Annexure VI

Guidelines for integrated vector management for control of *Aedes* mosquito

Introduction

Aedes aegypti (Ae aegypti) is the main vector species of Zika Virus Disease. This vector is widely prevalent in India and is common in most of the urban areas on account of deficient water management, presence of non-degradable tyres and long-lasting plastic containers as well as increasing urban agglomerations and inability of the public health community to mobilize the population to respond to the need to eliminate mosquito breeding sites. Overhead tanks, ground water storage tanks and septic tanks are usually the primary habitats. That is, *Ae aegypti* breeds almost entirely in manmade water receptacles found in and around households, construction sites, factories.

Natural larval habitats are rare, but include tree holes, leaf axles and coconut shells. The population of *Ae aegypti* fluctuates with rainfall and humidity. Under the optimal conditions the life cycle of aquatic stage of the *Ae Aegypti* (the time taken from hatching to adult emergence) can be as short as seven days. At low temperatures, however, it may take several weeks for adults to emerge. During the rainy season, when survival is longer, the risk of virus transmission is greater.

The rural spread of *Aedes* is a relatively recent occurrence associated with expanding network of rural water supply schemes and other development projects without health impact assessments, scarcity of water with consequent water storage, changing lifestyle with improper use of air coolers and indiscriminate use of disposable containers, bottles, etc, improved transport system.

Therefore, the key to control Zika virus disease is adoption of a comprehensive approach by way of regular vector surveillance and integrated management of the *Aedes* mosquitoes through biological and chemical control that are safe, cost effective; and environmental management, legislations as well as action at household and community levels.

2. Vector surveillance

2.1 Larval surveys: For larval surveys, the basic sampling unit is the house or premise, which is systematically searched for water holding containers. Containers are examined for the presence of mosquito larvae and pupae. Depending on the objective of the survey, the search may be terminated as soon as *Aedes* larvae are found, or it may be continued

until all containers have been examined. The collection of specimens for laboratory examination is necessary to confirm the species. Four indices that are commonly used to monitor *Ae aegypti* infection levels are:

i) House index (HI): percentage of houses infected with larvae and/or pupae

$$HI = \frac{\text{Number of Houses infected}}{\text{Number of Houses inspected}} \times 100$$

ii) Container Index (CI): percentage of water holding containers infected with larvae or pupae.

$$CI = \frac{\text{Number of positive containers}}{\text{Number of containers inspected}} \times 100$$

iii) Breteau Index (Bl): number of positive containers per 100 houses inspected

$$BI = \frac{\text{Number of positive containers}}{\text{Number of houses inspected}} \times 100$$

iv) Pupae Index (PI): number of pupae per 100 houses

$$PI = \frac{\text{Number of pupae}}{\text{Number of houses inspected}} \times 100$$

2.2 Adult Surveys:

I. Landing/biting collection: Landing/biting collection of humans is a sensitive means of detecting low level infestations of *Ae aegypti*, but are very labour intensive. Because adult males have low dispersal rates, their presence can be a reliable indicator of clear proximity to hidden larvae habitats. It is usually expressed in terms of landing/biting counts per man hour.
II. Resting collection: During periods of inactivity, adult mosquitoes typically rest indoors, especially in bedrooms and mostly in dark places, such as cloth closets and other sheltered sites. Resting collection requires systematic searching of these sites for adult mosquitoes with the aid of flashlight. Following a standard timed collection routine in selected rooms of each house, densities are recorded as the number of adults per house or number of adults per man hour of human efforts.
III. Oviposition traps: Ovitraps are devices used to detect the presence of *Ae aegypti* where the population density is low and larval surveys are largely unproductive

(when the Breteau index is less than 5) as well as normal conditions. The ovitrap is used for *Ae aegypti* surveillance in urban areas to evaluate the impact of adulticidal space spraying on adult female population.

3. Vector management

3.1. Environmental Management

The major environmental management methods used for control of immature stages of *Aedes* mosquito are:

I. **Environmental modification**: Long lasting physical transformation of vector habitats. For example, improved water supply, mosquito proofing of overhead tanks, cisterns or underground reservoirs.
II. **Environmental manipulation**: Temporary changes to vector habitats that involve the management of "essential" and "non-essential" containers and management of or removal of "natural" breeding sites.
III. **Changes in human habitations**: Efforts are made to reduce man-virus contact by mosquito proofing of houses with screens on doors/windows.

3.2. Personal Protection

Protective clothing and repellents are common means of personal protection against mosquitoes and other biting insects. Household insecticide products, namely, mosquito coils, pyrethrum space spray and aerosols have been used extensively for personal protection against mosquitoes. Insecticide treated mosquito nets have limited utility in Zika control, since the vector species bite during the day time. However, insecticide treated bed nets can be effectively used to protect infants and night workers while sleeping during daytime.

3.3. Biological Control

(i) Larvivorous fish are recommended for control of *Ae. aegypti* in large water bodies or large water containers.
(ii) Endotoxin-producing bacteria, Bacillus thuringiensis serotype H-14 (Bt H-14) has been found an effective mosquito control agent.

3.4. Chemical Control

Chemical control measures (larvicides, adulticides) are recommended in permanent big water containers where water has to be conserved or stored because of scarcity of water or irregular and unreliable water supply.

(i) **Larvicide**: Since *Ae aegypti* breeds in clean water, which is stored and used for household purposes, as such all the larvicides, which are safe, without any odour or colour, have residual effect with low mammalian toxicity and do not pose any health hazard should be used. Temephos, an organophosphate compound meets all the above mentioned requirements and this insecticide is being used under the public health programme. The recommended dose for application of Temephos (50 EC) is 1 ppm (1 mg per liter of water).

(ii) **Adulticide:** The following methods are recommended for the control of adult *Ae aegypti* mosquitoes:

a) Pyrethrum spray: It may be used in indoor situations as space spray at a concentration of 0.1% - 0.2% @ 30-60 ml/1000 cu. ft. Commercial formulation of 2% pyrethrum extract is diluted with kerosene in the ratio of one part of 2% pyrethrum extract with 19 parts of kerosene (volume/volume). Thus, one litre of 2% pyrethrum extract is diluted by kerosene into 20 litres to make 0.1% pyrethrum formulation ('ready-to-spray' formulation). After dilution, pyrethrum extract is sprayed with Flit pump or hand operated fogging machine fitted with micro-discharge nozzle.

b) Malathion fogging or Ultra Low Volume (ULV) spray: In application of ULV, minimum volume of liquid insecticide formulation is applied per unit area. That is, the insecticide is broken down into small droplets of a volume median diameter (VMD) of 40-80 microns with an objective of producing a cloud of insecticide droplets that remain suspended in air for an appreciable time and driven under the influence of wind. This provides maximum effectiveness against target vectors.

Since no diluent is used, the technique is more cost-effective than thermal fogging but it does not generate a visible fog. Most organophosphorus insecticides in their technical form can be applied as ULV spray. Under the public health programme, ULV spray (fogging) is undertaken by using 95% or pure technical malathion. The ground equipment mostly used for ULV spray includes portable motorized knapsack blowers and cold aerosol generators.

3.5. Legislative Measures

Suitable laws and byelaws should be enacted and implemented for regulating storage/utilization of water by communities, various agencies and avoidance of mosquitogenic conditions at construction sites, factories.

(i) **Model civic byelaws**: Under this Act fine/punishment is imparted, if breeding is detected. These measures are being strictly enforced by Mumbai, Navi Mumbai, Chandigarh and Delhi Municipal Corporations.

(ii) **Building Construction Regulation Act**: Building byelaws should be made for appropriate overhead / underground tanks, mosquito proof buildings, designs of sunshades, porticos, etc for not allowing stagnation of water vis-à-vis breeding of mosquitoes. In Mumbai, prior to any construction activity, the owners/builders deposit a fee for controlling mosquitogenic conditions at site by the Municipal Corporation.

(iii) **Environmental Health Act**: Suitable byelaws should be made for the proper disposal/storage of junk, discarded tins, old tyres and other debris, which can withhold rain water.

(iv) **Health Impact Assessments (HIA)**: Appropriate legislation should be formulated for mandatory HIA prior to any development projects/major constructions.