Neglected tropical diseases

Mosquito (vector) control emergency response and preparedness for Zika virus

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Summary

On 14–15 March 2016 the WHO Vector Control Advisory Group (VCAG) reviewed five potential vector control tools and existing tools for use in the context of the response to the Zika virus outbreak, including: (1) mosquito control of human pathogens in adult vectors (*Wolbachia*); (2) mosquito control through genetic manipulation (OX513A); (3) sterile insect technique; (4) vector traps; and (5) attractive toxic sugar baits.

The main conclusions and recommendations of the meeting are as follows:

1. Well implemented vector control programmes using existing tools and strategies are effective in reducing the transmission of *Aedes*-borne diseases, including Zika virus. These tools should be promoted and used to control the Zika virus. They include: (i) targeted residual spraying; (ii) space spraying; (iii) larval control; and (iv) personal protection measures.
2. Full-scale programmatic deployment is not currently recommended for any of the five new potential tools reviewed by VCAG. However, the VCAG recommended the carefully planned pilot deployment under operational conditions of two tools (*Wolbachia*-based biocontrol and OX513A transgenic mosquitoes) accompanied by rigorous independent monitoring and evaluation.
3. The VCAG concluded that more evidence is required before consideration of the pilot deployment of the three additional tools reviewed (sterile insect technique, vector traps and attractive toxic sugar baits).

Background

On 1 February 2016 the World Health Organization (WHO) declared the clusters of microcephaly and Guillain-Barré Syndrome having a temporal association with transmission of Zika virus as a Public Health Emergency of International Concern. On 8 March 2016 the Second meeting of the International Health Regulations (IHR) Emergency Committee on Zika virus issued temporary recommendations, including the following, on mosquito (vector) control:

1. Vector surveillance, including the determination of mosquito vector species and their sensitivity to insecticides, should be enhanced to strengthen risk assessments and vector control measures.
2. Vector control measures and appropriate personal protective measures should be aggressively promoted and implemented to reduce the risk of exposure to Zika virus.

3. Countries should strengthen vector control measures in the long term and the Director-General of WHO should explore the use of IHR mechanisms, and consider bringing this to a forthcoming World Health Assembly, as means to better engage countries on this issue.

In order to review the available evidence on vector control for Zika virus disease including the potential for new tools, VCAG and other experts held an extraordinary meeting (Geneva, 14–15 March 2016). The main outcomes of the meeting are summarized below.

Conclusions and recommendations of VCAG

1. Well-implemented vector control programmes using existing tools and strategies are effective in reducing the transmission of *Aedes*-borne diseases including Zika virus. Appropriate vector control interventions for the response to the Zika virus outbreak include:

- **Targeted residual spraying** of resting sites of *Aedes* spp. mosquitoes primarily inside and, to a lesser extent, around houses as the primary vector control intervention for immediate response.
- **Space spraying** is effective inside buildings where Aedes spp. mosquitoes rest and bite. It has no residual effect. Its application outdoors only suppresses vector populations temporarily and is not as effective as indoor space spraying.
- **Larval control including source reduction** and larviciding should be applied where appropriate through community mobilization.
- **Personal protection measures** should be used to protect against day biting mosquitoes. These include the use of appropriate repellents and wearing of light-coloured loose fitting clothing. This is especially important during pregnancy.

There are a number of challenges in implementing existing vector control interventions. These include: unplanned urbanization; inadequate programme implementation; lack of human, financial and infrastructural capacity; and political will. The strength and rigour of implementation of vector control must be improved to reduce infected vector populations and transmission of *Aedes*-borne diseases. All of these interventions should be well targeted, guided by local conditions, and entomological and epidemiological data, including insecticide susceptibility. WHO-recommended insecticides, to which mosquitoes are susceptible, should be used for vector control.

2. New tools. Several promising potential new vector control tools were reviewed in the context of the response to the Zika virus outbreak. These new tools have the potential to reduce vector populations and/or viral multiplication to minimal levels and thereby to prevent transmission.

While several tools showed strong evidence for entomological effect, given the absence of strong data on epidemiological impact for any *Aedes*-borne viruses, full-scale programmatic deployment is not currently recommended for any of these new tools. Available evidence does, however, warrant time-limited pilot deployment under operational conditions for two of the new tools, accompanied by rigorous monitoring and evaluation.

Specific recommendations

- **2a. Microbial control of human pathogens in adult vectors (*Wolbachia*)**. Available evidence indicates that symbiotic *Wolbachia*

spp. bacteria, when introduced into *Ae. aegypti* populations, reduce the mosquitoes' ability to transmit arboviruses to humans. Laboratory results show that *Wolbachia* infection reduces viral replication of dengue, chikungunya and Zika viruses within *Aedes* mosquitoes, and eliminates or substantially delays appearance of virus in mosquito saliva – reducing its competence for transmitting dengue viruses. The strategy involves establishing and sustaining *Wolbachia* in local *Aedes* spp. mosquito populations, thereby providing ongoing protection from virus transmission.

VCAG recommendation
This committee recommends carefully planned pilot deployment under operational conditions accompanied by rigorous independent monitoring and evaluation that builds entomological capacity to support operational use. Plans for randomised control trials (RCTs) with epidemiological outcomes should continue to build evidence for routine programmatic use of *Wolbachia* against *Aedes*-borne diseases.

- **2b. Mosquito population reduction through genetic manipulation**. OX513A is a transgenic strain of *Ae. aegypti* engineered to carry a dominant, repressible, non-sex-specific, late-acting lethal genetic system, together with a fluorescent marker. Without tetracycline or its analogues, larvae carrying OX513A gene develop normally, but die before functional adulthood. This technology has demonstrated the ability to reduce the *Ae. aegypti* populations in small-scale field trials in several countries, but there is an absence of data on epidemiological impact. Additionally, sustained release of transgenic male mosquitoes is needed to maintain suppression of wild *Ae. aegypti* populations.

  VCAG recommendation
  This committee recommends carefully planned pilot deployment under operational conditions accompanied by rigorous independent monitoring and evaluation that builds entomological capacity to support operational use. RCTs with epidemiological outcomes should be carried out to build evidence for routine programmatic use of OX513A *Aedes* against *Aedes*-borne diseases.

- **2c. Sterile insect technique (FAO/IAEA)**. This technique involves the mass production, sex-separation and sterilization of male mosquitoes. Males are sterilized by exposing them to low doses of radiation. Sterile males released into the wild mate with wild female mosquitoes of the same species, resulting in production of unviable eggs leading to a decline in wild mosquito populations. When the sterile males outnumber the fertile males in a natural environment, the target mosquito population is reduced. Sterile Insect Technique (SIT) is a well-established technology with a proven successful track record for agricultural and veterinary pests. FAO/IAEA provides technical support and guidance to Member States in the use of SIT technology and helps to build capacity. Regional networks are available in south and south-east Asia, and are being established in Latin America, the Caribbean and in Europe. SIT, combined with *Wolbachia*-induced Incompatible Insect Technique provides a promising new tool for the reduction of Aedes spp. populations.

  VCAG recommendation
  VCAG recommends carefully planned pilot studies to generate the entomological and epidemiological evidence to support use of SIT-based technology for Aedes spp. mosquitoes in different settings and in combination with existing or new tools (*Wolbachia*) in the framework of integrated vector management approaches. WHO should work closely with FAO/IAEA to develop the normative guidance on the epidemiological impact of the SIT-based technology to support its evaluation and implementation by the Member States.

- **2d. Vector traps for disease management**. Several traps for *Aedes*

surveillance and control have been submitted to VCAG. Vector trap technology may reduce mosquito populations by attracting and killing egg-laying female mosquitoes and also has potential for improved vector surveillance. The entomological efficacy of these traps has been demonstrated in limited field trials. Though preliminary evidence was reviewed by the committee, evidence for the public health value of vector traps needs to be more fully established and operational considerations addressed.

VCAG recommendation
In addition to RCTs with epidemiological outcomes to build evidence for routine programmatic use against *Aedes*-borne viruses, studies should be carried out to demonstrate the overall feasibility of use of traps for large-scale control of *Aedes* mosquitoes and to assess impact on disease. Studies should include evaluation of the sustainability, feasibility, cost effectiveness and community acceptability of vector traps in diverse use settings, as well as long-term management of traps. The potential of trap use for routine surveillance of *Aedes* mosquito populations should also be explored.

- **2e. Attract-and-kill baits/attractive toxic sugar bait (ATSB)**. ATSB is a novel application method involving use of insecticide classes that act as stomach poisons for mosquitoes. This technology is based on an "attract and kill" principle, where mosquito attractants are combined with oral toxins that kill the target insects. ATSB products are intended for spraying on vegetation harbourages for mosquitoes in and around houses or, in their absence, putting up treated bait stations to attract and kill sugar-seeking mosquitoes.

  VCAG recommendation
  Previous VCAG conclusions issued in November 2014 are still valid; further assessment including for field entomological and epidemiological impact, acceptability, compliance and exposure risk assessment are required before this tool can be considered for full-scale programmatic deployment.

Way forward

Control of *Aedes* spp. mosquitoes today and in the future has to change from a reactive approach to a sustained, proactive control intervention based on entomological and epidemiological evidence. The focus must be on improving the quality and extent of implementation of vector control interventions to ensure optimal impact – both within the context of the immediate response to Zika virus disease and, more broadly, against all *Aedes*-borne diseases. When planning and implementing programmes for the control of *Aedes*-borne diseases, a number of key factors should be considered, such as: country commitment, intersectoral collaboration and capacity building for entomological surveillance, sustained effective control and a rapid outbreak response.

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Further reading

- Vector Ecology and Management (VEM)
- Vector Control Advisory Group on new tools (VCAG)
- Protecting the health and safety of workers in emergency vector control of *Aedes* mosquitoes

Zika virus/complications »

This page links all WHO information to its response on the Public Health Emergency of International Concern.

Timeline and maps

- Zika virus: News and updates
- The history of Zika virus

Zika Virus

- Fact sheet: Zika virus
- Q&A: Zika virus
- More on Zika virus

Microcephaly

- Fact sheet: Microcephaly
- More on Microcephaly

Guillain–Barré syndrome

- Guillain–Barré syndrome
- Guillain–Barré syndrome

Information in Portuguese

- Fact sheet: Zika virus
- Q&A: Women, microcephaly and Zika virus