International Center for Enterprise Preparedness (InterCEP)

Waiting in the Wings: Emergence, Impact and Control of Mosquito-Borne Viruses

Web Forum

On April 14, 2016, Kathryn A. Hanley, Professor in the Department of Biology at New Mexico State University, discussed Zika virus and other mosquito-borne viruses. Her talk, titled “Waiting in the Wings: Emergence, Impact and Control of Mosquito-Borne Viruses,” addressed the origin and spread of these viruses, ways we can respond to the challenges they pose and potential outcomes for the near future.

**Zika Virus: Health and Economic Impacts**

Zika virus was discovered in 1947 in Uganda. At the time the main concern of the health community was yellow fever, which affected many parts of the world, and little attention was paid to Zika. In the 1980s it was isolated in Malaysia in the mosquito *Aedes aegypti*. Zika and other mosquito-borne viruses have preferences for particular species of mosquitoes and this shapes the epidemiology of the viruses and where they are likely to spread. In the case of Zika virus, for example, the virus is transmitted among humans by infected *Aedes* (*Aedes aegypti* and *Aedes albopictus*) mosquitoes.

Zika is typically a relatively mild disease in humans. About 80% of those infected with the virus don’t even know they have it. Symptoms may include conjunctivitis, rash, joint pain and fever and these symptoms may last 2-7 days. That’s why even though scientists knew Zika would eventually arrive in the Americas nobody was really worried about it. This was before a link between Zika and birth defects such as microcephaly was established. Microcephaly results in babies with smaller heads than expected and can lead to severe disability.

There is very good spatial and temporal association between the spread of Zika virus and increasing cases of microcephaly in Brazil and French Polynesia. This issue has raised the level of concern regarding this virus very significantly and has led to more discussions about family planning and how to prevent a further increase in children born with microcephaly in areas where Zika virus is common.

Why have we never seen this association between Zika virus and microcephaly before? The reason may be that even though Zika is probably associated with microcephaly in Africa and in Asia, these additional cases of microcephaly go undetected because of lack of specific diagnostics combined with relatively
little monitoring of birth defects. It is also possible that in areas with high rates of infection with Zika virus, women may develop immunity by the time they have children.

Zika virus has also been linked to an increase in the number of cases of Guillain-Barré syndrome, a disorder that results when the body’s immune system attacks the nervous system. This link is currently being studied.

In addition to health impacts, the spread of Zika virus has had substantial economic impacts. It is estimated that fear of the virus has already cost the tourism industry over $3 billion. This health issue has even led to discussions about whether the 2016 Olympics, scheduled to be held in Brazil, should be deferred or cancelled. Figure 1 shows a map of the countries that are currently experiencing active Zika virus transmission. It is important to note that this map is color-coded by country; Zika virus is not usually present over an entire country but rather in certain sections.

Figure 1. Countries and Territories with Active Zika Virus Transmission

Other Mosquito-Borne Viruses

A number of other mosquito-borne viruses also cause serious health issues. They also present a challenge for Zika virus epidemiology since the symptoms these viruses produce are very similar. These include:

- Dengue virus, which affects about 400 million people every year
- Chikungunya virus, which appeared in the Americas in 2013 and is here to stay

In Brazil people are now getting infected with Zika, chikungunya and dengue. They share the same mosquito vector, *Aedes aegypti*, which has an enormous geographic range. This mosquito was very common in the Eastern US. In fact, dengue fever was first described in Philadelphia in the late 1700s. This mosquito likes to live in homes, the females bite during the day and feed almost exclusively on blood. They go from human to human taking blood meals which makes them effective for transmitting these viruses.

The Asian tiger mosquito (*Aedes albopictus*) was introduced to Texas in the 1980s and is now very abundant in the Eastern US, where it has displaced *Aedes aegypti* from much of its original range. The feeding habits of the Asian tiger mosquito are different and they don’t always feed from human to human. They also feed on other species so they are less effective vectors than *Aedes aegypti*. Both species of mosquitoes are active all day long and they are very plastic in terms of their behavior. Even though they are supposed to be crepuscular, feeding mostly at dusk and dawn, the fact is they can be active at any time.

Response to Zika and Mosquito-borne Viruses: What can we do?

Airplanes and current travel patterns make it very easy to spread Zika virus. Fever screenings at airports would not be effective because many people are not symptomatic. Individual containment, which was used for Ebola, would not be as effective for mosquito-borne diseases because mosquitoes can go from person to person.

Scientists are currently trying to understand what happens to the virus when people are not infected and how it can circulate between other species living in the wild and people. There may be a bridge vector or amplification host that may result in the production of large numbers of virus.
Efforts to reduce exposure to mosquito-borne viruses include:

**Mosquito Control.** There were very effective efforts to control the *Aedes aegypti* mosquito in the 1960s but these efforts waned in the 1980s and now the range of this mosquito is greater than ever. We continue to create ideal breeding sites for mosquitoes, such as piles of tires, which makes eradicating them more difficult. In many parts of the world where there is poor access to piped water people store water in places where mosquitoes can reproduce. Night time fogging does not help since these mosquitoes often live indoors and are active during the day. Mosquitoes also evolve resistance to pesticides quite rapidly.

**Diagnostics.** We need better rapid diagnostics for Zika. Investigators currently use PRC and serology but this won’t work with large-scale outbreaks.

**Vaccination.** This is a classic approach to this kind of disease and we use vaccination to address yellow fever. We do not currently have a vaccine for Zika and it will take some time to develop one.

**New drugs.** New antiretroviral drugs could be used to limit Zika disease, but they will not be effective to stop virus spread.

**Condoms.** These should be made available widely since Zika is also sexually transmitted.

**Q&A**

How long will Zika remain a public concern? Will it go away or will vaccination be the only solution? Vaccination is probably the best way to address this health issue. Questions remain about whether the virus will go into a sylvatic cycle (i.e., a cycle maintained in non-human animals). The virus is very adaptable. If it adapts to transmission in American species of monkeys we will have it in the Americas forever. If we are unable to develop a vaccine and Zika becomes sylvatic we will have a situation similar to what we had in the 1880s with yellow fever.

What is recommended for people who become infected and who may want to have children? For women that are infected as young girls there may not be any carryover effects. They would not be expected to have any problems later in life at childbearing age. That is our current understanding.

If a woman is infected it would be advisable to wait six months before getting pregnant. If a man is infected it would be advisable to wait two years before trying to have children. There is already a test to see if a person has a history of Zika virus, but the test may test positive if the person has had dengue.
fever. Men who have been to Brazil or other areas where Zika is common and who are thinking of starting a family should consider getting a Zika test and may consider waiting at least six months before trying to impregnate their partner.

Is the United States is a better position to address Zika virus than other countries? We should not consider ourselves immune because we are a wealthy country. Zika virus is also a problem for the U.S. given that mosquitoes that can carry the virus are present here. Education and understanding how the virus is transmitted are very important. The public’s knowledge in this area is very sketchy and poor. We need to get good messages out to the public that they should protect themselves from mosquito bites and decrease mosquito breeding opportunities (i.e., standing water) around their home.

Zika came into an immunological naïve region, in the Americas everyone is vulnerable and susceptible. In the U.S. we are moving into summer. There are a lot of places where mosquitoes that can carry Zika are active in the summer. Zika could become an issue in the summer if the weather stays warm and wet for a long time.

Effective mosquito control requires household control. It’s not going to eradicate the problem but it will lead to fewer mosquitoes and fewer children exposed to the possibility of birth defects. We need to implement mosquito control measures until we have a vaccine. We need to think about those areas where we have sylvatic viruses, we need to stop being reactive so that we can be ahead of the ball. We shouldn’t wait for viruses to be a problem before we develop vaccines.

What actions can people take in their households? There are many measures that people can take such as getting rid of standing water. The mosquitoes that carry Zika virus only fly about 20 meters so it’s important to make sure there is not standing water around the household. It’s also a good idea to use insect repellents. This can be a challenge is some places, such as Venezuela at the moment, where these items may not be readily available. Unfortunately, urban infrastructure often creates too many potential breeding sites for mosquitoes. If you store water you breed mosquitoes and if you don’t have piped water you need to store water.

Should people take extra precautions in the summer if they go to the beach or the pool? For example, should people use different clothing? I would recommend long sleeves and pants on a summer day at peak mosquito season. Insect repellent is also a good idea at this time. 30% DEET is most effective. DEET can be toxic to young children so families should consult their pediatricians. A combination approach of long sleeves and pants and insecticide can reduce exposure. Some species of plants can also help repel mosquitoes. The goal is to think of ways you can minimize your exposure.
What about the use of genetically modified mosquitoes? Is that a potential solution? Sterile insect methods, which consist of releasing sterile males in the wild so that they breed with females and produce no offspring has been used to control mosquito populations. It is also possible to engineer a mosquito that has a deadly gene and release them so that they produce juveniles with lethal mutations. Another approach could be to use bacteria that make mosquitoes resistant to Zika virus. It is also possible that genetic mutations could allow mosquitoes to live but would no longer allow them to transmit the virus. Other than the sterile insect approach, which is a proven method, the other approaches are not quite mature yet. The question is whether they will work in the long-term and whether they can be successful in resource constrained countries.

Additional Resources:

- Pan American Health Organization:  
- New York City Department of Health and Mental Hygiene:  
  https://www1.nyc.gov/site/doh/health/health-topics/zika-virus.page
- The Hanley Lab, New Mexico State University: http://biology-web.nmsu.edu/~hanley/