MedCrave
Step into the World of Research

Obstetrics & Gynecology International Journal

Review Article

Open Access

CrossMark

Viral mosquito-borne illnesses in pregnancy: A look at *aedes*

Abstract

There has been much interest over the last few years to months on mosquito borne illnesses. Most recently the outbreak of Zika virus in Brazil has sparked physicians to take a closer look at these illnesses. We will hence review the viruses transmitted by the *Aedes aegypti* mosquito, the symptoms the illness presents with, diagnosis and impact on pregnancy and how to prevent transmission.

Keywords: Pregnancy, Mosquito-borne, Viral, Zika, Aedes, Egypti, Dengue, Chikun gunya

Volume 5 Issue 1 - 2016

Shamanique Shamona Bodie-Williams, Shantalasha Onika Knowles
Department of Obstetrics and Gynaecology, Bahamas Public Hospitals Authority, The Bahamas

Correspondence: Shantalasha Onika Knowles, Department of Obstetrics and Gynaecology, Bahamas Public Hospitals Authority, P.O. Box-N-9580 Nassau, Bahamas, Tel 242-376-3706, Email onika.knowles@yahoo.com

Received: June 25, 2016 | **Published:** July 27, 2016

Introduction

A mosquito borne illness is a disease in which mosquitoes transmit a viral, bacterial or parasitic infection to humans. Mosquitoes are abundant in warm, tropical and subtropical climates and linger in wet, damp, dark areas. There are 41 genera of mosquitoes, however 2 genera are implicated mostly in transmitting diseases to humans. These are *Aedes* and *Anopheles*.[1] The female *Anopheles*mosquito transmits malaria. The *Aedes* mosquito is distinguished physically from other genera because of the black and white markings on the body and legs. *Aegypti*is the species that is the culprit in yellow fever, zika virus infection, chikungunya, dengue and bunyamwera fever.

Women are easily exposed to the *A. aegypti* mosquito in nature. Only the female mosquito bites either early in the morning or just prior to sunset (dusk). It favours dark, shady areas and preferentially breeds in stagnant water. Vector control is extremely important in controlling and preventing disease epidemics. Fogging of affected areas can be implemented using malathion, propoxur or lindane. Other fogging chemical includes, dichlorodiphenyltrichloroethane (DDT), although banned in the USA, it is still used effectively in developing countries.[2] In addition, mosquito repellents such as DEET (N, N-diethylmetatoluamide, 20% to 30% concentration) is suggested by the Center for Disease Control (CDC). Also clearing away containers or items that can collect water including (but not limited to) old tires, trash bins, flowers vases, and buckets. Persons in an epidemic should wearing long clothing and use mosquito nets (in area without air-conditioning or unscreened rooms).

Yellow fever

Yellow Fever is an acute viral disease that is caused by an enveloped, single-stranded RNA virus of the genus *Flavi virus.* Historically, infected patients were called, "yellow jackets" as they were dressed in jackets with yellow patches in some hospitals to warn the staff of the presence of the disease.[3] The reference to color in the name is due to the symptom of jaundice (with subsequent yellowing of the skin and mucous membranes) experienced by some infected persons. Yellow fever (YF) is mostly found in tropical areas, but as airplane travel has allowed access to once remote or exotic areas, it can be isolated in any country. The World Health Organization estimates 200,000 cases of yellow fever, causing 30,000 deaths worldwide each year (with 90% occurring in Africa).[4] It is endemic in parts of Africa and South America. Over the past 30 years there has been a steady rise in the incidence of the disease due to global climate change, urbanization and decreased immunity within the population.

As stated earlier, the female *Aedes egypti* mosquito is the vector for yellow fever, however *Aedes albopictus* is also a known vector, other species are involved in non-human primate transmission. Once the mosquito ingests blood from an infected host it replicates and when the mosquito feeds again it injects infected saliva into the host. The virus enters the blood stream and replicates in the lymph nodes. The incubation period is 3 – 6 days. Symptoms occur in 3 phases, the acute phase has mild to moderate flu-like symptoms of fever, chills, headache, lower back pain, myalgia and loss of appetite. This phase can last about 4 days and often goes unnoticed as yellow fever infection. The second phase occurs in 15% of patients[5] within 24 hours of remission and it can be fatal. It is characterized by pyrexia often as high as 104˚F (with a pulse rate that is slow relative to the height of the fever [Faget's sign]), vomiting, abdominal pain and haemorrhage (which can manifest as petechiae, ecchymoses, and epistaxis, progressing to haematemesis and melena). Renal and hepatic damage ensues with jaundice and organ failure. Hepatorenal disease has a mortality rate of 20 to 50% and occurs within 7 – 10 days of disease onset.[6] Diagnosis of the disease is based on clinical features and rapid diagnostic tests such as enzyme-linked immunosorbent assay (ELISA) for determination of IgM antibodies and polymerase chain reaction (PCR) detecting the yellow fever viral genome sequence. Cross-reactivity with other *flavi viruses* can make serological testing difficult.

Yellow fever can be acquired in pregnancy, if bitten by an infected mosquito. It is important to question a patient about travel history if the disease is suspected. Vaccination history should also be obtained. The symptoms of yellow fever are the same in the pregnant state as in the non-pregnant state. However, these symptoms can lead to fetal consequences. For example, fever and vomiting can lead to depletion of maternal intravascular volume with subsequent decrease in uteroplacental perfusion leading to possible hypoxia and fetal heart rate abnormalities. Yellow fever in pregnancy is treated the same as in other patients. Women should be admitted to hospital for supportive

care, especially when second phase symptoms occur. We suggest assessment of fetal well-being with severe symptoms. There is no cure for YF, therefore, treatment is symptomatic, rest, intravenous fluids and analgesics to reduce pyrexia and pain should be used. Once a definitive diagnosis is made, women do not need to be quarantined, however exposure to mosquitoes should be avoided during the first few days of the illness in order to break the cycle of transmission (uninfected mosquito feeding on the patient and infecting others). If end-organ dysfunction is present laboratory values reflect such. Laboratory investigations should be guided by symptomatology and include, complete blood count, renal functions test, chemistries (including liver and renal function tests) and urinalysis.

Yellow Fever vaccine (17D Vaccine) is a live attenuated vaccine. Most available information on the yellow-fever vaccine in pregnancy is limited. It is a Category C drug. If travel to an endemic area is unavoidable, the question is whether the benefit of the vaccine outweighs the potential risk to the fetus? There are studies that show no evidence of fetal (or neonatal) effects when the vaccine is administered in pregnancy.[7-9] Thomas and others did a systematic review of several studies and in a total of 1,381 pregnant women found that no adverse perinatal outcomes were noted when the vaccine was administered during pregnancy.[10] In fact, maternal seroconversion (immunological response) is found to be very high when immunization is carried out in early pregnancy.[7,11] Data is also limited on yellow fever vaccine (YFV) in breast feeding, it should be avoided during breast feeding as it does enter breast milk. Three cases have been shown to be transmitted in lactating women.[12] If it must be administered in the post-partum period, supplemental formula feeding should be carried out for at least 10 days after the vaccine is administered.[11,13] A case report has been published describing vaccine-induced encephalitis in a breastfeeding neonate 8 days after primary vaccination of the mother.[11] WHO advises if travel to endemic areas cannot be postponed YFV should be administered in pregnancy and during breastfeeding. Recovery occurs in the majority of persons with YF infection and there is usually lifelong immunity. However, this immunity has not been shown to be transferable to the neonate in those infected during pregnancy.

Dengue fever

Dengue fever is public health problem in several countries as a result of increased air travel, the expansion of cities and the inability of countries to prevent the spread of the infection. As a result, dengue fever is the most common mosquito - borne infection. Dengue is an arbovirus of the *Flavi viridae* family and *Flavi virus* genus. *Aedes albopictus* is a vector. The first confirmed case report was written by Benjamin Rush in 1789.[14]

Dengue is fever is classified into three different types based on the symptoms and the severity of the disease presentation. They are classic fever, haemorrhagic dengue fever and haemorrhagic shock. There are four serotypes of the dengue virus (DEN-1, DEN-2, DEN-3, and DEN-4). Infection by one type confers lifetime immunity to that subtype and temporary immunity to the other types. However, secondary infection by other subtypes is thought to increase the chance of developing severe manifestation of the disease.[15]

Although a patient may be asymptomatic, when symptoms are presentit may include a high fever (lasting 2-10 days), facial flushing, headache, diarrhea, vomiting, muscle aches, fatigue, retroorbital pain, swollen glands, maculopapular or macular rash, sore throat, altered mental status, non-productive cough, and thrombocytopenia. Two case report describes myocarditis caused by dengue.[16-17]

Moreover, in severe cases dengue can complicate operative deliveries resulting in increased morbidity for the mother with increased risk of atony and hemorrhage.[18] Dengue can be diagnosed by identifying the presence of dengue IgM antibodies, dengue PCR or the detection of the NS1 (Non-structural protein 1) antigen by ELISA. The antibodies can persist for up to six months. Establishing a diagnosis is important so that delivery planning can be commenced because of the risk of hemorrhage. Mortality rates in the case of pregnancy or of haemorrhagic fever can be high especially in a low resource settings.[19-20] Perret et al.[21] has noted that serious disease may occur if the mother is at or near term decreasing the time for the mother to produce antibodies.[21] Studies show that findings include an increased risk for thrombocytopenia in the mother, premature labour,[22] oligohydraminios, antepartum and postpartum hemorrhage,[23-24] fetal distress, low birth weight, miscarriages,[25-26] intrauterine death,[22] and neonatal death.[27] Antibodies (protective to the neonate) can pass transplacentally during maternal infection, however these same antibodies can be a double-edge sword as it can increase the risk of dengue haemorrhagic fever and dengue shock syndrome in later infancy.[28-29]

Several case reports have demonstrated that there are cases of vertical transmission of the virus.[30-31] Vertically transmitted neonatal infection can be detected by reverse transcriptase polymerase chain reaction (RT-PCR). The reported vertical transmission rate is 1.6 percent[32] with no difference in the pregnancy outcome of infected women. Co-infections with malaria can cause jaundice and encephalopathy. They are also at risk for co-infections with Zika.[33]

WHO recommendations include the advice that all patients with severe dengue should be admitted to a unit that has access to an Intensive Care Unit and blood bank in the event that transfusions are needed. In the case of haemorrhagic shock, solutions of dextran 70 have been used including transfusions of blood and plasma. No vaccines are currently available as prophylaxis against dengue fever. However, testing is currently on the way. A tetravalent live recombinant vaccine is being evaluated.[34] Prevention of transmission of dengue fever in pregnant women (and the general population) include travel precautions, such as delaying travel to endemic areas. A high index of suspicion is required for diagnosis and support as the clinical and laboratory abnormalities may be similar to other obstetrical conditions.

Chikungunya virus

Chikungunya virus (CHIKV) is a RNA virus of the family *Toga viridae* and genus *Alpha virus*. It is much like other viruses transmitted by the *Aedes aegypti* and *albo pictus* mosquitoes in that it causes fever. But unlike yellow fever (for example) the majority of infections with CHIKV is symptomatic (up to 97%). Chikungunya is derived from a language know in Tanzania and Malawi and it means "that which bends up", "to become contorted", as the disease was first recognized in the region of the Makonde people.[35] The name describes the way some infected people look when afflicted with the symptoms. Like the other viruses, re-emergence is due mainly to travel. It was initially considered a tropical illness, however, due to epidemics in non-tropical areas that designation has changed. Outbreaks occurred intermittently in areas such as Asia, India, Africa, South America and the Caribbean. The disease was relatively quiescent until outbreaks reoccurred, a major one being in the Réunion Islands (2005 to 2006) with an estimated 300,000 cases.[36] Following close behind was an epidemic in India in 2006 affecting about 1.42 million people.[37] An outbreak occurred in 2013 in French Saint-Martin and spread through

Citation: Bodie-Williams SS, Knowles SO.Viral mosquito-borne illnesses in pregnancy:A look at *aedes*. *Obstet Gynecol Int J.* 2016;5(1):241–246.
DOI: 10.15406/ogij.2016.05.00139

the West Indies and other Caribbean Islands including Central and South America and 232 (imported) cases of chikungunya fever was reported in the U.S according to the Centers for Disease control (National Center for Emerging and Zoonotic Infectious Diseases).

Humans are the major reservoir for the virus, however between epidemics other animals maintain the virus in the environment (e.g. monkeys, rodents and birds). The incubation period for this virus is about 3-7 days, but can be as long as 12 days. The initial symptom is usually an abrupt onset of high fever reaching 102˚F to 105˚F with chills. Subsequently, there may be the development of headache, arthralgia, myalgia, retroorbital pain, joint inflammation (which is similar to the other acute febrile illnesses caused by other arboviruses) and an erythematous maculopapular rash. The most distressing symptoms is the severe joint points that often incapacitate the patient, usually it involves multiple sites simultaneously forcing the patient in a curled up, motionless position to prevent exacerbating the pain. Clinical signs of chikungunya have an excellent predictive value during an outbreak[38] Symptoms are difficult to differentiate from dengue fever however. Diagnosis can be confirmed by serological testing for CHIKV IgM antibodies (which become positive about 5 to 7 days into the infection.). RT-PCR can also be used. Rarely, chikungunya infection may cause maternal bleeding complications, however it has not be shown to cause an increase in antepartum or postpartum haemorrhage in infected patients.[38]

Rarely is the disease fatal, however in the 2005 outbreak in the Réunion Islands, the mortality rate was about 10.6%[39] Information on chikungunya in pregnancy was limited prior to this outbreak and the Chikungunya-Mère-Enfant cohort study describes some outcomes seen in pregnancy.[38] It was noted from this study that no adverse effects (low-birth weight, preterm-delivery, stillbirths or admission to NICU) occur during pregnancy with infection. Fetal chikungunya infection is rare.[36] Evidence is conflicting with regards to fetal transmission, some studies showing transmission in early pregnancy suggesting a possible role in miscarriage and others showing a lack of placental infection by the virus in histological specimens.[36,40,41] Most cases of infection in pregnancy is by vertical transmission during labour.[36,38] Presumably, small transfers of maternal blood into the fetal circulation account for this. However, cesarean section has not been shown to be protective.[40] Women with intrapartum infection have a vertical MTCT rate of 48.7% and about 2.5% of exposed infants become infected.[36] When infection occurs several days prior to delivery, the neonate may present by day 4 of life with symptoms and signs of infection including a maculopapular rash (rarely cutaneous hyperpigmentation), fever, respiratory distress, and elevated aspartate amniotransferase and complications such as seizures, myelomeningo encephalits, disseminated intravascular coagulation, intracerebral haemorrhage, myocarditis, peripheral oedema, necrotizing enterocolitis and sepsis has also been described.[42-45] Transmission of the virus in breast milk is not known. It is also unknown if maternal antibodies are protective to the neonate in women with previous infection. The Réunion Island outbreak showed no CHIKV RNA in 20 breast milk samples from infected mothers. There is not enough evidence to recommend that women infected in the postpartum period not breastfeed.

Treatment of chikungunya infection is similar in the pregnant and non-pregnant state, which is symptomatic, antipyretics and analgesics. Infection should be differentiated from dengue fever with serological or RT-PCR testing as use of NSAIDs can exacerbate bleeding and indirectly increase morbidity and mortality. Non-steroidal anti-inflammatory agents should not be used however, because of its association with premature closure of the ductus arteriosus when used in the third trimester. Non-stress testing (NST) done during pyrexia will show fetal tachycardia, but other NST parameters should be reassuring. Hydration should be done with intravenous fluids. Admission is usually not required, but should be considered for severe cases where there is electrolyte imbalances orhaemodynamic instability.

As there is no specific treatment or vaccine for chikungunya infection, pregnant women should avoid travelling to areas where there is an epidemic. If an outbreak occurs, efforts should be made to avoid infection by taking the precautions described earlier and seek medical care if infection is suspected. Vaccines are in the progress of being developed.[46]

Zika

The Zika virus was first noted in 1947 in Uganda in the Zika Valley in a rhesus monkey.[47] The first case documented in a human was also in Uganda in 1952.This virus is a mosquito borne disease that is related to the other viruses in this articles. The *Aedes aegypti* (subgenus: *Stegomyia*) and *albopictus* species of mosquitoes is responsible for the primary transmission of the virus. However, the virus is also transmitted through human to human contact through sexual intercourse or blood transfusions.[48-50]

The incidence is of Zika infection is unknown. However, the number of cases are increasing exponentially and is a current concern for obstetricians especially since it is thought to be linked to malformations in the fetus such as microcephaly.[51] Zika virus is a positive sense single stranded RNA molecule enclosed in a capsid and surrounded by a membrane that is similar in structure to other flavi viruses.[52] The incubation period is variable but the symptoms are thought to last two to seven days. Although most persons do not develop any symptoms a portion (1/4 of persons infected)are thought to develop symptoms.[53] The symptoms of the virus include fever, redness and muscle aches, headache, conjunctivitis (and other flu-like symptoms), ulceration of mucous membranes and digestive problems. Thrush and itching are rarely observed. Unlike dengue fever, yellow fever and chikungunya, there are no deaths reported. One case of blood in the semen has been reported. Cases of Guillian-Barre syndrome have also been documented.[55]

Although pregnant women are not thought to be more susceptible to acquiring the virus, cases of perinatal transmission and vertical transmission have been documented.[56] The virus is thought to be neurotrophic causing destruction in various parts of the brain resulting in calcifications in the eyes, small eyes (micro-ophthalmia) and a small head (microcephaly). It has also linked to hydrops fetalis, hydraencephaly and fetal demise.[57] Another recent study also described an association with fetal demise and CNS injury, including other fetal complications in 29% of Zika positive women (which was more than in Zika negative women), placental insufficiency and IUGR.[58]

Diagnosis should be considered in anyone that has lived or travelled to an area where the Zika virus has been confirmed in cases. The disease can be confirmed by detecting the Zika virus RNA. The FDA has recently approved a Zika IgM Antibody Capture Enzyme-Linked Immunosorbent Assay (Zika MAC - Elisa) which is able to pick up antibodies within days of the beginning of symptoms.[59]

If Zika is suspected in a pregnant woman with a history of travel to an area with ongoing Zika virus transmission or if she has had intercourse with a partner who has exposure to the Zika virus she should be tested using Zika virus reverse transcriptase PCR and Zika

Citation: Bodie-Williams SS, Knowles SO.Viral mosquito-borne illnesses in pregnancy:A look at *aedes*. *Obstet Gynecol Int J.* 2016;5(1):241–246.
DOI: 10.15406/ogij.2016.05.00139

IgM within 2-12 weeks of possible exposure.[60] If the result is positive you would manage the pregnancy as per ACOG/ CDC guidelines. If the mother is asymptomatic but has additional exposure check a Zika IGM at first visit and then repeat the test in late second trimester.

Fetal management should be based on test results. For example, if a mother has clinical symptoms and tests positive for the virus she should have an ultrasound approximately 3-4 weeks after exposure to look for findings associated with the virus such as calcifications and microcephaly. If these findings are noted, she may be advised to have an amniocentesis if greater than 15 weeks. If these findings are absent or her test is negative for the virus, she may be advised to repeat the testing and ultrasound as indicated.[61]

Currently, no vaccine exists for the Zika virus. The disease is self-limiting and supportive care is indicated. However, given the morbidity for fetuses associated with the Zika virus, prevention is important. Avoid travel to areas where Zika is endemic is one means of prevention, coverage of exposed skin with long sleeved shirts, long pants, and use of insect repellant. Also abstain from unprotected sex with someone who has been exposed or is infected with the Zika virus.

Bunyamwera fever

Bunyamwera fever is far less common than the other illnesses described above. It is caused by a virus from the genus *Orthobunyavirus* (family *Bunyaviridae*). The genome contains 3 segments of single-stranded RNA.[62] It can cause a haemorrhagic fever that is most commonly seen in African countries. Outbreaks are sporadic. Not much information is available on bunyamwera virus in humans, except its reassortant, known as Ngari virus, has led to outbreaks in East Africa.[63]

Typical symptoms are that of a viral-illness with fever, headache, arthralgia lasting about 5 days and fatigue persisting for about 10 days. The disease is usually self- limiting but can leading to hemorrhagic fever. Neck-stiffness can be noted when there is meningeal involvement.[64] Diagnosis is by ELISA and serological testing.

Due to the rarity of Bunyamwera infection in relation to the arboviruses there have been no studies done in pregnant women. It is not known what effects this virus has on maternal or perinatal outcome. It can be deduced that its haemorrhagic fever may cause maternal bleeding complications similar to dengue haemorrhagic fever, but studies would be needed to confirm this. No firm recommendation can be made on breastfeeding while infected. Considering the paucity of information in this virus in pregnancy it is suggested by the authors that if a pregnant woman has been in an environment where an active outbreak is occurring that she seeks medical care if symptoms should ensue. No vaccine is currently available for Bunyamwera Virus.

Conclusion

Clinician awareness of the differentials, clinical presentation, and possible laboratory finding in these illnesses will allow physicians to have a more focused approach to the infected patient. Also early recognition, treatment, and counseling of the patient on the prognosis and possible implications of the illness on the pregnancy is imperative in helping to allay fears and dispel myths in the patient's mind, and ensure the best fetal and maternal outcome. More research is required so that treatment guidelines can be developed for all of the illness out lined in this article. We hope that the review contributes towards increasing awareness.

Acknowledgments

None.

Conflicts of interest

None.

References

1. Centers for Disease Control and Prevention. Anopheles Mosquito. USA. 2015.
2. Lear Linda J. Rachel Carson: Witness for Nature. 2009.
3. Oldstone, Michael. *Viruses, Plagues, and History: Past, Present and Future*. Oxford University Press, USA. 2009;Pp.102–104.
4. WHO. Yellow Fever Fact Sheet. 2014.
5. Centers for Disease Control and Prevention. National Center for Emerging and Zoonotic Infectious Diseases (NCEZID) Division of Vector–Borne Diseases (DVBD). *Yellow Fever*. 2016.
6. Monath TP, Gershman M, Staples JE, et al. Yellow fever vaccine. In: Plotkin SA, et al. (Eds.), *Vaccines*. (6th edn), Saunders Elsevier, Philadelphia, PA, USA. 2013;pp.870–968.
7. Suzano CE, Amaral E, Sato HK, et al. Campinas Group on Yellow Fever Immunization during Pregnancy. The effects of yellow fever immunization (17DD) inadvertently used in early pregnancy during a mass campaign in Brazil. *Vaccine*. 2006;24(9):1421–1426.
8. Nasidi A, Monath TP, Vandenberg J, et al. Yellow fever vaccination and pregnancy: a four–year prospective study. *Trans R Soc Trop Med Hyg*. 1993;87(3):337–339.
9. Keller–Stanislawski B, Englund JA, et al. Safety of immunization during pregnancy: a review of the evidence of selected inactivated and live attenuated vaccines. *Vaccine*. 2014;32(52):7057–7064.
10. Thomas RE, Lorenzetti DL, Spragins W, et al. The Safety of Yellow Fever Vaccine 17D or 17DD in Children, Pregnant Women, HIV+ Individuals, and Older Persons: Systematic Review. *Am J Trop Med Hyg*. 2012;86(2):359–372.
11. Imbert P, Moulin F, Mornand P, et al. Should yellow fever vaccination be recommended during pregnancy or breastfeeding?. *Med Trop (Mars)*. 2010;70(4):321–324.
12. World Health Organization. Weekly Epidemiological Record. 2013;88:208–210.
13. Anselem O, Parat S, Théau A, et al. Vaccination and pregnancy. *Presse Med*. 2014;43(6 Pt 1):715–721.
14. Rush AB. Medical Inquiries and Observations. An account of the bilious remitting fever, as it appeared in Philadelphia in the summer and autumn of the year. *Prichard and Hall*, Philadelphia, USA. 1780;pp.104–117.
15. Durbin A, Schimdt A, Elwood D, et al. Heterotypic Dengue Infection with Live Attenuated Monotypic Dengue Virus Vaccines: Implications for Vaccination of Populations in Areas Where Dengue Is Endemic. *J Infect Dis*. 2011;203(3):327–334.
16. Tahir H, Daruwalla V, Hayat S. Myocarditis leading to severe dilated cardiomyopathy in a patient with dengue fever. *Case Rep Cardiol*. 2015;2015:319312.
17. Zea D, Foley K, Carey J. Myocarditis in a traveler returning from the Dominican Republic: an unusual presentation of dengue fever. *Am J Trop Med Hyg*. 2014;91(1):156–158.
18. Hashmi M, Zainab G, Khan F. Anticipated and unanticipated complications of severe dengue in a primigravida. *Indian J Crit CareMed*. 2015;19(11):678–680.
19. Mota AK, Miranda Filho AL, Saraceni V, et al. Maternal mortality and impact of dengue in Southeast Brazil: an ecological study, 2001–2005. *CadSaude Publica*. 2012;28(6):1057–1066.

Citation: Bodie-Williams SS, Knowles SO.Viral mosquito-borne illnesses in pregnancy:A look at *aedes*. *Obstet Gynecol Int J.* 2016;5(1):241–246.
DOI: 10.15406/ogij.2016.05.00139

20. Machado CR, Machado ES, Rohloff RD, et al. Is Pregnancy Associated with Severe Dengue? A review of data from the Rio de Janeiro surveillance information system. *PLoS Negl Trop Dis*. 2013;7(5):e2217

21. Perret C, Chanthavanich P, Pengsaa K, et al. Dengue infection during pregnancy and transplacental antibody transfer in Thai mothers. *J Infect*. 2005;51(4):287–293

22. Ismail NA, Kampan N, Mahdy ZA, et al. Dengue in pregnancy. *Southeast Asian J Trop Med Public Health*. 2006;37(4):681–683.

23. Chotigeat U, Kalayanarooj S, Nisalak A. Vertical transmission of dengue infection in Thai infants: two case reports. *J Med Assoc Thai*. 2003;86Suppl3:S628–S632.

24. Thaithumyanon P, Thisyakorn U, Deerojnawong J, et al. Dengue infection complicated by severe hemorrhage and vertical transmission in a parturient woman. *Clin Infect Dis*. 1994;18(2):248–249.

25. Waduge R, Malavige GN, Pradeepan M, et al. Dengue infections during pregnancy: a case series from Sri Lanka and review of the literature. *J Clin Virol*. 2006;37(1):27–33.

26. Friedman EE, Dallah F, Harville EW, et al. Symptomatic Dengue Infection during Pregnancy and Infant Outcome: A Retrospective Cohort Study. *PLoS Negl Trop Dis*. 2014;8(10):e3226.

27. Chye JK, Lim CT, Ng KB, et al. Vertical Transmission of Dengue. *ClinInfectDis*. 1997;25(6):1374–1377.

28. Watanaveeradej V, Endy TP, Samakoses R, et al. Transplacentally transferred maternal–infant antibodies to dengue virus. *AmJ Trop Med Hyg*. 2003;69(2):123–128.

29. Kliks SC, Nimmanitya S, Nisalak A, et al. Evidence that maternal dengue antibodies are important in the development of dengue hemorrhagic fever in infants. *Am J Trop Med Hyg*. 1988;38(2):411–419.

30. Samara LC Maroun, Roberta CC Marliere, et al. Case Report: Vertical Dengue Infection. *J Pediatr (Rio J)*. 2008;84(6):556–559.

31. Sirinavin S, Nuntnarumit P, Supapannachart S, et al. Vertical dengue infection: case reports and review. *Pediatr Infect Dis J*. 2004;23(11):1042–1047.

32. Tan PC, Rajasingam G, Devi S, Omar SZ. Dengue infection in pregnancy: prevalence, vertical transmission, and pregnancy outcome. *Obstet Gynecol*. 2008;111(5):1111–1117.

33. Singla N, Arora S, Goel P, et al. Dengue in pregnancy: an under–reported illness, with special reference to other existing co–infections. *Asian Pacific J of Trop Med*. 2015;8(3):206–208.

34. World Health Organization. Weekly Epidemiological Record. 2015;p.90.

35. Morens DM, Fauci AS. Chikungunya at the door–déjà vu all over again? *N Engl J Med*. 2014;371(10):885–887.

36. Gérardin P, Barau G, Michault A, et al. Multidisciplinary prospective study of mother–to–child chikungunya virus infections on the island of La Réunion. *PLoS Med*. 2008;5(3):e60.

37. Renault P, Solet JL, Sissoko D, et al. A major epidemic of chikungunya virus infection on Reunion Island, France, 2005–2006. *Am J Trop Med Hyg*. 2007;77(4):727–731.

38. Fritel X, Rollot O, Gérardin P, et al. Chikungunya Virus Infection during Pregnancy, Réunion, France, 2006. *Emerging Infectious Diseases*. 2010;16(6):418–425.

39. Economopoulou A, Dominguez M, Helynck B, et al. Atypical Chikungunya virus infections: clinical manifestations, mortality and risk factors for severe disease during the 2005–2006 outbreak on Rénuion. *Epidemiol Infect*. 2009;137(4):534–541.

40. Lenglet Y, Barau G, Robillard PY, et al. Chikungunya infection in pregnancy: evidence for intrauterine infection in pregnant women and vertical transmission in the parturient. Survey of the Reunion Island outbreak. *J Gynecol Obstet Biol Reprod(Paris)*. 2006;35(6):578–583.

41. Touret Y, Randrianaivo H, Michault A, et al. Early maternal–fetal transmission of the Chikungunya virus. *Presse Med*. 2006;35(11 Pt 1):1656–1658.

42. Ramful D, Carbonnier M, Pasquet M, et al. Mother–to–child transmission of Chikungunya virus infection. *Pediatr Infect Dis J*. 2007;26(9):811–815.

43. Passi G, Khan, YZ, Chitnis DS. Chikungunya infection in neonates. *Indian Pediatr*. 2008;45(3):240–242.

44. Villamil–Gómez W, Alba–Silvera L, Menco–Ramos A, et al. Congenital Chikungunya Virus Infection in Sincelejo, Colombia: A Case Series. *J Trop Pediatr*. 2015;61(5):386–392.

45. Vasani R, Kanhere S, Chaudhari K, et al. Congenital Chikungunya–A Cause of Neonatal Hyperpigmentation. *Pediatr Dermatol*. 2016;33(2):209–212.

46. Weaver SC, Osorio JE, Livengood JA, et al. Chikungunya virus and prospects for a vaccine. *Expert Rev Vaccines*. 2012;11(9):1087–1101.

47. Dick GWA, Kitchen SF, Haddow AJ. Zika virus Isolations and serological specificity. *Trans R Soc Trop Med Hyg*. 1952;46(5):509–520.

48. Foy BD, Kobylinski KC, Foy JL, et al. Probable non–vector–borne transmission of Zika virus, Colorado, USA. *Emerg Infect Dis*. 2011;17(5):880–882.

49. Marano G, Pupella S, Vaglio S, et al. Zika virus and the never–ending story of emerging pathogens and transfusion medicine. *Blood Transfus*. 2016;14(2):95–100.

50. Musso D, Nhan T, Robin E, et al. Potential for Zika virus transmission through blood transfusion demonstrated during an outbreak in French Polynesia, November 2013 to February 2014. *Euro Surveill*. 2014;19(14):20761.

51. Schuler–Faccini L, Ribeiro EM, Feitosa IM, et al. Possible Association Between Zika Virus Infection and Microcephaly – Brazil, 2015. *MMWR Morb Mortal Wkly Rep*. 2016;65(3):59–62.

52. Thiel JH, Collet MS, Gould EA, et al. Family Flaviviridae. Virus Taxonomy: *Eighth Report of the International Committee on Taxonomy of Viruses*. Elsevier Academic Press, San Diego, USA. 2005;pp.981–998.

53. Duffy MR, Chen TH, Hancock WT, et al. Zika virus outbreak on Yap Island, Federated States of Micronesia. *N Engl J Med*. 2009;360(24):2536–2543.

54. Ioos S, Mallet HP, Leparc Goffart I, et al. Current Zika virus epidemiology and recent epidemics. *Med Mal Infect*. 2014;44(7):302–307.

55. Baudoin L, Blake A, Cao Lormeau V, et al. Guillain–Barré Syndrome outbreak associated with Zika virus infection in French Polynesia: a case–control study. *Lancet*. 2016;387(9583):1531–1539.

56. Oliveria Melo AS, Malinger G, Ximenes R, et al. Zika virus intrauterine infection causes fetal brain abnormality and microcephaly: tip of the iceberg? *Ultrasound Obstet Gynecol*. 2016;47(1):6–7.

57. Sarno M, Sacramento GA, Khouri R, et al. Zika Virus Infection and Stillbirths: A Case of Hydrops Fetalis, Hydranencephaly and Fetal Demise. *PLoS Negl Trop Dis*. 2016;10(2):e0004517.

58. Brasil P, Pereira JP, Gabaglia CR, et al. Zika Virus Infection in Pregnant Women in Rio de Janeiro–Preliminary Report. *N Engl J Med*. 2016.

59. New CDC Laboratory Test for Zika Virus Authorized for Emergency Use by FDA. *Centers for Disease Control and Prevention*. 2016;(404):639–3286.

Citation: Bodie-Williams SS, Knowles SO.Viral mosquito-borne illnesses in pregnancy:A look at *aedes*. *Obstet Gynecol Int J.* 2016;5(1):241–246.
DOI: 10.15406/ogij.2016.05.00139

60. Balm MN, Lee CK, Lee HK, et al. A diagnostic polymerase chain reaction assay for Zika virus. *J Med Virol*. 2012;84(9):1501–1505.

61. Practice Advisory: Updated Interim Guidance for Care of Obstetric Patients And Women Of Reproductive Age During a Zika Virus Outbreak. *American College of Obstetrician Gynecologist*. 2016.

62. Bridgen A, Weber F, Fazakerley JK, et al. Bunyamwera bunyavirus nonstructural protein NSs is a nonessential gene product that contributes to viral pathogenesis. *Proc Natl Acad Sci,USA*. 2001;98(2):664–669.

63. Gerrard SR, Li L, Barrett AD, et al. Ngari virus is a Bunyamwera virus reassortant that can be associated with large outbreaks of hemorrhagic fever in Africa. *J Virol*. 2004;78(16):8922–8926.

64. Schaechter, Moselio. Encyclopedia of Microbiology (3rd edn), *Elsevier, Amsterdam*. 2009;pp.317.

Citation: Bodie-Williams SS, Knowles SO.Viral mosquito-borne illnesses in pregnancy:A look at *aedes*. *Obstet Gynecol Int J.* 2016;5(1):241–246.
DOI: 10.15406/ogij.2016.05.00139