

# Mosquitoes as a Potential Host for Emerging Infectious Diseases

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Infectious diseases have been a cause of human illness and a major cause of human death for centuries. At one point in history, with the advent of antibiotics, scientists predicted that human suffering from infectious disease would soon come to an end. However, the emergence of “new” infectious diseases has proven to be a problem that just will not go away. *Emerging* infectious diseases are those that have increased in incidence in the past 20 years or those with the potential for increasing significantly. *Re-emerging*, or *resurging*, diseases are those that have been around for decades, even centuries, but have come back in a different form or different location. These diseases can be spread by direct contact with an infected person or animal, ingesting contaminated food or water, contact with contaminated surroundings, or through insects like mosquitoes. Mosquitoes act as potential hosts for these emerging infectious diseases by carrying arthropodborne viruses, or arboviruses. Approximately 100 of the more than 520 known arboviruses cause human disease. At least 20 of these have the potential to fulfill the criteria for emerging viruses, appearing in epidemic form at generally unpredictable intervals. A few examples of these emerging or re-emerging diseases hosted by mosquitoes include West Nile virus, malaria, and various types of encephalitis.

Mosquitoes act as biological vectors of disease by playing an essential role in the life cycle of the pathogen. Since the female mosquito needs the blood of a warm-blooded animal for the proper development of her eggs, she needs to bite such an animal. The mosquito can take in as much as twice its body weight in blood, thus creating a relatively good chance of picking up infectious agents such as malarial parasites circulating within the host’s capillaries. The anatomy of a mosquito is particularly adapted to transmit disease. The mouthparts of the female mosquito consist of sharp stylets that are forced through the host’s skin to the subcutaneous capillaries. One of these needlelike stylets is hollow, and the mosquito’s saliva is pumped through it. The

saliva increases blood flow and prevents clotting as the victim's blood is sucked into a tube formed by the other mouthparts of the insect. After the mosquito has taken more than one blood meal, she can transmit disease from one animal to the next. Viruses found in the blood of the first animal are then transmitted to the next, and so on.

In addition to the anatomy of a mosquito allowing it to act as a host for disease, humans are contributing to its ability to spread disease as well through many ecological factors. Mosquito-borne illnesses are more prevalent where people have changed landscapes. This ecological change puts humans in closer contact with the virus. For example, population movements and the intrusion of humans and domestic animals into arthropod habitats cause an increase in disease threats. Other ecological changes include deforestation, irrigation projects, uncontrolled urbanization, increased long distance air travel, increased long-distance livestock transportations, and new routing of long distance bird migration - all of which contribute to mosquitoes hosting emerging diseases. Uncontrolled urbanization can cause vector populations to breed in accumulations of water such as trash cans, old tires, or swimming pools. The ease of international air travel and increased livestock transportation promotes transport of the arthropod vectors and spread of infections. Lastly, the new routing of bird migration is brought about by new man-made water resources and contributes to the spread of transmittable diseases making mosquitoes more apt to be potential hosts of emerging infectious diseases.

In the Western Hemisphere, West Nile virus is an example of a mosquito-borne re-emerging disease. The first outbreak of West Nile virus in the United States occurred in New York City in 1999. During this outbreak, there were sixty-two confirmed human cases, and seven deaths, causing widespread concern and implementation of surveillance and prevention methods. Before its appearance in the U.S., West Nile surfaced in Africa in the late 1930's and

spread through Asia, Europe, and the Middle East. However, since reaching the East Coast of the U.S., the virus is now found throughout the country and fought heavily through mosquito control agencies and public health education. Wild birds are the principal hosts of West Nile virus and are able to maintain a long-term infection. Birds do not normally show any symptoms of West Nile virus; rather, they serve as natural reservoirs of the virus and are able to pass it on to feeding mosquitoes. When a mosquito bites a bird that is infected, the virus then enters the mosquito's bloodstream and circulates for a few days before settling in the salivary glands. Now that the virus is on the mosquito's salivary glands, it can easily enter the host's bloodstream when the mosquito bites an animal or human. Most mammals act as dead end hosts because they never develop enough of the virus to transfer it. However, once in the host's bloodstream, illness can occur. The virus can cross the blood-brain barrier and infect the brain and its linings causing an inflammatory response and symptoms to arise. Although most people infected show no symptoms, some symptoms may include fever, headache, muscle aches, backache, lack of appetite, nausea, vomiting, diarrhea, skin rash, and swollen lymph glands.

Malaria is a disease in which most people in the developed world just do not think about. Yet more than one million people with malaria die each year, and every 30 seconds a child dies of malaria. Malaria is another infectious disease in which mosquitoes act as the biological vector and spread the disease from host to host. *Anopheles* species of mosquitoes can pick up *Plasmodium*, a parasite that causes malaria, from the blood of an infected person, and transmit the protozoan to an uninfected person. The most virulent malaria-causing parasite is *Plasmodium falciparum*, and the *Anopheles gambiae* is one of the important mosquito species that carries the parasite. There is continuous reintroduction of malaria parasites each year which allows subsequent local transmission to remain a possibility. Cases of local transmission have

occurred in Michigan as recently as 1995, making mosquitoes a potential host of re-emerging disease in the U.S. Precise identification of species and subspecies is important because different species of mosquito differ greatly in their breeding areas, time of feeding, and choice of host. This greatly effects which specific species may be a potential host for certain diseases and allows the U.S. to implement mosquito control organizations and keep malaria abated in the U.S.

In addition to West Nile virus and malaria, mosquitoes act as hosts for various types of encephalitis including St. Louis Encephalitis (SLE), Eastern Equine Ecephalitis (EEE), and LaCrosse Encephalitis. SLE is one of the most important epidemic arboviral diseases in the United States. The last SLE epidemic in the U.S. was in 1975 when 1,815 cases and 142 deaths were reported occurring in 30 states. SLE continues to occur since 1975, and three cases were reported as recent as 2002. Transmission of SLE is primarily through birds and several species of mosquitoes. EEE is a disease that causes high incidence of neurological damage and occurs in horses each summer along the Gulf and Atlantic coasts of the U.S. Human cases of EEE are rare; however, they have occurred. The epidemiological pattern of equine disease is generally one of sporadically dispersed infections. Lastly, LaCrosse Encephalitis has been represented as a serious and growing infectious disease problem in the U.S. The disease is most prevalent in the Midwest and mid-Atlantic states. The LaCrosse activity coincides with peak mosquito populations during the summer months, and it causes symptoms that range from mild and transient meningitis to severe encephalitis and death. The natural transmission cycle of the LaCrosse virus involves small mammals such as squirrels, chipmunks, or field mice that transmit the disease to a mosquito when bitten. The mosquito can then act as the host and transmit it to a human. All three of these types of encephalitis' contribute to mosquitoes acting as potential hosts for emerging infectious diseases. Epidemic viral encephalitis diseases such as SLE, EEE,

and LaCrosse are all arboviruses that must continue to be monitored to prevent their awful pathogenesis.

West Nile Virus, Malaria, and types of encephalitis are just a few of many mosquito-borne diseases in which mosquitoes can transmit. Acting as biological vectors that contribute to the life cycle of the pathogen, pinpoints mosquitoes as the source for these emerging infectious diseases. In addition to the importance of a mosquito's anatomy in spreading infectious diseases, it is also important to understand that humans are contributing as well by coming in closer contact with dense mosquito populations.

It is important for me to be knowledgeable about these emerging infectious diseases because I am a prospective nursing student. By being properly educated on arboviruses and their cause and prevention, I can inform patients and answer questions more effectively about these particular diseases. If a patient were to come to me concerned about a particular arbovirus, I would be able to inform them about the preventative measures for avoiding mosquito-borne disease. I could also inform them that the best and most effective form of prevention is simply the avoidance of mosquito bites.

People can best avoid mosquito bites by wearing protective clothing such as long-sleeve shirts and long pants in mosquito-infested areas. Mosquitoes are most active in warm weather during dawn and dusk hours; therefore, avoiding outdoor activities at these times will reduce the risk of a mosquito bite. The application of mosquito repellent is another good way to reduce mosquito bites. Repellents with ten to thirty percent Deet are most effective depending on the number of hours of protection needed. It is also highly encouraged that people eliminate mosquito breeding sites to lower the mosquito population. Since female mosquitoes lay their

eggs in standing water, people can eliminate mosquito breeding by dumping out all standing water and paying close attention to new irrigation projects.

In a healthcare field such as nursing, it is also important for me to understand what is being done on a local and national level for disease surveillance and prevention for diseases such as West Nile virus, malaria, and various types of encephalitis' mentioned earlier. The biologist at Saginaw County Mosquito Control , Bill Stanuszek, described the disease surveillance done by the biology department. He said, "Knowing how much virus is in your area can dictate your course of action." The goal of the biology department is to monitor mosquito populations and mosquito transmitted diseases such as West Nile virus in Saginaw County. This is done through an Integrated Pest Management System in which areas of high mosquito densities are targeted and potential disease carrying species are monitored. Biologists check natural habitats, collect mosquitoes using baited traps, and sample birds and small animals for evidence of mosquito-borne diseases such as West Nile. Several different kinds of traps are utilized in the collection of mosquitoes. Some of the baits used are light, carbon dioxide (dry ice), and hay infusion water. The biology department at Saginaw's Mosquito Control also takes part in identifying the certain disease-carrying mosquitoes (*Culex*) and testing the blood they may have ingested for disease.

In addition to actions being taken on a local level, the Centers for Disease Control and Prevention (CDC) works with state departments, the Food and Drug Administration, and other government agencies to prepare for and prevent new cases of West Nile virus, SLE, EEE, and LaCrosse Encephalitis. Some responsibilities of the CDC include coordinating a nation-wide electronic database where states share information about arboviruses, helping states carry out mosquito control programs, developing better tests to detect these diseases, and creating new education tools and programs.

In conclusion, there are many factors contributing to why mosquitoes are potential hosts for infectious diseases. The anatomy of a mosquito and increased contact with mosquitoes by urbanization are just a couple of factors. Also, West Nile virus, malaria, St. Louis Encephalitis, Eastern Equine Encephalitis, and LaCrosse Encephalitis are examples of diseases that are transmitted by mosquitoes and must be continually monitored. Through prevention of mosquito bites and knowledge of these diseases, humans can take significant steps in reducing the incidence of these diseases in the United States and around the world.

## Resources

- Bellenir, Karen, ed. Infectious Diseases Sourcebook. (2004). Detroit: Omnigraphics.
- CNN.com West Nile Virus. (2006). Retrieved August 4, 2008, from <http://www.cnn.com/HEALTH/library/DS/00438.html>.
- Day, Nancy. Malaria, West Nile, and Other Mosquito-Borne Diseases. Berkely Heights: Enslow Publishers, Inc., 2001.
- Department of Health and Human Services. (2005). *CDC West Nile Virus Fact Sheet*.
- Donson, David A. (2005) *eMedicine Health: West Nile Virus*. Retrieved August 4, 2008, from <http://www.emedicinehealth.com/script/main/art.asp?articlekey=58767&pf=&page=1>.
- Fauci, Anthony S. 2005 Robert H. Ebert Memorial Lecture Emerging and Re-emerging Infectious Diseases: The Perpetual Challenge. New York: Milbank Memorial Fund. 2005.
- Flaskerud, J.H., Serkey, J.M., Yost, A.J. (1999). *The Nursing Clinics of North America: Contemporary Infection Control for Nurses volume 34*. Philadelphia: W.B. Saunders Company.
- Midland County Mosquito Control. (2008). *Mosquito-borne Diseases in Michigan*. Retrieved August 21, 2008 from <http://www.co.midland.mi.us/departments/extra.php?id=19&pid=244>.
- Nester, E.W., Anderson, D.G., Roberts, C.E., Nester, M.T. (2007). *Microbiology: A human perspective, fifth edition*. New York: McGraw Hill Companies, Inc.
- Stanuszek, Bill. Personal communication. June 5, 2008.
- Weeks, Byron T. M.D. (2008) *Educate-Yourself: Emerging Killer Viruses*. Retrieved August 21, 2008 from <http://educate-yourself.org/ed/edarticle15.shtml>.