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# Insect Borne Diseases Transmitted by Some Important Vectors of Class Insecta Hurtling Public Health

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## Abstract

The goal of the present article is to provide technical guidance for the insect borne diseases and make some improvements in management practices necessary to control the vector problems in order to meet the needs of expanding and emerging disease situations. Historically, harmful arthropods represent one of the greatest environmental hazards to human and insect borne diseases have caused more casualties than battle injuries. Insect borne diseases such as malaria, dengue, yellow fever, typhus and plague alone are responsible for the loss of working capacity, food damage and restrict development of states. Insect vector is an organism that carries a pathogen from a different organism to another. Insects may transmit these pathogens by biological (after arthropod acquires pathogen from an infected host following an appropriate development of the pathogen, the vector becomes infective and can transmit the pathogen to another animal the next time it feeds to serve as an intermediate host) or mechanical mean (vector serves only as carrier of the pathogens that adhere to mouthparts, body or legs, picks up the pathogen while feeding on an infected host and carries to another host). Although some agile vectors such as adults of black flies, biting midges and tsetse flies, have dispersed into new habitats by flight or wind, human-aided transport is responsible for the arrival and spread of most invasive vectors such fleas, lice, kissing bugs and mosquitoes. From the previous century to the present, successive waves of invasion of the vector mosquitoes *Anopheles stephensi*, *Aedes aegypti*, *Culex pipiens* complex and most recently, *Aedes albopictus* have invaded new localities. Weather influences survival and reproduction rates of vectors, in turn influencing habitat suitability, distribution and abundance, intensity and temporal pattern of vector's activity (particularly biting rates) throughout the year, and rates of development, survival and reproduction of pathogens within vectors. However, climate is only one of many factors influencing vector distribution, such as habitat destruction, land use, pesticide application and host density. Vector-borne diseases can be restricted by avoiding insect bites by wearing long sleeved clothing and long pants, use of insect repellents, adopting regular pest control measures, avoiding traveling to places with high prevalence of disease, when have to travel it is advisable to get vaccinated when possible, sleeping in screened areas or air-conditioned rooms and use of bed nets. Research on infectious diseases must often be conducted in the midst of epidemics and in concert with management efforts.

## Keywords

Insect Borne Diseases, Anopheles, Aedes, Culex, Insect Vector

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## 1. Introduction

Bacterial, viral and parasitic diseases that are transmitted by mosquitoes, lice, sand flies and fleas are collectively called vector-borne diseases (the insects are the vectors that carry the diseases). The entry and development of an infectious agent take place in the body of a person or animal. An infection may be either apparent (called manifest) where the infected person appears to be sick or unapparent wherever there is no outward sign that an infectious agent has entered that person at all. The

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transmission mechanism of infectious agents such as a virus through which pathogen is spread from a reservoir (or source) to a human being is very significant. Usually each type of infectious agent is ordinarily spread by only one or a few of the different mechanisms. The chain of infection for insect borne diseases involves a pathogenic organism in an infected person or animal (the reservoir), an arthropod to transmit the disease (vector) and a susceptible person (the host). The significance of vector efficiency in disease transmission from reservoir to host is related to many factors. Some of the factors are species-related such as vector reproductive capacity, physiology, morphology and genetics. Other factors that affect the vectors ability to transmit disease are physical and related to environmental conditions, such as temperature, moisture, rainfall, weather, geographical and topographical location, photoperiod and wind. Peoples living in a field environment must break the chain of infection for insect borne diseases or arthropod injury by limiting arthropod vector exposures (Epstein, 2001; Rogers and Randolph, 2006; Sarwar et al., 2015; Sarwar et al., 2014; 2015 a; 2015 b; 2015 c).

## 2. Vector-Host Relationships

Public-health personnel can better design and manage control programs for a particular problem by understanding how a disease is transmitted and the involvement of vectors in pathogen transmission. Mechanical transmission of disease pathogens can be considered more or less accidental and it occurs when a vector transports organisms such as bacteria that cause dysentery, on its feet, body hairs and other body surfaces to the host. There is no multiplication or development of the pathogen within the vector's body. For example, the house fly, *Musca domestica*, is a passive (mechanical) transmitter of bacillary dysentery. In biologically transmitted diseases, disease-causing pathogens need help to move from one host to another. The arthropod acquires the pathogen from one host, the pathogen then develops in the arthropod's body and is transmitted to another host. Within the arthropod, the pathogen may or may not multiply. If the pathogen or parasite that causes the disease undergoes the sexual portion of its life cycle in a host, that host is the primary or definitive host, as in the mosquito that harbors malaria. For malaria, a human is the intermediate host in which the asexual stages of the parasite are found (Gratz, 1999; Mullen and Durden, 2002).

## 3. Human Diseases Spread by Insect Vectors

There are many insects that are the primary or intermediate hosts or carriers of human diseases. Pathogens that are capable of being transmitted by insects include protozoa, bacteria, viruses, and such helminths as tapeworms, flukes and roundworms. There are two methods of transmission of a pathogen by insects, mechanical and biological. The most common insect borne diseases that affect human are briefly discussed in the below segment (Higley et al., 1989; Lane and Crosskey, 1993; Daszak et al., 2000; Eldridge. and Edman, 2000; Service, 2012).

### 3.1. Louse Borne Typhus, Relapsing and Trench Fever

Historically, the diseases transmitted by body lice (*Pediculus humanus*), are common where peoples are confined together and could not wash or delouse their clothing. Typhus is caused by the *Rickettsia prowazeki* (bacteria), trench fever by *Rickettsia quintana* (bacteria) and relapsing fever by *Borrelia* (spirochaete bacteria) wherein all are body louse *P. humanus* (Phthiraptera) borne.

### 3.2. Plague

Fleas are the vector for the plague (or Black Death), which infects man as well as rats and other rodents. There are three forms of plague that occur in humans, such as bubonic, pneumonic and septicemic. The bubonic type, in the form of the bacterium *Yersina pestis,* is transmitted by fleas mainly *Xenopsylla cheopis* (includes rat flea). The disease is passed as fleas regurgitate plague bacilli when biting, when flea feces are scratched into the skin, or when the host ingests an infected flea. The reservoir of murine plague is domestic rats, the bacteria multiply in the flea's crop and stomach where they may form an obstruction. When the flea attempts to feed, the blood cannot pass beyond the blockage and becomes contaminated with the plague bacilli. The contaminated blood is then regurgitated into the wound caused by the flea bite. Squirrels, rats, voles, mice, rabbits, hares and dogs can support infestations of fleas infected with plague, which can cause bubonic plague in humans by infective bite. In the bubonic form of plague, symptoms include the sudden onset of fever with painful swelling of the lymph nodes. If the infection spreads to the lungs (pneumonic plague), it produces pneumonia that is highly contagious and often fatal.

### 3.3. Enteric Diseases

There are many bacterial diseases that are transmitted by some form of fecal contamination of food or water, either directly or indirectly. House flies are a primary agent in transmitting these diseases, and do so mechanically. Typhoid fever (*Salmonella typhi*) is a well-known enteric disease and affects humans worldwide, while cholera is another enteric disease of great importance. The *Shigella,* causing dysentery and diarrhea and *Escherichia coli* causing urogenital and intestinal infections, are widespread enteric diseases. House flies

transmit many human enteric diseases such as dysentery, cholera and typhoid fever. Sometimes the organisms are carried on the fly's tarsi or body hairs and frequently they are regurgitated onto food when the fly attempts to liquefy it for ingestion. Because the house fly has a wide flight range and varied food tastes, and because the female is naturally attracted to filth where it can lay its eggs, the presence of flies in dining facilities or homes is dangerous. Along with flies and filth flies, cockroaches by food contamination are also associated with transmission of typhoid fever.

### 3.4. Sleeping Sickness

This disease is also known as African Trypanosomiasis and the disease is transmitted by the tsetse fly in the genus Glossina (Diptera: Glossinidae). The causative agent of African trypanosomiasis is protozoan *Trypanosoma brucei* (two forms). The disease is known to have a high mortality rate, not only among peoples, but among cattle, which is one of the reasons that parts of Africa could not be settled. Extensive destruction of habitat and reservoir hosts has some positive impacts on the distribution of the disease.

### 3.5. Chagas Disease

Chagas disease or American Trypanosomiasis is a disease spread by triatomine bugs. These bugs transmit the protozoan parasite *Trypanosoma cruzi* that is the causative agent of Chagas disease. It invades the muscle cells of the digestive tract and heart and sometimes also the skeletal muscle, and there the protozoa multiply. Adult trypanosomes may circulate in the blood, but they do not invade blood cells in the way as malaria parasites do. Transmission of the protozoa is by blood-sucking reduviid conenose bugs also known as kissing bugs mainly Triatoma, Panstrongylus and Rhodnius, and is by the bug's feces, but not the bite. Conenose bugs feed at night on their sleeping victims. Symptoms of Chagas disease include malaise, fever, swelling of eyes and swollen lymph nodes.

### 3.6. Onchocerciasis

It is a non-fatal disease affecting the skin and eyes (blindness) of the victim due to casual organism *Onchocerca volvulus* (nematode worm) due to black fly Simulium (Diptera: Simuliidae) vector.

### 3.7. Leishmaniasis

Leishmaniasis or Kala-Azar or Black Fever or African Trypanosomiasis, is a disease caused by protozoa Leishmania. The infected sand fly or tsetse fly (*Phlebotomus aregentipes*) (Psychodidae: Phlebotominae) acts like intermediate host to transmit the disease. Really, it is a disease syndrome with varying symptoms including disfigurement of the skin, and various Leishmania species are implicated in human infection and there are an even larger number of vector species. Symptoms include recurrent fever, loss of appetite, anemia, dryness and discoloration of skin, and enlargement of spleen and liver. Temperature influences the biting activity rates of the vector, diapause and maturation of the protozoan parasite in the vector.

### 3.8. Filariasis

Filariasis is transmitted among humans by Mansonia, Culex, Anopheles, Ochlerotatus and Aedes mosquito species, wherein the filarial nematode parasite (*Wuchereria bancrofti*) lives in the human lymphatic system. Other forms of filariasis found in some areas are caused by filarial worms in the genus Brugia. They cause extreme enlargement of soft tissues, called elephantiasis. The disease causes swelling of legs with thickening of skin and underlying tissues and skin rash. The *W. bancrofti* may also affect legs, ear lobes, arms, vulva, breasts and scrotum, and extreme swelling is termed elephantiasis. Mosquitoes pick up the microfilariae by feeding on infective humans. After developing through the larval stages, the infective (third-stage) larvae leave the mosquito and enter the human host as the female mosquito penetrates the skin in search of blood.

### 3.9. Acquired Immune Deficiency Syndrome (AIDS)

When the AIDS virus is initially discovered in humans, there have been exhaustive laboratory tests conducted using a wide range of blood-feeding insects. Currently, there is no scientifically based, credible evidence to suggest or imply that mosquitoes or other biting arthropods can transmit the virus to humans either biologically or mechanically, for example, infected blood on the mouthparts of vector. While that question may not have been fully answered, it is safe to say that the involvement of blood-feeding insects and other arthropods in transmission of this disease is biologically insignificant (Semenza and Menne, 2009).

## 4. Diseases Transmitted by the Mosquito Vectors

Mosquitoes are vectors for many important diseases and being a vector means these vectors carry diseases from one host to another. Many of these diseases have a wide distribution, high mortality rate and a high number of cases, but some have do not. Arboviruses diseases are caused by viruses that are biologically transmitted by the bite of mosquitoes. There are about 28 viruses of major public health importance that are transmitted by a variety of mosquitoes. Dengue and yellow fever are transmitted by mosquitoes in the genus Aedes. There

are several kinds of Encephalitis, and these are transmitted by mosquitoes in the genera Aedes and Culex (Desowitz, 1991; Lounibos, 2002; Hales et al., 2002; Kuhn et al., 2002; Medlock et al., 2006; Halstead, 2007; Scholte and Schaffner, 2007; Guerra et al., 2008). Here is a little information owing to that anyone can learn some facts about a few of the mosquito vectored diseases.

### 4.1. Malaria

The foremost disease carried by insects is malaria, involving a Plasmodium protozoan that is transmitted by mosquitoes of the genus Anopheles. The disease is transmitted by several species of Anopheles mosquitoes and some members of the *A. quadrimaculatus* species complex are important vectors. Another species, *A. crucians*, is a vector also but probably to a lesser degree, but the other major vectors are *A. hermsi* and *A. freeborni*. Malaria is the deadliest insect borne disease in the world affecting the millions of peoples around the sphere. It is a serious disease occurring most commonly in tropical and semitropical regions. Human malaria is caused by any of four microscopic species of Plasmodium protozoan parasite that causes fever, chills, sweating, headache, nausea and vomiting. The parasite first attacks the liver and then destroys the red blood cells, causes weakness, and anemia. There can be kidney and brain complications that could result in a coma, and if untreated, it may cause shock, renal failure, acute encephalitis and death.

### 4.2. Dengue Fever

The vectors for this disease are *Aedes Aegypti* and *A. albopictus* mosquitoes that pass virus from human to human. Some symptoms are rash, fever, headache, joint pain, pain behind the eyes, muscle pain, nausea, and vomiting. Dengue viruses of multiple types are now endemic throughout most tropical areas of the world and are highly endemic in certain localities. Like yellow fever, it is transmitted by the Aedes mosquito. Symptoms are fever (lasting about 5 days), intense headaches, skin rash, and muscle pain which can be severe; for this reason, another name for dengue fever is break bone fever. This disease seldom results in death, but the recovery time is usually long and the victim may be fatigued and depressed. Four strains of dengue virus are recognized, each of which produces lifelong immunity against the infecting virus. Exposure to infection by a second strain of dengue virus in an already immune individual may result in a more severe form of dengue known as dengue hemorrhagic fever with accompanying dengue shock syndrome. In some cases, the illness progress to dengue hemorrhagic fever which causes internal bleeding and may be fatal.

### 4.3. Yellow Fever

This one is a disease of forest monkeys due to yellow fever virus that can be spread to peoples. Yellow fever is caused by a virus closely related to the dengue virus. In fact, the infections produce dengue like symptoms in humans, but the effects of fever are normally much more severe. As with dengue, the yellow fever virus is transmitted in urban areas by *A. aegypti,* and with *A. albopictus* and *O. japonicus* as potential vectors as well. Symptoms are fever, headache, backache, jaundice and internal bleeding, and if untreated, yellow fever can result in death.

### 4.4. West Nile Fever

The disease is a type of encephalitis called arboviral encephalitis and casual organism West Nile virus is spread by the Culex mosquito species. The virus cycles are from mosquito to bird, while humans and horses are incidental hosts and the vector cannot get the virus back from feeding. The virus uses the mosquito (the vector) to infect birds which are the main reservoirs. Some symptoms of disease are vomiting, fever, headaches, swollen lymph glands, body aches and rash. It can sometimes lead to sever problems with the brain, spinal cord and nerves.

### 4.5. Japanese Encephalitis

This is an arboviral virus and this virus is spread by the *Culex Tritaeniorhynchus* mosquito**.** The virus is cycled from pig host or bird host and back. Humans and horses are incidental hosts like in West Nile virus, and mosquitoes cannot bite a person and get the virus back. In most cases the symptoms are a fever or headache, stupor, tremors, disorientation, coma, loss of coordination and other meningeal signs. In serious cases it can cause paralysis, comas, seizures and even death.

### 4.6. Arboviral Encephalitis

These viruses cause encephalitis and go through a transmission cycle of a primary host of a bird or small mammal. The transmission cycle is about the same as for the arboviral viruses and there is a main cycle between mosquitoes and birds (or sometimes small animals). The mosquitoes can bite peoples and horses by accident giving them the virus. The mosquitoes cannot get the virus back from these hosts, so, these are called dead-end hosts for this reason. Many peoples do not get symptoms or they might get flu-like symptoms owing to this disease. Some peoples may get a sudden high fever and headache. In few cases some peoples get encephalitis which causes problems in the central nervous system including paralysis, comas and seizures that can cause death.

### 4.7. Chikungunya

Chikungunya is caused by *Alpha virus*, in the family Togaviridae, which is transmitted to human beings by the bite of infected mosquitoes such as *A. aegypti* and *A. albopictus*.

Symptoms include fever, chills, headache, skin rash, nausea and vomiting. The patient shows a contorted posture with severe joint pain and its treatment is symptomatic.

## 5. Control of Arthropod Vectors of Human Diseases

In tropical climate, there are certain areas in the world for the higher frequency of insect born human diseases, such as malaria, dengue, trypanosomiasis, viral infections (yellow fever), various filariasis and chiefly onchocerciasis. Control of arthropod vectors is very important indeed in these areas, and it requires a close collaboration between entomologists, biologists, hygienists and tropical physicians. Chemical control is still preponderant, but it must be associated, as often as possible, with physical, biological and genetic means of vectors control. However, the economic damage caused by a few arthropods make some vector's management practices necessary to control the disease problems (Sarwar, 2015 a; 2015 b; 2015 c; 2015 d; Mughal et al., 2015).

## 6. General Measures to Avoid Insect-Borne Diseases

Insects play a major role in transmission of many diseases, which are sometimes life-threatening and affect public health and economy. Hence, it is necessary to take preventive measures to avoid such diseases, especially in areas where these insects are prevalent. Vector-borne diseases can be restricted by avoiding insect bites by wearing long sleeved clothing and long pants, use of insect repellents, adopting regular pest control measures, avoiding traveling to places with high prevalence of disease, when have to travel it is advisable to get vaccinated when possible, sleeping in screened areas or air-conditioned rooms and use of bed nets. Always wash and cook any food that could be contaminated with insect feces to avoid risk of pathogenic infection (Mukhtar, 2010; Sarwar, 2014 a; 2014 b; 2014 c; 2014 d).

## 7. Needs and Opportunities

Vector-borne diseases cast emphasis on some of the aforementioned issues and present unique considerations for research and control (National Academy of Sciences, 2008). Briefly, these challenges include the following: -

1. Integration of research efforts and findings on infectious diseases in humans, livestock, and wild animals, as well as in crop and wild plants.
2. Training, research, laboratory and field based surveillance in areas where diseases are likely to emerge.
3. More and better trained personnel, capacity, and tools for disease detection, diagnosis and response.
4. Need for improved vaccines, drugs and diagnostics.
5. Outbreak response plans that feature well-defined triggers for implementation.
6. Containment of outbreaks as local public health events.
7. Measures to limit the movement of pathogens and vectors via global transportation.
8. Risk communication that provides timely, reliable information to the public in the event of an outbreak, thereby preventing panic.
9. Political will sufficient to deliver economic support for these measures.

## 8. Conclusion

Diseases transmitted to human by insects are some of the most serious issues known to man. Uncontrolled of these illnesses can cripple or destroy human health and economy of the state. The effect of these diseases on man can range from a very mild illness to death in severe cases. House flies and other flying insects that are attracted to human wastes or other organic material can spread disease organisms to food and water. The disease organisms or parasites of humans are carried from diseased humans or animals (reservoirs) by insects (vectors) to other humans or animals (hosts). Thus, vector-borne diseases still represent a significant threat to human health despite of considerable national and international control efforts. Population growth, urbanization and migration, and poor environmental sanitation are some of the major causes of the emergence and re-emergence of vector-borne diseases in developing countries. In the past and today, control of vectors has been a major component of disease management, but the effectiveness of the available vector control methods has been limited by logistic problems, high cost, insecticide resistance and by environmental pollution concerns. Therefore, novel and sustainable approaches to disease carrier vector's control are urgently needed. It has been noted that there are major gaps in knowledge of the biology, ecology and behavior of many disease vectors, and of vector plus pathogen interactions. Research into the discovery and development of new control strategies and the implementation of research in the field is inadequate to meet the needs of many disease carrier vector control programs around the world. This is emphasized that expanded research activity in these areas might identify vector weaknesses that could be exploited. These recommendations would provide a basis for extending further vector research programs, taking into account its comparative advantages in both research and capacity-building activities.

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