Dengue Vector Control in Viet Nam Using Mesocyclops Through Community Participation

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Abstract

In Tanminh commune (Thuongtin district, Hatay province), a community-based vector control programme was implemented. Using local communication network and with the participation of health volunteers and schoolchildren under the direction of local authority, and in consultation with health staff, campaigns for the elimination of discarded containers and release of Mesocyclops proved to be highly effective for vector control and for the improvement of people's knowledge of dengue fever/dengue haemorrhagic fever (DF/DHF).

Introduction

Dengue fever/dengue haemorrhagic fever (DF/DHF) was first recorded in Viet Nam in 1959. Since then, it has become endemic in the whole country. According to epidemiological surveillance, during the period 1979-1995 the morbidity rate of the disease varied from 41.02 to 462.24 and the mortality rate varied from 0.16 to 2.70 per 100 000 inhabitants. Two species of mosquitoes, Aedes aegypti and Aedes albopictus, were found in Viet Nam. The main vector for the transmission of dengue viruses is Aedes aegypti. As elsewhere in other countries around the world, for many years, dengue vector control in Viet Nam was based predominantly on ultra-low-volume (ULV) insecticide spraying to kill infected mosquitoes during epidemics (Gratz, 1991)(1). Meanwhile, the dengue surveillance system remained inadequate; therefore, spraying usually was too late to prevent epidemic transmission (Gubler, 1994)(2). Reiter (1992)(3) has proved low
effectiveness of insecticide spraying and quick return of vector population thereafter. The most effective method of controlling *Aedes aegypti* mosquitoes is source reduction to eliminate the mosquito larvae from habitats in and around homes where most of the transmission occurs. *Aedes aegypti* breeds and develops in artificial water containers and its life is closely associated with human activities. In order to control these mosquitoes successfully, it is important to gain community participation. The use of the new measure of low-cost, easy application with high, sustainable effectiveness such as *Mesocyclops*, a biological agent to control *Aedes aegypti* larvae, is encouraging for high-risk areas of dengue fever\(^4,5\). In Viet Nam, with the support of the Medical Committee Nederland-Vietnam, such a model has been applied and discussed.

**Materials and methods**

The study has been conducted in Tanminh commune (Thuongtin district, Hatay province, 25 km west of Hanoi city) since August 1995. This commune consisted of four hamlets with 1 600 households, where epidemics had occurred during the years 1988-1992. The control area of Tienphong commune, 1 km away from Tanminh, with a similar natural, social and DF/DHF situation, was selected.

Two training courses had been held for project field staff on DF/DHF vector control measures using *Mesocyclops*, community participation and field organizing skills. Knowledge, attitude and practice (KAP) studies of the community were carried out once before the implementation and another after an interval of 18 months following pre-printed questionnaires of the National Institute of Hygiene and Epidemiology (NIHE).

Community participation in eliminating discarded water containers and releasing *Mesocyclops* in other breeding sites was mobilized through monthly activities of local communication network (videos, loudspeakers, posters, affiches), home visits by health volunteers, schoolchildren and by the leadership of local authority and health staff.

Effectiveness of the methods was assessed by the results of KAP surveys, by monthly vector surveillance (using indoor resting mosquito collection by two trained persons in 30 houses and larval survey), by number of DF/DHF patients, serological surveillance, by survival and development of *Mesocyclops* population, and by community acceptance.

**Results and discussion**

*Aedes aegypti* breeding sites and training field workers

In Tanminh, as well as in other rural communes of north Viet Nam, most of the people are agriculturists. Due to lack of piped water, people collect water from wells and rainwater from rooftops and store it in tanks and jars for daily cooking and washing. Results of investigation of water containers and *Aedes aegypti* breeding sites are given in Table 1. There were six kinds of water containers in Tanminh. Breeding sites of *Aedes aegypti* concentrated in cement tanks, jars and
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discarded containers, of which cement tanks and jars accounted for 66.2%. Although 45.2% of the cement tanks had fishes, the percentage of tanks infected with *Aedes aegypti* larvae was the highest.

**Table 1.** Breeding sites of *Aedes aegypti* identified for *Mesocyclops* releases and community participation, Tanminh, 1995

<table>
<thead>
<tr>
<th>Containers</th>
<th>Infected with <em>Ae. aegypti</em> larvae</th>
<th>Having fish</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%</td>
</tr>
<tr>
<td>1 Cement tanks</td>
<td>1742</td>
<td>36.2</td>
</tr>
<tr>
<td>2 Jars</td>
<td>796</td>
<td>19.6</td>
</tr>
<tr>
<td>3 Wells</td>
<td>819</td>
<td>20.1</td>
</tr>
<tr>
<td>4 Metal tanks</td>
<td>4</td>
<td>0.1</td>
</tr>
<tr>
<td>5 Discarded containers</td>
<td>935</td>
<td>23.0</td>
</tr>
<tr>
<td>6 Aquarium</td>
<td>45</td>
<td>1.1</td>
</tr>
<tr>
<td>Total</td>
<td>4071</td>
<td></td>
</tr>
</tbody>
</table>

A total of 214 persons, including local authority leaders, health volunteers, teachers and field staff were trained on DF/DHF, its vector, larval sites and methods and measures of prevention by using biological predators *Mesocyclops* and eliminating discarded containers. A total of 321 householders were inter-viewed for their knowledge of DF/DHF and measures of prevention; 31.2% of them knew about DF/DHF and 38.9% understood that the disease was transmitted by mosquitoes.

**Activities for community education**

Community education to improve the inhabitants’ perception was conducted through local communication network, home visits by health volunteers, school activities and through community meetings. From September 1995 until April 1997, there were 30 DF/DHF videotape shows held, 383 broadcasts made on loudspeaker, 2,000 posters distributed, 40 banners drawn, and 16 health volunteers made visits to every house at least once a month, giving direct communication for 24,768 times/people, average 3.7 times per person. Fifty-eight primary school teachers were provided with information about DF/DHF, 526 pupils participated in competitions on DF/DHF and its prevention, and among them 16 won prizes and became their schools’ propagandists. The results of post-treatment interviews showed that the proportion of the householders’ understanding regarding the transmission mode of DF/DHF had increased from 38.9% to 82.2% after eight months and up to 95.3% after 18-month treatment.

**Releasing Mesocyclops and eliminating discarded containers**

There were three species of *Mesocyclops* predacious to *Aedes aegypti* larvae collected from ponds and water containers in Tanminh. These were *M. woutersi, M. ruttnemer* and *M. thermocyclopoides*. These species of *Mesocyclops* were available in the commune in water containers such as cement cisterns, wells and ponds. Health volunteers collected them from these containers and released them into other
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Containers without Mesocyclops. Up to April 1997, Mesocyclops were persisting in 1467 cement cisterns (84.21% baseline count), 274 jars (34.4%), 953 wells (116.4%), 65 aquariums and four discarded water containers. No Aedes aegypti larvae were detected in water containers having Mesocyclops. While releasing Mesocyclops, volunteers instructed householders how to maintain and to inoculate Mesocyclops. The Commune People Committee had organized a launching ceremony for the campaign. According to the reports of volunteers, in October 1996, the number of Aedes larvae-infested water containers had been reduced by 21.7 times (P < 1x10^{-7}) compared with the data of September 1995, and no infested containers were detected in April 1997 (15 months post-treatment). The relationship between the number of containers having Mesocyclops and the number of Aedes larval-infested containers showed in Figures 1 and 2 proved clearly the role of biological agent Mesocyclops in controlling Aedes aegypti larvae in the field trial.

Elimination of discarded containers, the breeding sites of Aedes aegypti, was carried out together with the release of Mesocyclops and community education, conducted by health volunteers and schoolchildren. During the first year of the project, health volunteers went to every house to detect and to persuade and instruct how to treat about 2900 discarded containers. The quantity of discarded containers in October 1996 had been reduced 5.1 times as compared with the baseline data. Pupils of 12 classes from the primary school were involved in this activity under the supervision of its principal and health volunteers. However, discarded containers were not treated fully. Breeding sites were still detected in discarded containers, in some clay pots and cisterns, but most of them were found in discarded water containers. During the second year, besides education and release of Mesocyclops, the volunteers emphasized on support to householders and pupils in detecting and managing discarded containers to eliminate all Aedes aegypti in the study area.

Vector surveillance

The results of vector surveillance showed that the Aedes aegypti population decreased significantly as compared with control and with its baseline data. Post-treatment data showed that the average density index of adult Aedes aegypti mosquito (Fig. 3) was 0.05 per house, 11.8 times (91.5%) lower than the pre-treatment phase (0.59 per house), and was 7.2 times lower than the control phase (86.1%, P = 0.00014). Similarly, the larvae House Index (Fig. 4) had declined 2.8 times (64.5%) as compared with pre-treatment and 4.5 times (77.6%, P < 1 x 10^{-5}) compared with the control. The larvae container index (Fig. 5) had been reduced 3.2 times (68.8%) and 3.6 times (72.5%) respectively as compared with the pre-treatment and the control village. These results proved that releasing Mesocyclops and eliminating discarded containers were highly effective in rural areas of Viet Nam. The networking of volunteers, primary school pupils and health staff and close direction of local authority were substantial factors appropriate for the mobilization of community participation in the realization of DF/DHF vector control in rural areas of Viet Nam.
**Figure 1.** Number of cement tanks affecting with *Ae. Aegypti* larvae and number of cement tanks having *Mesocyclops* in Tanminh, Hatay, 1995-1997

**Figure 2.** Number of jars infecting with *Ae. Aegypti* larvae and number of jars having *Mesocyclops* in Tanminh, Hatay, 1995-1997
Figure 3. Density Index of *Ae. Aegypti* in the field of community participation and using Mesocyclops in Tanminh, Hatay, 1995-1997

Figure 4. House Index of *Ae. Aegypti* in the field of using Mesocyclops and community participation in Tan minh, Hatay, 1995-1997
Serological surveillance

There was no clinical dengue case reported in both treated and control communes, but the result of the serological surveillance indicated clearly that the number of dengue-infected schoolchildren was reduced significantly in the treated commune as compared with the control commune. The first finger-bleed was taken on 15 May 1996 with a total of 200 blood samples from schoolchildren aged 11-13 years. The samples were tested with ELISA to identify recent dengue infection. Five out of 100 samples from the treated village were positive with dengue, whereas two of the 100 samples from the untreated village were found positive. The second bleed was undertaken on 16 January 1997 (at the end of dengue season) for 150 children who were negative with dengue fever from the previous examination. Results with HI test showed the difference in changing dengue antibody response between the treated and untreated communes (Table 2).

Table 2. Result of serological surveillance of dengue fever

<table>
<thead>
<tr>
<th>Name of commune</th>
<th>First bleed (ELISA test)</th>
<th>Second bleed (HI test)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of samples</td>
<td>No. of Positives</td>
</tr>
<tr>
<td>Tan minh (treated)</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>Tien Phong (untreated)</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td>7</td>
</tr>
</tbody>
</table>

Figure 5. Percentage of containers infected with *Ae. Aegypti* larvae Tanminh, Hatay, 1995-1997
Discussions and conclusions

Community-based vector control is an emerging new strategy for the prevention of dengue fever and other mosquito-borne diseases in Viet Nam.

The findings of Riviere et al. (1987)(6) showed that *M. aspericornis* survived up to 17% of the inoculated tree holes and 48% of the wells after five years of inoculation, and *Aedes* breeding had been reduced by 91-200% for at least 6-12 months and for up to five years. The result of Lardeux's experiments (1992)(7) in Tuhathera village, Tikihau atoll, yielded mixed results; five months post-inoculation, *M. aspericornis* was present in 100% of the covered wells, 3.4% and 12.5% of the covered and open rainwater tanks, and in 8.7% of the 200-litre drums. When they survived, copepods proved effective biocontrol agents of *Aedes* larvae. Similarly, in Queensland, Australia, out of the seven species evaluated in laboratory, all but *M. notius* were found to be effective predators of both *Aedes aegypti* and *Anopheles farati*, but not of *Cx. quinquefasciatus* (Kay, 1996)(6). The results in Thailand were mixed, but in the Americas there was some success. This work was carried out by Gerry Marten and Macro Suarez in the USA, Mexico, Honduras, Puerto Rico and Colombia. Of the six species of cyclopoids tested in tyres around New Orleans as control agents of *Ae. aegypti*, *Ae. albopictus* and *Ae. triseriatus*, *D. navus*, *M. longisetus* and *M. albidas* reduced the larval population by 99%. In Honduras (Marten et al. 1989)(10), *M. longisetus*, and *Macrocyclops albidas* survived well in outdoor concrete tanks, 200-litre drums, tyres and vases with live plants during the 20-30-week test period and gave excellent control of *Ae. aegypti*. As found with other community-based projects in Puerto Rico, Anguila and Brazil, householders readily accept cyclopods and often are willing to take extra precautions to ensure that these biological control agents are not discarded when cleaning the containers (Marten et al. 1994)(9). In Viet Nam, use of *Mesocyclops* and community participation for dengue vector control were tested with a great amount of success in the field. In a village-scale trial, *Mesocyclops* was introduced into wells, large cement tanks, ceramic jars and other domestic containers that served as *Aedes aegypti* breeding sites in Phanboi village (400 houses), Haihung province, in February 1993. The use of *Mesocyclops* was complemented by community participation that eliminated unused and discarded containers that collected rainwater that could not be treated effectively with *Mesocyclops*. *Ae. aegypti* disappeared from the treated village in August 1994 and has not reappeared so far. Extended field trials now carried out in Tauminh commune further support the effectiveness of the measure and its cost-effectiveness. This method is low-cost as *Mesocyclops* are available locally, have a high predacious capacity, are easy to be inoculated and released, and can survive for a long time. *Mesocyclops* are especially appropriate for large containers like cement cisterns, wells, steel tanks and clay pots (of big size). Discarded containers, mostly of small size which infrequently contain little water, are not appropriate for *Mesocyclops*; therefore, the solution is to eliminate them. In combination with the community recycling it, *Mesocyclops* is an
easy and inexpensive method of *Ae. aegypti* control that should be effective for many communities in Viet Nam and elsewhere.

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**References**


6. Riviere F, Kay BH, Klein JM and Sechan Y. *Mesocyclops aspericornis* (copepoda) and *Bacillus thuringiensis* var. israelensis for the biological control of *Aedes* and *Culex* vectors (Diptera: Culicidae) breeding in crab holes, tree holes and artificial containers. J. Med. Entomol., 1987, 24:425-430.


