

UN MEDICAL SERVICES DIVISION
**Best Management Practice for Mosquito Control Program
for UN Duty Stations**
Updated on 23 February 2016

Aim of Document

This document is targeted towards UN duty stations with mosquito-borne diseases, and aims to provide best management practices to support implementation of a comprehensive mosquito control and surveillance program in such duty stations.

Background

The mosquito is an extraordinarily efficient vector for human disease. Through the years, the tiny mosquito has caused life threatening epidemics throughout the world including that of malaria, dengue fever, encephalitis, chikungunya, yellow fever and Zika. These diseases are reported in more than 100 countries and it is estimated that over 60% of the world's population is at risk of infection.

Many types of vector control strategies exist including physical, chemical, biological, mechanical and environmental methods. Individuals, local communities, and larger organized public health vector management programmes frequently need to work together to effectively identify and control mosquito breeding.

The *Aedes* species of mosquitoes can spread dengue, chikungunya, and Zika viruses. Typically, these mosquitoes bite in the day, do not fly far and the majority remain within 400 metres of breeding sites. Common breeding habitats include common household containers (e.g., pots/containers used for domestic water storage and decorative plants) as well as rain-filled habitats (e.g., used tyres, discarded food and beverage containers, blocked gutters and construction sites). Efforts must be made to destroy mosquito eggs and reduce larval and adult densities.

Overview of Control Strategies

The World Health Organization recommends Integrated Vector Management (IVM) as a strategy to improve vector control. IVM is a decision-making process for the management of vector populations, so as to reduce or interrupt transmission of vector-borne diseases. IVM combines common-sense practices that maximize effective, safe, environmentally sensitive and economical approaches to control disease vectors. IVM is based on ecological, economic and social criteria and integrates multidisciplinary methodologies into pest management.

Effective, well tested vector control strategies include:

- (i) **Environmental Management:** source reduction and habitat modification / manipulation, for example digging ditches and covering ponds in the targeted marshlands;
- (ii) **Mechanical Control:** screening window and doors, drilling holes in fenders and removal and safe storage of scraps;
- (iii) **Biological Control:** larvivorous fish and bio-larvicides, for example mosquito fish (*Gambusia*) in ditches and ponds or other predators to control mosquito larvae¹.

¹ While adult mosquito biological control by means of birds, bats, dragonflies and frogs has been employed by various agencies, supportive data is anecdotal and there are no documented studies to show that bats, purple martins, or other predators consume enough adult mosquitoes to be effective control agents.

- (iv) **Chemical Control:** Larvicides (e.g. Antilarval spraying with temephos) and Adulticides (Fogging, Indoor Residual Spraying, Insecticide Treated Bed-nets, etc)
- (v) **Personal Protection measure²:** Use of repellents, long sleeve clothing, etc.

Surveillance tools

The foundation of an effective mosquito control program is surveillance. Monitoring the immature and adult stages of mosquitoes must be carried out in dry and the rainy seasons. For immature mosquito stages (mainly larvae and pupae), it is essential to reduce the density of the vector and where it is reproducing (e.g., water containers) to decide on the appropriate interventions. When conducting surveillance, the necessary equipment and supplies for vector surveillance including larval dippers, bottles, droppers, flashlights, alcohol, work spreadsheets, and ovitraps should be made available.

Pesticides/Insecticides

Insecticides (which are type of pesticide that is used to specifically target and kill insect) may be applied to control mosquito larvae (larvicides) or adults (adulticides). Non-chemical methods should be used as a first line strategy and complemented by targeted chemical methods for vector control. Selecting which chemical and/or non-chemical methods to use should be based on their efficacy, sustainability and cost-effectiveness. Adulticides and larvicides are applied only after the presence of mosquitoes is demonstrated by surveillance, including larval surveillance and adult collections.



Application of insecticides should follow the label instructions, and appropriate personal protective equipment should be used (such as gloves, masks, coveralls or respirators, as needed). Care should be exercised in the use of any insecticide. All insecticides must have the name and amount of active ingredient (AI) appearing on the label; examples are DEET and pyrethroids. Safety Data Sheets (SDS / MSDS) contain basic information about the product and are intended to help operators work safely with pesticides. More information on the use of insecticides for vector control can be found at

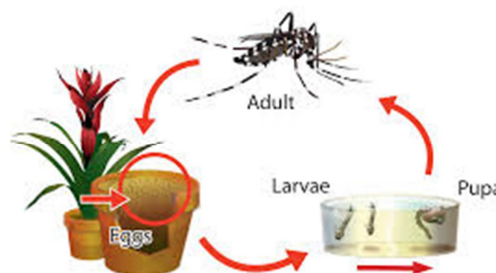
http://apps.who.int/iris/bitstream/10665/69795/1/WHO_CDS_NTD_WHOPE_S_GCDPP_2006.1_eng.pdf.

Larval Control

An efficient way to control mosquitoes is to find and eliminate their larval habitats. Studies show that a majority of mosquitoes come from 3-5 priority breeding sites in a community. Simple larval or pupal counts can be used to identify these sites and target them to have the largest impact on mosquito populations.

Large scale source reduction, such as eliminating large larval development sites in swamps, sluggishly moving streams or ditches may require community-wide efforts,

which is usually a task for organized mosquito control programs. Such programs might impound an area of water, establish ditches or canals or control the aquatic weeds (cattails, water lettuce) on a body of water. Larvicides may be applied by programs to bodies of water to target immature



² For more info on personal protection measures for individual staff, please refer to MSD's Advice on Protection against Mosquito Bites available at https://hr.un.org/sites/hr.un.org/files/ZikaPersonalProtection_UN%20Staff_MSD_2016-02-09_EN_0.pdf and on the Zika HR Portal website at <https://hr.un.org/page/zika-virus>

mosquitoes (larvae or pupae). Larvae usually inhabit areas near the shoreline of lakes, stream or ditches, and larvicides are applied to a limited targeted area where the larvae grow and mature. Larvicides can be classed as mosquito stomach toxins, contact larvicides, surface agents, biological larvicides (e.g. Bti) and insect growth regulators (IGRs, e.g. pyriproxyfen).

A list of WHO recommended larvicides can be found at http://www.who.int/whopes/Mosquito_Larvicides_25_Oct_2013.pdf

Other new larval control tools under evaluation include lethal ovitraps and acoustic larvicide systems. Lethal ovitraps attract egg-laying female mosquitoes and kill developing larvae and eggs inside the traps. The acoustic larvicide is a mechanical device that transmits sound energy into water to kill mosquito larvae in breeding sites.

UN Duty Stations should ensure the following steps are taken to prevent mosquito breeding on UN compound/s:

1. Destroy or dispose of tin cans, old tyres, buckets, unused plastic swimming pools or other containers that collect and hold water. Do not allow water to accumulate in the saucers of flowerpots, cemetery urns or in pet dishes for more than 2 days.
2. Clean debris from rain gutters and remove any standing water under or around structures, or on flat roofs. Check around faucets and air conditioner units and repair leaks or eliminate puddles that remain for several days.
3. Change the water in birdbaths and wading pools at least once a week and stock ornamental pools with predacious minnows or guppies. Known as mosquito fish, these minnows are about 1 - 1-1/2 inches in length and can be purchased or native fish collected from local streams. Ornamental pools may be treated with biological larvicides (*Bacillus thuringiensis* subsp. *israelensis* (*Bti*)) or growth regulators (e.g., S-methoprene containing products). Commercial products containing *Bti* or IGRs can be purchased at hardware/garden stores for homeowner use.
4. Fill or drain puddles, ditches and swampy areas, and either remove, drain or fill tree holes and stumps with mortar. These areas may be treated with *Bti* or IGR products also.
5. Eliminate seepage from cisterns, cesspools, and septic tanks.
6. Eliminate standing water around animal watering troughs. Flush livestock water troughs twice a week.
7. Check for trapped water in plastic, used tyres or canvas tarps used to cover boats, pools, etc. Arrange the tarp to drain the water.
8. Check around construction sites or do-it-yourself improvements to ensure that proper backfilling and grading prevent drainage problems.
9. Irrigate lawns and gardens carefully to prevent water from standing for several days.
10. If ditches do not flow and contain stagnant water for one week or longer, they can produce large numbers of mosquitoes. Be sure that UN personnel in your duty station know which entity to report such conditions to.

Adult Control

- ◆ **Space Sprays.** WHO recommends that during outbreaks, space spraying of insecticides may be carried out following the technical guidance provided by WHO to kill flying adult mosquitoes. If applicable to your duty station, trained personnel may use ultra-low volume (ULV) space spray insecticides (cold fog or thermal fog) applied with portable backpack sprayers or thermal foggers, or vehicle-mounted aerosol generators, which vaporize liquid insecticide into droplets that form an aerosol / fog when discharged. This fog has a “knockdown effect” on the vector in and around domestic spaces. The purpose of this intervention (space-spraying) against adult vectors is to reduce transmission by knocking down infective females to control spread of the pathogen. Instructions on both the insecticide label and fogging attachments for application procedure should be followed. ULV insecticide application (cold aerosol or thermal fog) should only be used in areas where transmission of mosquito-borne disease is occurring, and is supplemental to larval control measures (mentioned above); WHO recommended insecticides for space spraying can be found at http://www.who.int/whopes/Space_Spray_products_February_2016.pdf?uq=1. WHO specifications (<http://www.who.int/whopes/quality/en/>) should be used for quality control. Fogging should only be done early in the morning (before sunrise) or late in the evening (after sunset) to prevent evaporation and wastage of insecticides.



- ◆ **Individual² and Household Protection.** Clothing that minimizes skin exposure during daylight hours when *Aedes* species mosquitoes are most active affords some protection from the bites of vectors and is encouraged particularly during outbreaks. Repellents may be applied to exposed skin or to clothing. Repellents should contain DEET (N, N-diethyl- 3-methylbenzamide), IR3535 (3-[Nacetyl-N-butyl]-aminopropionic acid ethyl ester) or Icaridin (1-piperidinecarboxylic acid,2-(2-hydroxyethyl)-1-methylpropylester). The use of repellents must be in strict accordance with label instructions. Insecticide-treated mosquito nets afford good protection for those who sleep during the day (e.g., infants, the bedridden and night-shift workers).

Where indoor biting occurs, household insecticide aerosol products, mosquito coils or other insecticide vaporizers may also reduce biting activity. Household aerosol sprays are most effective indoors, as outdoors, the insecticide particles disperse rapidly and may not kill many mosquitoes. A disadvantage of space spraying is that it will not manage insects for long periods of time.

Household fixtures such as window and door screens and air-conditioning can also reduce biting. Mosquitoes can be kept out of the home by keeping windows, doors and porches tightly screened (16-18 mesh). Those insects that do get into structures can be eliminated with a fly swatter or an aerosol space spray containing synergized pyrethrum.

- ◆ **Environmental Management.** While identifying and eliminating local mosquito breeding sites is the most effective way to reduce mosquito populations, cutting down weeds adjacent to the house foundation and in their yards, and cutting grass regularly to acceptable length can also reduce areas where adult mosquitoes can find shelter. Perifocal treatment of larval habitats and peripheral surfaces such as vegetation, walls and other potential mosquito resting areas with insecticides can be used to reduce adult and larval breeding and resting sites. Suitable insecticides can be applied with hand-operated compression sprayers. Safety precautions for pesticide use – including care in the handling of pesticides, safe work practices for those who apply them and appropriate field application – should be followed.

- ◆ **Mosquito Traps.** Devices are available for purchase that claim to attract, repel or kill outdoor mosquitoes. For example, insect electrocutors (bug zappers) and mosquito trapping devices are marketed to provide relief from backyard biting mosquitoes and other pests. Other mosquito traps are designed to mimic a potential mammalian host (horse, cattle, man and domestic pets) by emitting a plume of carbon dioxide, heat and moisture, which is often combined with an additional attractant, i.e., octenol, to create an attractant to mosquitoes, no-see-ums, biting midges and black flies. After drawing the insects to the trap, a vacuum device sucks the insects into a net or cylinder where they dehydrate and die. No electric killing grid or pesticides are used.



Traps should be thoroughly researched before being purchased, as more data is needed on the effectiveness of traps for vector control and some of the mosquito traps can be quite expensive.

Delivery of Vector Control Interventions

Targeting vector-borne diseases requires work at both individual and community levels in order to reduce vector larval habitats successfully, and in turn to reduce the number of adult mosquitoes available to transmit disease. A comprehensive mosquito control and surveillance program should be put in place in all duty stations that have mosquito-borne disease transmission in the area/country.

Monitoring and Evaluation

A functional monitoring and evaluation system is vital to the successful implementation of all vector control programmes. Monitoring and evaluation guides the planning and implementation, assesses effectiveness of intervention, identifies areas for improvement and optimizes the use of resources. Monitoring and evaluation is often the weak link in many vector control programmes and frequently requires strengthening. Tracking larval or pupal populations can be used as indicators for monitoring larval control measures and monitoring of adult density should also be used to assess the effectiveness of adult control interventions.