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Proposals for the Control of Principal Dengue Fever Virus Transmitter *Aedes aegypti* (Linnaeus) Mosquito (Diptera: Culicidae)

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ABSTRACT

Dengue fever or break-bone fever is a painful mosquito-borne infection caused by four different types of virus in various localities of the world. There is no any particular medicine or vaccine to treat person suffering from dengue fever. The dengue fever viruses are mainly transmitted by mosquito *Aedes aegypti* (Linnaeus) (Diptera: Culicidae) in tropical and subtropical climates. The proper management of dengue fever virus transmitting mosquito *A. aegypti* is the key step to avoid infection transmission to save millions of lives primarily in developing countries. This embraces provides standard guidelines and capacity building in the planning and implementation of dengue prevention and control measures. In this direction, the three foremost points of focus are dengue vector control, case management and community awareness. It is meant that along with consultancy to advise on a vector control strategy, the other priorities including clinical management of hospitalized dengue cases have to address essentially. This paper will explore the answers to the questions of dengue prevention through an effective vector control strategy in the interest of public health worldwide.

Introduction

The vector is any arthropod or insect that transmits a disease through its feeding activity on its vertebrate hosts. Typically the vectors become infected by a disease causing agent at the same time when feeding on infected host and after that convey the infectious organism to a vulnerable person. Nearly in every case, an infectious organism ought to infect and multiply inside the vector prior to the insect through its salivary glands is able to transmit the disease in human host. Commonly, the vector-borne disease is an illness caused by an infectious microorganism that is transmitted by blood-sucking arthropods to the inhabitants. Among the insects that mainly serve as vector universally include different species of blood sucking mosquitoes. Dengue fever or break-bone fever is a painful and fastest emerging mosquito-borne infection mainly transmitted by *Aedes aegypti* (Linnaeus) mosquito (Diptera: Culicidae) in tropical and subtropical countries.

Dengue as a Global Health Problem

The rising level of dengue infections has become a serious international concern imposing a heavy economic and health burden on states, families and individual patients. Dengue fever is a lethal complication caused by dengue viruses of the family Flaviviridae in genus *Flavivirus* having a size of 35-45 µm in diameter, which carries a single strand of RNA as its genome (infectious upon transfection into cells). This genus comprises many important human pathogens including dengue (DENV), yellow fever and encephalitis. Flaviviruses are enveloped viruses with a positive-sense RNA genome that encodes three structural and seven non-structural proteins. Regulated by pH, membrane anchored proteins E and M function during dengue virus maturation and membrane fusion. The DENV non-structural protein contains enzymatic activities required for capping and replication of the viral RNA genome that occurs in the host cytoplasm. There are 4 subtypes of dengue virus, each with slightly different 10 viral proteins: DEN-1, DEN-2, DEN-3 & DEN-4. Among the four serotypes of dengue virus, the DENV-2 and 3 proteins accumulate in the nucleus, whereas DENV-1 and 4 are predominantly if not exclusively localized to

the cytoplasm. The identification of serotypic differences in the properties of dengue virus proteins is important for understanding viral pathogenesis and developing antiviral strategies [1, 2].

The risk of dengue viral disease is higher in urban regions than in nonurban areas, but dengue infections are increasing in rural communities. Around 2.5-3 billion people are currently at risk of dengue infections allover the world. In recent years, the numbers of dengue cases reported have risen dramatically. Dengue is becoming a greater threat to public health than it has been in the past. Primarily, the epidemics have occurred in nearly all tropical and some subtropical regions of the world. Dengue has spread to new countries, and this increase in dengue transmission may be due to a number of factors, including population growth, more long-distance travel, growing urban areas, lack of sanitation and poor mosquito control strategy. The higher number of proceedings may also be the result of worse surveillance and official reporting of dengue cases. Now a day, the rapid spread of dengue is a serious international concern. The symptoms of dengue fever can differ broadly, even though a number of patients have no symptoms in any way. The classic symptoms of dengue include a high fever, severe pain in the muscles, bones and joints, pain behind the eyes, severe headaches, nausea and vomiting, and appearance of rashes. Most patients recover from dengue infections with rest and fluids. On the other hand, some patients develop severe dengue, which is a more serious condition that occurs when blood plasma leaks through the capillaries. The severe dengue can lead to internal bleeding, shock and organ failure. As soon as treated quickly with intravenous fluid replacement, most patients recover from severe dengue [3, 4].

Cure for Dengue Infections

Currently, there is no any particular cure or specific medication to treat dengue infections in all peoples. The individuals who think that they may have dengue should consult a physician. The pain symptoms associated with dengue can be managed with pain relievers that do not increase the risk of bleeding. In addition, dengue patients require rest and fluids treatment. It is important that patients with dengue must be carefully monitored for signs of severe dengue so that they can be treated with fluid replacement in a timely manner and can make a full recovery. At this time, there is no medicine or drug to cure for dengue and no vaccine to prevent dengue infections, thus, the only strategic options available to reduce viral transmission are case management and vector control to prevent casualty.

Control of Dengue Fever Virus Transmitter *Aedes aegypti* Mosquito

The emphasis for mosquito control for dengue prevention might be on sustainable, community-based and integrated with partial reliance on insecticides such as larvicides and adulticides. Mosquito control programs might integrate a variety of different strategies to suppress or destroy mosquitoes. The principle activities to undertake for mosquito control include vector surveillance or monitoring, source reduction, use of biological control agents and other forms of program to repel vector from human biting.

Vector Surveillance

When there is a threat of a dengue outbreak, and preventative measures need more attention, the mosquito vector surveillance is needed which may include the techniques and equipments that are used in the monitoring of nuisance. The successful long term mosquito control requires knowledge of long-term monitoring of adult mosquitoes that will indicate where mosquitoes are a recurring problem and where preventative measures need more attention. The number of mosquitoes collected in mosquito light traps and or the number of mosquitoes caught during landing counts normally determine the need for an organized program for the control of nuisance species. Mosquito landing counts or number of mosquitoes collected in mosquito traps can also be used as an index of mosquito activity. The counts, carried out according to standard methods, should find average numbers of landing mosquito per minute over a 10-minute period at sunset on the front of exposed human body. Dividing the total counts by 10 will give an average count of mosquitoes per minute for that time of day and location. Usually, when the numbers exceed one mosquito per minute, they have reached a level that will not be tolerated by most peoples. With vector surveillance traps, live mosquitoes are usually collected to determine the percentage of suspected vector species that are infected with the virus and sometimes to know their reproductive age. The live or dead mosquitoes are collected to obtain an estimate of the population size of the mosquito vectors. The most commonly used trap for live collections of vector mosquitoes is the light trap baited with dry ice. The efficiency of this trap can be enhanced by placing it close to an oviposition site that is attractive to the adult female mosquitoes. This trap may collect some female mosquitoes that have already laid eggs and may be infected with a virus. Monitoring of adult mosquito of vector counts can be used to assess their activity throughout the season and to compare their activity over the years. Before insecticides are applied for the control of nuisance species, an adult mosquito monitoring program should detect an increase in the population above a pre-determined baseline [5; 6].

Source Reduction

It is extremely difficult to fully eliminate or control *A. aegypti* mosquitoes for the reason that they have adaptations to the environment that make them highly flexible, or with the ability to rapidly bounce back to initial numbers after disturbances resulting from natural phenomena, for instance droughts or human interventions such as control measures. The public not only provides the mosquitoes with blood meals but also water-holding containers needed to complete their development in and around their home. Because, *A. aegypti* is a container inhabiting mosquito, one of the mainly successful and cost-effective methods to reduce its populations is by preventing containers around the home from collecting water. The residents might be responsible for keeping their yards and patios free of standing water where mosquitoes can be produced. The objects that can collect rainwater or store water, for instance, plastic containers, drums, gallons, buckets, and used automobile tires, ought to be properly covered or discarded. At least once a week, vases with fresh flowers, and pet and animal watering containers should be cleaned and emptied to remove eggs or larvae of vector.

The use of air conditioning or window and door screens can reduce the possibility of mosquitoes coming indoors. The risk of dengue infection for international visitors is increased if epidemics is in progress in certain localities or travelers are living in housing that are without air conditioning or screened doors and windows. Proper screening will eliminate the mosquito eggs and larvae and reduce the number of mosquitoes present in these areas.

Good land use practices near wetlands can preserve water quality and favor the increase of diverse populations of aquatic organisms including predaceous insects that feed on any mosquito larvae present. Draining or filling natural wetlands is a viable control measure for mosquitoes controlling because most mosquito breeding sites are small, temporary pools that only hold water for a few weeks. In some cases, it may be possible to reduce larval mosquito sources and at the same time preserve or enhance fish, fish habitat, wetlands and other desirable habitats [7]. Source reduction of mosquito breeding sites may involve; installation of catchments i.e., a small area into which rain water drains, installation of tile leading to a catchment or drain, modification of grade to facilitate drainage, filling and leveling of small water filled depressions, and removal of emergent vegetation from certain potential breeding sites.

Application of Mosquito Repellents

Appropriate application of mosquito repellents containing 20-30% active ingredient DEET diethyl-meta-toluamide on the clothing and exposed skin can decrease the menace of mosquitoes biting. Because using DEET as mosquito repellent is associated with the health and environmental problems, a lot of people are looking for repellents based on other chemicals. A variety of plant-based products have been developed to meet this need [8]. The chemical composition of the essential oil obtained from the leaves of *Plectranthus incanus* Link, has been analyzed and a total of 16 constituents, representing 95.2% of the oil, are identified. The major components of the oil are fenchone, piperitone oxide, piperitenone and piperitenone oxide. The repellent activity of the volatile oil at different concentrations has been measured by the protection period against the bites of mosquitoes. The tested oil has shown stronger repellent activity than citronella oil, which has as a positive control. Thus, *P. incanus* may be regarded as a potential valuable source of chemicals that have strong mosquito repellent activity, and could be used for the preparation of mosquito repellent formulations [9]. This means that due to the direct exposure of peoples to repellents, it is suggested to choose these carefully if it is needed to use repellents. In this way, considering both the effectiveness of a repellent and its potential health hazards is necessary. When peoples are not using a repellent that is giving enough protection and spending time in areas where there are so many mosquitoes, considering use of mesh clothing, like hats, shirts, pants, socks, and jackets outdoor is important.

Biological Control

Models can be useful tools at many different levels when considering complex issues such as biological control of mosquitoes. At an early stage, exploratory models are valuable in exploring the characteristics of an ideal biological control agent and for guidance in data collection. When more data are available, models can be used to explore alternative control strategies and the likelihood of success. The underlying biology of the mosquito host and the biological control agent must be carefully considered when deciding what to include in a model. Factors such as density dependent population growth in the host, the searching efficiency and aggregation of a natural enemy, and the resource base of both have been shown to influence the stability and dynamics of the interaction. Including existing mosquito control practices into a model is useful if biological control is proposed for locations with current insecticidal control [10].

Earlier researchers have shown that they could cut the lives of disease-carrying mosquitoes in half by infecting them with bacteria. The intracellular Wolbachia bacteria also makes the mosquitoes more resistant to infection by viruses that are a growing threat to humans, including those responsible for dengue fever. Once infected with Wolbachia, *A. aegypti* mosquitoes also become less suitable as hosts for a form of malaria. The

mosquito, *A. aegypti* feeds predominantly on humans to obtain nutrients for egg maturation, despite having the capacity to use blood from other hosts for this process. The females *A. aegypti* infected with a virulent strain of the bacterium *Wolbachia pipientis* have a reduced ability to use blood for egg development. Because of this, Wolbachia has attracted considerable interest as a potential mechanism for spreading disease-blocking transgenes through vector populations. This might be very powerful in reducing pathogen transmission by *A, aegypti* to humans, particularly for dengue, and Wolbachia infection can invade natural mosquito populations [11; 12].

Entomopathogenic fungi could be useful tools for reducing populations of the dengue mosquito *A. aegypti.* The efficiency of fungus (*Metarhizium anisopliae*) impregnated cloths with and without imidacloprid has been evaluated against adult *A. aegypti,* by releasing mosquitoes into the test rooms, and the lowest survival rates (38%) are seen. The blood fed *A. aegypti* has lower landing frequencies on black cloths than sucrose fed insects during the first 24 h following feeding, which may have been due to reduced flight activity. Few mosquitoes (4-5%) have been observed to land on the cloths during the hours of darkness. The landing pattern of sucrose-fed mosquitoes on non-treated and fungus-treated cloths is similar. The synergism between *M. anisopliae* and imidacloprid significantly reduced Aedes survival, thus, the use of fungus impregnated cloths is a promising point source application method for the control of adult *A. aeypti* [13].

The Cyclopoid Copepods *Mesocyclops longisetus* (Thiebaud), *Mesocyclops thermocyclopoides* Harada, *Mesocyclops venezolanus* Dussart, and *Macrocyclops albidus* (Jurine) are found effective in controlling *A. aegypti* larvae in a variety of containers around homes All four cyclopoid species have killed >20 larvae per cyclopoid per day under container conditions. The *M. longisetus* proved most effective, not only because it is the most voracious predator, but also because it can survive best in the containers. The *M. longisetus* maintained long-term populations in 200-liter drums, tires, vases, and cement tanks (without drains), providing the cyclopoids are not dried or poured out. The *M. longisetus* reduced third-and fourth-instar *A. aegypti* larvae by >980/0 compared with control containers without cyclopoids. The *M. longisetus* should be of practical value for community-based *A. aegypti* control if appropriate attention is directed to maintain it in containers after introduction [14].

When communities do not have adequate dengue protective programs, peoples, businesses, government and pets are all at risk. Preventing epidemic dengue fever requires a coordinated community effort to increase awareness about disease, how to recognize it, and how to control the mosquitoes that transmit it. Fact sheets, posters, school poster contests, media contacts, and formal presentations can all be employed to let residents know what the municipality is doing about mosquitoes and to solicit their cooperation. The guidelines include different research highlights, such as impact fact sheets, fact sheet backgrounders, cross-promotional environmental health messages, preferred language, social facts and innovative financing information. An important note from the research is that communities need to develop a mosquito control program that is appropriate to the local threat, should compatible to the situation changes, and entire community needs to be involved. For these reasons, entomological studies should be included to give support before and throughout vector control operations.

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