CONTROL OF DENGUE FEVER WITH ACTIVE SURVEILLANCE AND THE USE OF INSECTICIDAL AEROSOL CANS

Ken Osaka[1], Do Quang Ha[2], Yoichi Sakakihara[3], Ha Ba Khiem[2] and Takusei Umenai[3]

[1]Infectious Disease Surveillance Center, National Institute of Infectious Diseases, Tokyo, Japan; [2] Pasteur Institute-Ho Chi Minh City, Vietnam; [3]Department of Health Policy and Planning, the University of Tokyo, Japan

Abstract. An interventional study was conducted in southern Vietnam to evaluate the feasibility and effectiveness of a new approach to control dengue fever. The approach consisted of active surveillance of dengue patients and the use of insecticidal aerosol cans. Febrile patients were tested serologically at local health centers and insecticidal aerosol cans were given to the family and employed in the neighborhood of dengue patients instead of ultra low volume (ULV) fogging with insecticide. The number of dengue IgM antibody positive cases among febrile patients, the number of reported dengue hemorrhagic fever patients and the total cost were compared in the 2 approaches (prompt focal ULV fogging and the use of insecticidal aerosol cans) in 1997.

The aerosol cans were employed 5 times (in June, July, August, September and October) in the study area. ULV fogging in the control area was performed 5 times (in March, May, July, August and September). Twenty-two serologically positive cases were found in the study area which was about half that found in the control area (43 cases). A total of 16 dengue hemorrhagic fever patients was reported in the study area and 43 in the control area. Compared with the reported numbers of the previous year, the reduction rate in the number of dengue hemorrhagic fever cases was 71.4% in the study area and 51.7% in the control area. There were statistically significant differences in the morbidity of dengue fever and the reduction rate of dengue hemorrhagic fever. The cost of the insecticidal aerosol cans was US$393 which was lower than the cost of US$553 for ULV fogging. The findings suggest that insecticidal aerosol cans were effective and feasible for dengue fever control.

INTRODUCTION

Dengue fever and its severe form dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS) are prevalent in over 100 countries and threaten the health of more than 2.5 billion people living in tropical and subtropical regions (WHO, 1997). Controlling dengue fever and the vector mosquito are urgent health problems in these areas.

In dengue control, early case detection in sentinel health facilities, early warning systems and prompt countermeasures for vector control have been considered essential (WHO, 1997). Concerning the early detection, a number of commercial serological test kits for anti-dengue IgM and IgG antibodies are available (Lam *et al*, 1998). These test kits should be widely introduced in the near future. In contrast to the progress in detection of dengue fever, little progress has been reported in countermeasures for controlling dengue fever. Methods to reduce sources of larval growth were introduced, for instance, putting away old tires and covering the tops of water jars. The Breteau index, house (premise) index and container (receptacle) index have been used as indicators to evaluate the number of larvae and sources of mosquitos. However a reduction of these indicators does not always reflect the reduction of dengue fever (Goh, 1997). Environmental control or large-scale source reductions such as destroying ponds or puddles were carried out in Cuba in the 1980's (Jose and Rafael, 1986). This approach was reported to be very effective if large amounts of money and human resources are available. However, the re-emergence of dengue fever in Cuba was reported recently (Kouri *et al*, 1998). Biological agents such as larval fish (Wu *et al*, 1987) and *Toxorhynchites* spp. (Annis *et al*, 1990) have been used to control mosquito larvae. Education targeting local people and school children has also been found to be important to reduce the sources of larval growth. (Swaddiwudhipong *et al*, 1992). However, these approaches could not be adopted in all endemic areas.

One of the other general approaches to control dengue is killing adult mosquitos in dengue endemic areas. The most widely used method is insecticidal fogging as well as mosquito coils (sticks). How-

Correspondence: Ken Osaka, Infectious Disease Surveillance Center, National Institute of Infectious Diseases, Toyama 1-23-1, Shinjuku-ku, Tokyo 162-8640, Japan.
Tel: 81-3-5285-1111(ext2539); Fax: 81-3-5285-1129; E-mail:kosaka@nih.go.jp

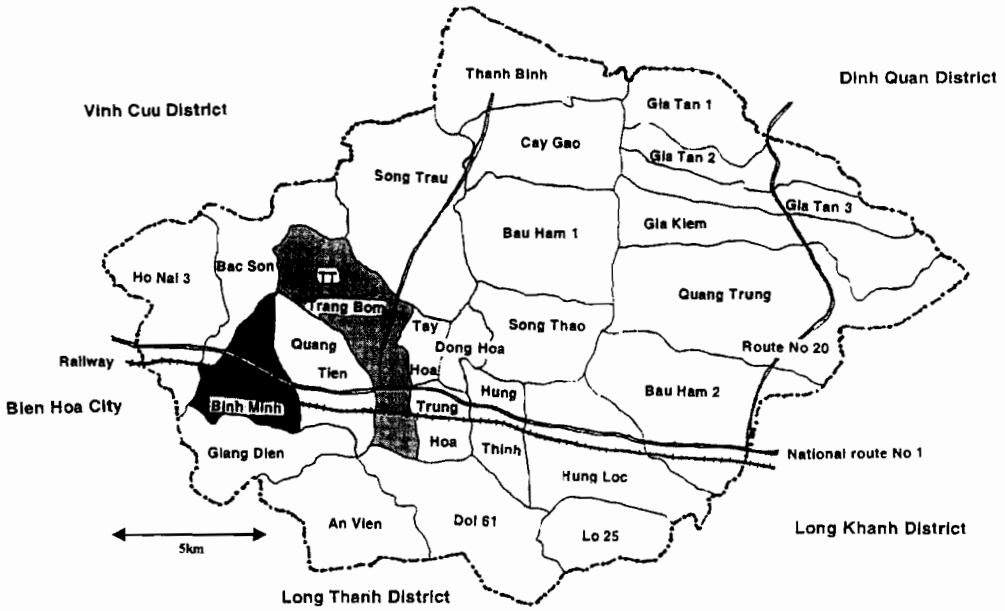

Fig 1–Map of study areas.

ever, it was not always effective because of a delay or the gap between the peak of outbreaks and the start of insecticide fogging. A newly developed Olyset Net screen which is a wide mesh net made of polyethylene thread impregnated with permethrin has very good short-term effect on vector reduction (Nguyen *et al*, 1996). It can be widely introduced if the price of nets decreases. We implemented a combination approach of early active serological case detection and focal insecticide spraying in a 50-100 m radius around houses of dengue patients. However, a study on the ecology of the mosquito revealed that *Aedes aegypti* can fly more than 100 m (Reiter *et al*, 1995).

The protective measures of individuals as well as systemic approaches are essential for the prevention of dengue fever. WHO recommended the use of personal protective measures such as the use of household aerosol insecticides and source reduction efforts at home and in neighborhoods (WHO, 1997). In the present study, we evaluated the effectiveness and feasibility of the personal use of insecticidal aerosol cans as the countermeasures to reduce the incidence of dengue fever.

MATERIALS AND METHODS

Study areas and periods

This study was conducted at Binh Minh commune (study area) and Trang Bom commune (control area) of Thong Nhat district, Dong Nai Province located about 50km from Ho Chi Minh City (Fig 1). To cover the entire rainy season which usually starts in June and ends in November, the study was conducted between February 1997 and December 1997.

Detection of suspected dengue fever cases

Patients with dengue fever were treated at commune health centers or district hospitals. Working staff, including physicians, assistant-physicians, nurses, midwives, Red Cross workers and private physicians in commune health centers and district hospitals were requested to assess febrile illness among children. Cases of fever over 38°C for more than 2 days underwent blood tests for dengue in the 2 communes. The samples were sent to the laboratory center for preventive medicine in the province. The blood samples were processed for dengue specific IgM antibodies. Sera were tested by IgM capture ELISA (MAC-ELISA) using 4 kinds of DEN antigens (DEN-1, 2, 3, 4).

Countermeasures

Prompt vector control was carried out when dengue IgM antibody was confirmed among febrile cases or when a DHF patient was reported. Insecticidal aerosol cans (Dainihon Jochugiku Co Ltd) were provided and local people used them inside and outside of the patients' houses and neighboring houses in the study area within a diameter of 25 m,

usually consisting of 8 neighboring houses. This insecticidal aerosol can contained 0.05% w/v Phthalthrin, 0.20% w/v Fenitrothion and 0.50% w/v Dichlovos. On the other hand, ultra low volume fountain machine was used in the control area for fogging insecticide (K-Othrine) inside and outside the patients' houses within a 100-meter diameter. This fogging was conducted by the team which was sent from the preventive medicine center in central province.

Interview

People in the 2 areas were interviewed for the practices of personal countermeasures for preventing mosquito bite in November 1997.

Evaluation of the results

Evaluation of the results was based on comparisons of the morbidity of serologically confirmed dengue fever cases in the 2 areas and the morbidity of reported DHF cases graded as third and fourth by WHO criteria. The total costs of the 2 countermeasures (the provision of insecticidal aerosol cans and the ULV fogging) were also calculated. The practices of personal countermeasures for preventing mosquito bite were also compared.

For statistical analysis, chi-square test was carried out using Epi-info software ver 6.03.

Table 1
Demography of 2 communes in 1997.

Commune	Population	Household
Study area	13,550	2,408
Control area	11,274	2,342

RESULTS

The demographic situations of the 2 areas are shown in Table 1. The 2 areas were similar with respect to the population and number of households. The comparison of the number of blood samples collected from febrile cases and results of serological tests are shown in Table 2. The provisions of insecticidal aerosol cans were done 5 times (in June, July, August, September and October) in the study area. The ULV fogging applications of insecticide were carried out 5 times (in March, May, July, August and September) in the control area. Blood samples were collected, 396 in the study area and 758 in the control area. The number of IgM positive cases was 22 in the study area and 43 in the control area. There was a statistically significant difference in the morbidity of serological confirmed dengue fever ($p = 0.0008$). The peak month for the number of IgM positive patients and positive rate was August in the study area (17 positive cases among 110 febrile patients and positive rate:15.5%) and July in the control area (21 positive cases among 137 febrile patients and positive rate:15.3%). No case was positive in June in the study area (Table 3).

Table 2
Blood collected from febrile patients with its MAC-ELISA results and the insecticidal treatments.

1997 Month	Study area	Control area
	positive cases/febrile patients (positive rate %)	
March	0/2	1/9 (11.1%)
April	0/14	0/9
May	0/55	5/141 (3.5%)
June	3/35 (8.6%)	1/123 (0.8%)
July	0/52	21/137 (15.3%)
August	17/110 (15.5%)	8/138 (5.8%)
September	1/25 (4%)	3/66 (4.5%)
October	1/86 (1.2%)	2/72 (2.8%)
November	0/17	0/30
December	0	2/33 (6%)
Total	22/396	43/758
Morbidity of dengue fever	$162/10^5$*	$381/10^5$*

–underline indicates the time of insecticide treatments or provision of insecticidal aerosol cans.

* significant difference in morbidity of dengue fever by χ^2 test ($p = 0.0008<0.001$)

Table 3
Number of DHF cases reported by month in 2 study communes, 1997.

Commune	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Study area	2	1	0	0	1	0	2	5	1	2	1	1	16
Control area	3	0	1	0	1	7	7	8	6	4	3	3	43

Table 4
Comparison of morbidity of DHF in 2 study areas in 1996 and 1997.

	1996 annual cases (morbidity)	1997 annual cases (morbidity)	reduction rate
Study area	56 cases ($413/10^5$)	16 cases ($118/10^5$)	71.4%*
Control area	89 cases ($789/10^5$)	43 cases ($381/10^5$)	51.7%*

*significant differences by χ^2 test. ($p=0.239<0.5$)

The reported numbers of DHF patients in the 2 communes are shown in Table 3 and Table 4. Sixteen patients were reported in the study area and 43 patients in the control area. In comparison with the previous year, the reduction rate was 71.4% (56- > 16 cases) in the study area and 51.7% (89 ->43 cases) in the control area. There was a statistically significant difference in the reduction rate ($p = 0.239<0.5$).

The total cost of the 2 countermeasures is shown in Table 5. The provision of insecticidal aerosol cans cost 5,100,000 Vietnamese Dong (equivalent to 393 US dollars) and the cost of ULV fogging was 7,180,000 Vietnamese Dong (equivalent to 553 US dollars).

The practices of personal countermeasures in the 2 communes are shown in Table 6. Thirty-seven percent of responders used insecticidal aerosol cans in the study area, but this included the aerosol cans which were provided in this research. In the control area only small number of people (15%) used insecticidal arerosol cans which they bought by themselves and majority used mosquito sticks and 12.8% did nothing for preventing mosquito bite.

DISCUSSION

The total numbers of reported DHF and serologically confirmed dengue fever cases were smaller in the study area. The peak of dengue IgM antibody positive number and rate in the control area occurred 1 month earlier than the peak in the study area. In the neighboring commune, Bac Son, which is adjacent to the study area and the control area, 64 cases of dengue hemorrhagic fever were detected, though ULV fogging was carried out. Reiter *et al* (1995) suggested that source reduction (elimination of the breeding site) might enhance dissemination of virus-infected mosquitos by reducing the number of available oviposition sites. It was speculated that dengue outbreaks transmitted from the control area or neighboring commune into the study area. Therefore, it is difficult to evaluate the exact effectiveness of the approach unless it is introduced in an expanded area. However, the comparison of numbers of both sero-postive cases and DHF patients, reduction rate of DHF cases and the cost suggested that this approach was at least equally effective and less expensive than ULV fogging. The budget for urgent countermeasures for the dengue epidemic and the human resources necessary for implementing ULV fogging could be reduced.

In the control area, only a small number of individuals (15%) used insecticidal aerosol cans and the majority (57%) used only mosquito sticks to prevent mosquito biting. The advantages of using insecticidal aerosol cans are considered to be as follows:1) Timing: local people do not have to wait for a team for implement ULV fogging which usually comes from the provincial center of preventive medicine, 2) community participation: individual protection might enhance the community participation which is important for long-term preventive measures, 3) easiness: aerosol cans can be used very easily inside and outside the house.

This approach should be studied further in expanded areas for longer periods and it will better to be combined with simple serological tests that can

Table 5
Materials used and cost of controlling dengue fever in the 2 communes, 1997.

Materials used	Study area	Control area
Mosquito stick bundles	500	400
Insectcidal aerosol cans	180	
K-Othrine for ULV		12 liters + 228 liters of petroleum + 120 liters of gasoline
Cost	5,100,000 dong (US$393)	7,180,800 dong (US$553)

Table 6
Practice of personal countermeasures for preventing mosquito bite.

	Study area	Control area
Responders/interviewed	1,106/1,972	1,435/1,832
Used aerosol cans	409*(37.0%)	213 (14.8%)
Used mosquito sticks	321 (29.0%)	817 (56.9%)
Did nothing	184 (16.6%)	183 (12.8%)
Others and unknown	192 (17.0%)	222 (15.5%)

*included the aerosol cans provided in this study.

be easily performed in peripheral areas. The use of insecticidal aerosol cans will become more popular instead of ULV fogging in areas where few people use the aerosol cans.

ACKNOWLEDGEMENTS

We would like to thank Dainihon Jochugiku Co Ltd for providing the insecticidal aerosol cans.

REFERENCES

Annis B, Nalim S, Hadisuwasono, Widiarti, Boewono DT. *Toxorhynchites amboinensis* larvae released in domestic containers fail to control dengue vectors in a rural village in central Java. *J Am Mosq Control Assoc* 1990; 6: 75-8.

Goh KT. Dengue-a re-emerging infectious disease in Singapore. *Ann Acad Med Singapore* 1997; 26: 5 664-70.

Hoang Thuy Nguyen, Tran Van Tien, Truong Uyen Ninh, Nguyen Thuy Hoa. The effect of Olyset net screen to control the vector of dengue fever in Viet Nam. *Dengue Bull* 1996; 20: 87-92.

Kourí G, Guzmán MG, Valdes L, *et al.* Reemergence of dengue in Cuba: a 1997 epidemic in Santiago de Cuba. *Emerg Infect Dis* 1998; 4: 189-92.

Jose AG, Rafael FG. Application of environmental management principles in the program for eradication of *Aedes aegypti* in the Republic of Cuba, 1994. *PAHO bull* 1996; 20: 186-93.

Lam SK, Devine PL. Evaluation of capture ELISA and rapid immunochromatographic test for the determination of IgM and IgG antibodies produced during dengue infection. *Clin Diagn Virol* 1998; 10: 75-81.

Reiter P, Amador MA, Anderson RA, Clark GG. Short report: dispersal of *Aedes aegypti* in an urban area after blood feeding as demonstrated by rubidium-marked eggs. *Am J Trop Med Hyg* 1995; 52: 177-9.

Swaddiwudhipong W, Chaovakiratipong C, Nguntra P, Koonchote S, Khumklam P, Lerdlukanavonge P. Effect of health education on community participation in control of dengue haemorrhagic fever in an urban area of Thailand. *Southeast Asian J Trop Med Public Health* 1992; 23: 200-6.

WHO. Dengue Haemorrhagic Fever Diagnosis, Treatment, Prevention and Control, 2nd ed. 1997.

Wu N, Wang SS, Han GX, Xu RM, Tang GK, Qian C. Control of *Aedes aegypti* larvae in household water containers by Chinese cat fish. *Bull WHO* 1987; 65: 503-6.