भारत सरकार/GOVERNMENT OF INDIA
रेल मंत्रालय/ MINISTRY OF RAILWAYS
(रेलवे बोर्ड)/RAILWAY BOARD

No.2010/H-1/9/6 New Delhi, dated : 6-9.2010

General Managers,
All Indian Railways & Production Units.

Sub : National Vector Borne Diseases Control Programme – Guidelines for Prevention and Control of Dengue.

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Enclosed please find Guidelines for Prevention and Control of Dengue {Dengue Fever (DF)/Dengue Haemorrhagic Fever (DHF)}. All efforts should be made to implement the above Guidelines.

Please acknowledge receipt.

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GUIDELINES FOR PREVENTION AND CONTROL OF DENGUE

Introduction

No vaccine is available yet for the prevention of dengue infection and there are no specific drugs for its treatment. Hence DF/DHF control is primarily dependent on the control of *Ae. aegypti.*

In order to achieve sustainability of a successful Dengue Fever (DF)/Dengue Haemorrhagic Fever (DHF) vector control programme, it is essential to focus on larval source reduction and to have complete cooperation with non-health sectors, such as nongovern-mental organizations, civic organizations and community groups, to ensure community understanding and involvement in implementation. There is, therefore, a need to adopt an integrated approach to mosquito control by including all appropriate methods (environmental, biological and chemical) which are safe, cost-effective and environmentally acceptable. A successful, sustainable *Ae. aegypti* control programme must involve a partnership between government control agencies and the community. The approaches described below are considered necessary to achieve long-term, sustainable control of *Ae. aegypti.*

A. Environmental Management

Environmental management involves any change that prevents or minimizes vector breeding and hence reduces human-vector contact.

Environmental methods to control *Ae. aegypti* and to reduce man-vector contact are source reduction, solid waste management, modification of man-made breeding sites, and improved house design.

- **Enviromental modification**

Improved water supply

Whenever piped water supply is inadequate and available only at restricted hours or at low pressure, the storage of water in varied types of containers is encouraged, thus leading to increased *Aedes* breeding. The majority of such containers are large and heavy (e.g storage jars) and can neither be easily disposed of nor cleaned. In rural areas, unpolluted, disused wells become breeding grounds for *Ae. aegypti.* It is essential that potable water supplies be delivered in sufficient quantity, quality and consistency to reduce the necessity and use of water storage containers that serve as the most productive larval habitats.

Mosquito-proofing of overhead tanks/cisterns or underground reservoirs

Where *Ae. aegypti* larval habitats include overhead tanks/cisterns and masonry chambers of piped waterlines, these structures should be mosquito-proofed[42]. Similarly, mosquito-proofing of domestic wells and underground water storage tanks should be undertaken. Masonry chambers of sluice valves and water meters are required to be provided with soak pits as part of preventive maintenance.

- **Environmental manipulation**

Draining of water supply installations

Water collection/leakages in masonry chambers, distribution pipes, valves, sluice valves, surface boxes for fire hydrants, water meters, etc. collect water and serve as important *Ae.aegypti* larval habitats in the absence of preventive maintenance.

Domestic storage

The major sources of *Ae. aegypti* breeding in most urban areas of South-East Asia are containers storing water for household use including clay, ceramic and cement water jars of 200 litre size, 210 litre (50 gallon) metal drums, and smaller containers storing fresh water or rain water. Water storage containers should be covered with tight-fitting lids or screens, care being taken to replace them after water is used.

Flower pots/vases and ant traps

Flower pots, flower vases and ant traps are common sources of *Ae. aegypti* breeding. They should be punctured to produce a drain hole. Alternatively, live flowers can be placed in a mixture of sand and water. Flowers should be removed and discarded weekly and vases scrubbed and cleaned before reuse. Ant traps to protect food storage cabinets can be treated with common salt or oil.

Aedes breeding in incidental water collections

Desert (evaporation) water coolers, condensation collection pans under refrigerators, and air conditioners should be regularly inspected, drained and cleaned.

Building exteriors

Drainage pipes of rooftops sunshades/porticos often get blocked and become breeding sites for *Aedes* mosquitoes. There is a need for periodic inspection of buildings during the rainy season to locate potential breeding sites.

Mandatory water storage for fire fighting

Fire prevention regulations may require mandatory water storage. Such storage tanks need to be kept mosquito-proofed.

Solid waste disposal

Solid wastes, namely tins, bottles, buckets or any other waste material scattered around houses, should be removed and buried in land fills. Scrap material should be stored appropriately until disposal. Household and garden utensils (buckets, bowls and watering devices) should be turned upside down to prevent the accumulation of rain water. Plant waste should be disposed of properly and without delay.

Tyre management

Used automobile tyres are of major importance as breeding sites for urban *Aedes*, and are therefore a significant public health problem. Tyre depots should always be kept under cover to prevent the collection of rain water.

Used tyres can be filled with earth or concrete and used for planters or traffic/crash barriers.

Filling of cavities of fences

Fences and fence posts made from hollow trees such as bamboo should be cut down to the node, and concrete blocks should be filled with packed sand, crushed glass, or concrete to eliminate potential *Aedes* larval habitats.

Glass bottles and cans

Glass bottles, cans and other small containers should be buried in land fills or crushed and recycled for industrial use.

B. Personal Protection

- **Protective clothing**

  Clothing reduces the risk of mosquito biting if the cloth is sufficiently thick or loosely fitting. Long sleeves and trousers with stockings may protect the arms and legs, the preferred sites for mosquito bites.

- **Mats, coils and aerosols**

  Household insecticidal products, namely mosquito coils, pyrethrum space spray and aerosols have been used extensively for personal protection against mosquitoes. Electric vaporizer mats and liquid vaporizers are more recent additions which are marketed in practically all urban areas.

- **Repellents**

  Repellents are a common means of personal protection against mosquitoes and other biting insects. These are broadly classified into two categories, natural repellents and chemical repellents. Essential oils from plant extracts are the main natural repellent ingredients, i.e. citronella oil, lemongrass oil and neem oil. Chemical repellents such as DEET (N, N-Diethyl-m-Toluamide) can provide protection against *Ae. albopictus, Ae. aegypti* and anopheline species for several hours. Permethrin is an effective repellant when impregnated in cloth.

- **Insecticide-treated mosquito nets and curtains**

  Insecticide-treated mosquito nets (ITMN) have limited utility in dengue control programmes, since the vector species bites during the day. However, treated nets can be effectively utilized to protect infants and night workers who sleep by day. They can also be effective for people who generally have an afternoon sleep.

C. Biological Control

The application of biological control agents which are directed against the larval stages of dengue vectors has been somewhat restricted to small-scale field operations.

- **Fish**

Larvivorus fish (*Gambusia affinis* and *Poecilia reticulata*) have been extensively used for the control of *An. stephensi* and/or *Ae. aegypti* in large water bodies or large water containers. The applicability and efficiency of this control measure depend on the type of containers.

- **Bacteria**

Two species of endotoxin-producing bacteria, *Bacillus thuringiensis* serotype H-14 *(Bt.H-14)* and *Bacillus sphaericus (Bs)* are effective mosquito control agents. They do not affect non-target species. *Bt.H-14* has been found to be most effective against *An. stephensi* and *Ae. aegypti*, while *Bs* is the most effective against C*ulex quinquefasciatus* which breeds in polluted waters. There is a whole range of formulated *Bti* products produced by several major companies for control of vector mosquitoes. Such products include wettable powders and various slow-release formulations including briquettes, tablets and pellets. Further developments are expected in slow-release formulations. *Bt.H-14* has an extremely low-level mammalian toxicity and has been accepted for the control of mosquitoes in containers storing water for household use.

D. **Chemical Control**

Chemicals have been used to control *Ae. aegypti* since the turn of the century.

- **Chemical Larviciding**

Larviciding or "focal" control of *Ae. aegypti* is usually limited to domestic-use containers that cannot be destroyed, eliminated, or otherwise managed. It is difficult and expensive to apply chemical larvicides on a long-term basis. Therefore chemical larvicides are best used in situations where the disease and vector surveillance indicate the existence of certain periods of high risk and in localities where outbreaks might occur. Establishing the precise timing and location are essential for maximum effectiveness. Control personnel distributing the larvicide should always encourage house occupants to control larvae by environmental sanitation. There are three insecticides that can be used for treating containers that hold drinking water.

- **Temephos 1% sand granules**

One per cent temephos sand granules are applied to containers using a calibrated plastic spoon to administer a dosage of 1 ppm. This dosage has been found to be effective for 8-12 weeks, especially in porous earthen jars, under normal water use patterns. Although resistance to temephos in *Ae. aegypti* and *Ae. albopictus* populations has not been reported from India, the susceptibility level of *Aedes* mosquitoes should be monitored regularly in order to ensure the effective use of the insecticide.

- **Insect growth regulators**

Insect growth regulators (IGRs) interfere with the development of the immature stages of the mosquito by interference of chitin synthesis during the molting process in larvae or disruption of pupal and adult transformation processes.

Bacillus thuringiensis H-14 (Bt.H-14)

Bt.H-14, which is commercially available under a number of trade names, is a proven, environmentally-nonintrusive mosquito larvicide. It is entirely safe for humans when the larvicide is used in drinking water in normal dosages.

- **Space sprays**

Space spraying involves the application of small droplets of insecticide into the air in an attempt to kill adult mosquitoes. It has not been effective. Recent studies have demonstrated that the method has little effect on the mosquito population, and thus on dengue transmission [53,54,55]. Moreover, when space spraying is conducted in a community, it creates a false sense of security among residents, which has a detrimental effect on community-based source reduction programmes. From a political point of view, however, it is a desirable approach because it is highly visible and conveys the message that the government is doing something about the disease. This, however, is poor justification for using space sprays. The current recommendations are that space spraying of insecticides (fogging) should not be used except in the most extreme conditions during a major DHF epidemic. However, the operations should be carried out at the right time, at the right place, and according to the prescribed instructions with maximum coverage, so that the fog penetration effect is complete enough to achieve the desired results.

When space sprays are employed, it is important to follow the instructions on both the application equipment and the insecticide label and to make sure the application equipment is well maintained and properly calibrated. Droplets that are too small tend to drift beyond the target area, while large droplets fall out rapidly. Nozzles for ultra-low volume ground equipment should be capable of producing droplets in the 5 to 27 micron range and the mass median diameter should not exceed the droplet size recommended by the manufacturer. Desirable spray characteristics include a sufficient period of suspension in the air with suitable drift and penetration into target areas with the ultimate aim of impacting adult mosquitoes. Generally, there are two forms of space-spray that have been used for *Ae. aegypti* control, namely "thermal fogs" and "cold fogs". Both can be dispensed by vehicle-mounted or hand-operated machines.

- **Thermal fogs**

Thermal fogs containing insecticides are normally produced when a suitable formulation condenses after being vaporized at a high temperature. Generally, a thermal fogging machine employs the resonant pulse principle to generate hot gas (over 200°C) at high velocity. These gases atomize the insecticide formulation instantly so that it is vaporized and condensed rapidly with only negligible formulation breakdown. Thermal fogging formulations can be oil-based or water-based. The oil(diesel)-based formulations produce dense clouds of white smoke, whereas water-based formulations produce a colorless fine mist. The droplet (particle) size of a thermal fog is usually less than 15 microns in diameter. The exact droplet size depends on the type of machine and operational conditions. However, uniform droplet size is difficult to achieve in normal fogging operations.

- **Ultra-low volume (ULV), aerosols (cold fogs) and mists**

ULV involves the application of a small quantity of concentrated liquid insecticides. The use of less than 4.6 litres/ha of an insecticide concentrate is usually considered as an ULV application. ULV is directly related to the application volume and not to the droplet size. Nevertheless, droplet size is important and the equipment used should be capable of producing droplets in the 10 to 15 micron range, although the effectiveness changes little when the droplet size range is extended to 5-25 microns. The droplet size should be monitored by exposure on teflon or silocone-coated slides and examined under a microscope. Aerosols, mists and fogs may be applied by portable machines, vehicle-mounted generators or aircraft equipment.

- **House-to-house application using portable equipment**

Portable spray units can be used when the area to be treated is not very large or in areas where vehicle-mounted equipment cannot be used effectively. This equipment is meant for restricted outdoor use and for enclosed spaces (buildings) of not less than $14m^3$.Portable application can be made in congested low-income housing areas, multistoried buildings, godowns and warehouses, covered drains, sewer tanks and residential or commercial premises. Operators can treat an average of 80 houses per day, but the weight of the machine and the vibrations caused by the engine make it necessary to allow the operators to rest, so that two or three operators are required per machine.

- **Vehicle-mounted fogging**

Vehicle-mounted aerosol generators can be used in urban or suburban areas with a good road system. One machine can cover up to 1500-2000 houses (or approximately 80 ha) per day. It is necessary to calibrate the equipment, vehicle speed, and swath width (60-90m) to determine the coverage obtained by a single pass.

- **Insecticide formulations for space sprays**

Organophosphate insecticides, such as malathion, fenitrothion and pirimiphos methyl have been used for the control of adult *Aedes* vectors. Undiluted technical grade malathion (active ingredient 95%+) or one part technical grade diluted with 24 parts of diesel have been used for ULV spraying and thermal fogging respectively. For undiluted technical grade ULV malathion applications from vehicles, the dosage on an area basis is 0.5 liters per hectare.

Apart from the above-mentioned formulations, a number of companies produce pyrethroid formulations containing either permethrin, deltamethrin, lambda-cyhalothin or other compounds which can be used for space spray applications. It is important not to under-dose during operational conditions. Low dosages of pyrethroid insecticides are usually more effective indoors than outdoors.

Also, low dosages are usually more effective when applied with portable equipment (close to or inside houses) than with vehicle-mounted equipment, even if wind and climatic conditions are favourable for outdoor applications. Regardless of the type of equipment and spray formulations and concentrations used, an evaluation should be made from time to time to ensure that effective vector control is being achieved.

- **Intergated Control Approach**

  The use of insecticides for the prevention and control of dengue vectors should be integrated into environmental methods wherever possible. During periods of little or no dengue virus activity, the routine source reduction measures described earlier can be integrated into larvicide application in containers that cannot be eliminated, covered, filled or otherwise managed. For emergency control to suppress a dengue virus epidemic or to prevent an imminent outbreak, a programme of rapid and massive destruction of the *Ae. aegypti* population should be undertaken with both insecticides and source reduction, using the techniques described in these guidelines in an integrated manner.

- **Insecticide susceptibility monitoring**

  During the past 40 years, chemicals have been widely used to control mosquitoes and other insects from spreading diseases of public health importance. As a result, *Ae. aegypti* and other dengue vectors have developed resistance to commonly-used insecticides, including temephos, malathion, fenthion, permethrin, propoxur and fenitrothion. It is therefore advisable to obtain baseline data on insecticide susceptibility before insecticidal control operations are started, and to continue monitoring susceptibility levels periodically.

- **Safety precautions for chemical control**

  All pesticides are toxic to some degree. Safety precautions should therefore be followed, including care in the handling of pesticides, safe work practices for those who apply them, and their appropriate use in and around occupied housing.