that the effects of the virus on an infected fetus are even more serious than first thought. In a report published in *Radiology* August 2016, the authors analyzed brain scans and ultrasounds of 45 babies in Brazil whose mothers were infected with Zika during pregnancy. They found serious damage that went beyond microencephaly including "abnormalities in ventricular size, gray and white matter volume loss, brain- stem abnormalities, and calcifications". Furthermore, some of the damages were in parts of the brain that continued to develop after birth, meaning that those born without any observable defects could encounter problems as they age (Oliveira-Szenjnfeld, et al., 2016).

In the present article, we noted that the United States was proposing $1.8 billion to fight Zika virus. The World Bank recently stated that the virus could cost the world $3.5 billion this year due to the avoidance of travel to infected areas (Muchmore, 2016). This figure doesn't even take into consideration the cost of care for infected infants or vaccine development. In short, not only have the effects of Zika virus become more serious than first thought - the costs for care and prevention have also exceeded previous estimations. Thus, it is imperative that allocation of funds by Congress to fight the disease and develop vaccine proceed as rapidly as possible.

References

Belluck, P. 2016, "Patch of Miami is ground zero for the Zika virus", The New York Times, http://www.nytimes.com/2016/08/09/health/zika-virus-florida.html?_r=0 (Accessed: August 10, 2016).

Cao-Lormeau V.M., Roche C., Teissier A., Robin E., Berry A.L., Mallet H.P., Sall A.A., Musso D. 2014, "Zika virus, French Polynesia, South Pacific, 2013", Emerg. Infect. Dis., 20,1085-1086.

CAP. 2016, "The population of pregnant women at potential risk of Zika virus infection", The Center for American Progress, https://www.americanprogress.org/issues/healthcare/report/2016/05/26/138321/the-population-of-pregnant-women-at-potential-risk-of-zika-virus-infection/ (Accessed: August 14, 2016).

CDC. 2016a, "Zika virus disease in the United States, 2015–2016", Center for Disease Control and Prevention, http://www.cdc.gov/zika/geo/united-states.html (Accessed: April 25, 2016).

CDC. 2016b, "Zika Symptoms, Diagnosis, & Treatment", Center for Disease Control and Prevention, http://www.cdc.gov/zika/symptoms/index.html (Accessed: April 26, 2016).

CDC. 2016c, "Zika Transmission and Risks", Center for Disease Control and Prevention http://www.cdc.gov/zika/transmission/index.html (Accessed: October 3, 2016).

CDC. 2016d, "Pregnant Women with Any Laboratory Evidence of Possible Zika Virus Infection in the United States and Territories, 2016", Center for Disease Control and Prevention, http://www.cdc.gov/zika/geo/pregwomen-uscases.html (Accessed: October 3, 2016).

CDC. 2016e, "Case count in the U.S.", Center for Disease Control and Prevention, http://www.cdc.gov/zika/geo/united-states.html (Accessed: October 3, 2016).

Chesarino N.M., McMichael T.M., Yount, J.S. 2014, "Regulation of the trafficking and antiviral activity of IFITM3 by post-translational modifications", Future Microbiol., 9 (10), 1151-63.

Dick, G.W. 1952, "Zika virus (II). Pathogenicity and physical properties", Trans. R. Soc. Trop. Med. Hyg., 46, 521-534.

Dick, G.W. 1953, "Epidemiological notes on some viruses isolated in Uganda; Yellow fever, Rift Valley fever, Bwamba fever, West Nile, Mengo, Semliki forest, Bunyamwera, Ntaya, Uganda and Zika viruses", Trans. R. Soc. Trop. Med. Hyg., **47**, 13-48.

Dick, G.W., Kitchen, S.F., Haddow, A.J. 1952, "Zika virus isolations and serological specificity", Trans. R. Soc. Trop. Med. Hyg., **46**, 509-520.

DNA. 2016, "Scientists identify internal protein defense against Zika virus", DNA India, http://www.dnaindia.com/health/report-researchers-identify-internal-protein-defense-against-zika-2219812 (Accessed: August 14, 2016).

Dupont-Rouzeyrol, M., O'Connor, O., Calvez, E., Daures, M., John, M., Grangeon, J.P., Gourinat, A.C. 2015, "Co-infection with Zika and dengue viruses in 2 patients, New Caledonia, 2014", Emerg. Infect. Dis., **21**, 381-382.

Fauci, A.S., Morens, D.M. 2016, "Zika virus in the Americas — yet another arbovirus threat", N. Engl. J. Med., 374, 601-604.

Fox, M. 2016, "Congress Struggles to Get a Deal to Pay for Zika Virus Defense", NBC News, http://www.nbcnews.com/storyline/zika-virus-outbreak/congress-struggles-get-deal-pay-zika-virus-defense-n562956 (Accessed: August 14, 2016).

Gulland, A. 2016, "Zika virus is a global public health emergency, declares WHO", Brit. Med. J., 352, 657.

Hammon, W.M., Schrack, W.D., Sather, G.E. 1958, "Serological survey for a arthropod-borne virus infections in the Philippines", Am. J. Trop. Med. Hyg., 7, 323-328.

Healy, M. 2016, "Two new vaccines can protect against Zika after a single shot", Los Angeles Times, http://www.latimes.com/science/sciencenow/la-sci-sn-zika-vaccine-20160628-snap-story.html (Accessed: August 14, 2016).

Jong, H.N. 2016, "Zika infection present in almost third of world", The Jakarta Post, http://www.thejakartapost.com/life/2016/05/17/zika-infection-present-in-almost-third-of-world.html (Accessed: August 14, 2016)

Langlois, J. 2016, "Zika-Linked Microcephaly Costs Are Stressing an Already Strapped Brazil", Fortune, http://fortune.com/2016/03/02/zika-costs-microcephaly-brazil/ (Accessed: August 14, 2016).

Leefeldt, E. 2016, "The true cost of Zika in the U.S. could be staggering", CBS News, http://www.cbsnews.com/news/the-true-cost-of-zika-in-the-u-s-could-be-staggering/ (Accessed: August 11, 2016).

MacNamara, F.N. 1954, "Zika virus: A report on three cases of human infection during an epidemic of jaundice in Nigeria", Trans. R. Soc. Trop. Med. Hyg., 48, 139-145.

McNeil, D.G. 2016, "Zika May Be Transmitted by Oral Sex, Scientists Find", The New York Times, http://www.nytimes.com/2016/06/03/health/zika-oral-sex-kissing-transmission.html?_r=2 (Accessed: August 14, 2016).

Muchmore, S. 2016. "Costs of Zika among the many unknowns of the virus", Modern Healthcare, http://www.modernhealthcare.com/article/20160720/NEWS/160719976 (Accessed: September 5, 2016).

Mykhyalyshyn, I, Omri, R. 2016, "Zika Cases in the United States", The New York Times, http://www.nytimes.com/interactive/2016/07/29/us/zika-cases-united-states.html (Accessed: August 10, 2016).

NIAID. 2016, "NIH begins testing investigational Zika vaccine in humans", The National Institute of Allergy and Infectious Diseases, https://www.niaid.nih.gov/news/newsreleases/2016/Pages/Zika-Investigational-Vaccine.aspx (Accessed: August 14, 2016)

Oliveira-Szejnfeld, P.S., Levine, D., Melo, A.S.O., Amorim, M.M.R., Batista, A.G.M., Chimelli, L., Tanuri, A., Aguiar, R.S., Malinger, G., Ximenes, R., Robertson, R., Szejnfeld, J., Tovar-Moll, F. 2016, "Congenital Brain Abnormalities and Zika Virus: What the Radiologist Can Expect to See Prenatally and Postnatally", *Radiology*, Ahead of Print, http://pubs.rsna.org/doi/full/10.1148/radiol.2016161584 (Accessed: September 5, 2016)

Petersen, L.R., Jamieson, D.J., Powers, A.M., Honein, M.A. 2016, "Zika Virus", N. Engl. J. Med., 374, 1552-1563.

Pond, W.L. 1963, "Arthropod-borne virus antibodies in sera from residents of South-East Asia", Trans. R. Soc. Trop. Med. Hyg., 57, 364-371.

Smith, L. 2016, "Zika Virus: Symptoms, Facts, Diagnosis", Med. News Today, http://www.medicalnewstoday.com/articles/305163.php (Accessed: March 31, 2016).

Smithburn, K.C. 1954, "Neutralizing antibodies against arthropod-borne viruses in the sera of long-time residents of Malaya and Borneo", Am. J. Hyg., **59**, 157-163.

Smithburn, K.C., Kerr, J.A., Gatne, P.B. 1954b, "Neutralizing antibodies against certain viruses in the sera of residents of India", J. Immunol., **72**, 248-257.

Smithburn, K.C., Taylor, R.M., Rizk, F., Kader, A. 1954a, "Immunity to certain arthropod-borne viruses among indigenous residents of Egypt", Am. J. Trop. Med. Hyg., **3**, 9-18.

STAT, 2016, "Experimental Zika vaccine approved for clinical trial for first time in US, STAT news, https://www.statnews.com/2016/06/20/zika-vaccine-inovio/ (Accessed: August 14, 2016).

WHO. 2016a, "Situation report", World Health

Organization, http://www.who.int/emergencies/zika-virus/situation-report/23-june-2016/en/ (Accessed: August 14, 2016).

WHO. 2016b, "Zika Virus", World Health Organization, http://www.who.int/mediacentre/factsheets/zika/en/ (Accessed: August 14, 2016)

WHO. 2016c, "Prevention of sexual transmission of Zika virus", World Health Organization, http://www.who.int/csr/resources/publications/zika/sexual-transmission-prevention/en/ (Accessed: August 14, 2016).

Zaman, M.S., and Sizemore, R. 2016, "Zika Virus: Origin, Transmission, Risk and Prevention", Adv. Sci. Technol. **10,** 1-4.

Zoroya, G., Szabo, L. 2016, "Military discloses at least 11 troops infected with Zika virus this year", USA Today, http://www.usatoday.com/story/news/nation/2016/06/03/military-discloses-least-11-troops-infected-zika-virus-year/85343632/ (Accesses: August11, 2016).