A COMPARISON OF DENGUE HEMORRHAGIC FEVER CONTROL INTERVENTIONS IN NORTHEASTERN THAILAND

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Abstract. This study compared the effectiveness of the currently available interventions of dengue vector and dengue hemorrhagic fever (DHF) control used in northeastern Thailand, an area with a high incidence of the disease. Also, the basic knowledge of dengue vector and DHF control of a group of 568 participants from local communities was measured. These communities were divided into two groups that had no reported cases in the previous year (non-DHF) and a group that had reported cases (DHF). Three current interventions of dengue vector and DHF control were assessed: insecticide fogging, 1% w/w temephos sand granules, and a combination of these two. Assessment included numbers of DHF cases, vector indices [house index (HI), container index (CI), and Breteau index (BI)], and cost. A multiple choice questionnaire was used to measure participants' basic knowledge desirable for knowledge retention. Data was statistically analyzed by the use of means, standard deviations, percentages, ANOVA repeated measure, and logistic regression. The results showed 1% w/w temephos sand granules as the most effective intervention of dengue vector and DHF control and there was a statistically significant difference between the control measures ($p = 0.001$). Most participants had either a very low or very high level of knowledge and basic knowledge was statistically significantly associated with vector index (BI) ($p = 0.008$). Participants stated that they mainly gained knowledge about dengue vector and DHF control from public health workers followed by television and public media. Overall, the findings of this study illustrated the importance of public health workers and communities in health issues at the local level and the need to assess the benefits of current interventions and combinations of current and new interventions of dengue vector and control.

INTRODUCTION

Dengue hemorrhagic fever (DHF) has been one of the world's major health problems in the last 40 years (Thawara, 2001). In Thailand, the annual reported cases of DHF fluctuate from 20,000 cases to more than 100,000 cases but the fatality rate has recently decreased significantly (Bureau of Epidemiology, 1997). The increase in people, especially in rural areas, climate change, improvements in transport allowing people to be more mobile, and a growing multicultural population are believed to be factors in the high national incidence of DHF (Nimmanitya, 2002). The density of mosquito vectors, particularly *Aedes aegypti*, plays a significant role in outbreaks and Wathanasri (1996) identified four important epidemiological factors, the agent (vector), the

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host, the environment, and the economics. Several indices are currently used to monitor *Aedes aegypti* population for dengue virus transmission including house index (HI), container index (CI), and Breteau index (BI) and these indices demonstrate the presence or absence of the vector and could also indicate the severity of infection (Sangtharathip, 2002).

Standard dengue vector surveillance in Thailand is based on the implementation of three interventions: environmental control, physical protection, and vector control before, during, and after outbreaks. Physical, chemical, and biological methods are used for environmental control. The most common of these is chemical via insecticides such as 1% w/w temephos sand granules. However, some research has shown this not to be popular due to its effect on the taste of fresh water (Utha, 2000; Thavara, 2004). A more convenient chemical control method is insecticide fogging, pyrethroid ULV space fog. Other studies evaluating individual interventions of dengue vector and DHF control have been completed but many had limitations and there was no comparison of the effectiveness of the different interventions (Anonymous, 1972; Phanthumachinda *et al*, 1980; Reiter and Gubler, 1997; Bang and Pant, 2000). As a result of this restricted research situation, the authors aimed to evaluate the effectiveness of the currently available interventions of dengue vector and DHF control in Thailand and assess the basic knowledge of the local population about the use of different interventions.

The northeastern region of Thailand has a high incidence of DHF, 56.9% of patients with fever of unknown origin being reported with dengue vectors (Srijakrawanwong *et al*, 1993; Sathimai *et al*, 1998). For example, at the national level, the province of Ubon Ratchathani was ranked fourth in incidence of DHF (172.20 cases per 100,000 population) (Bureau of Epidemiology, 2003). The objectives of this study were to compare the effectiveness of currently available interventions of dengue vector and DHF control in northeastern Thailand, and to measure the basic knowledge of the local population about the use of different interventions of dengue vector and DHF control.

MATERIALS AND METHODS

Population/sampling

The study site was located in Kantharalak District, Si Sa Ket, a province next to Ubon Ratchathani, and an area with a high incidence of DHF in the last three years. Six sub-districts were selected for the study via a purposive sampling, 3 in non-DHF groups (no DHF cases reported during January to December 2006) and 3 in DHF groups (at least 1 case reported in that period). Five hundred and sixty-eight people one from one household were randomly selected into the study via the sampling methods (Lwanga and Lemeshow, 1991).

Process of evaluation

The study took place over 7 months from March to September 2007. The following larvicidal interventions were tested: A) pyrethroid ULV space thermal fogging containing Ald-allethrin and d-phenothrin, both at 5.0% w/w was applied in- and outside the house every month at a dosage of 1.0 liter/ha; B) 1% w/w (0.05 mg/l AI) temephos sand granules in containers (water jars, tires, cement tanks, guard jars) every month: and C) a mixture of A and B every month. All these interventions were conducted by local public health staff from each area (Fig 1).

The assessments of the effectiveness of the various treatments included three factors: (i) the numbers of DHF cases confirmed by clinical symptoms (high fever, rash, headache, hepatomegaly, and shock) and laboratory values (Hct >20%), platelet (<100,000 cells/mm^3)] (Bhamarapravati, 1993; Kalayanarooj, 1997;

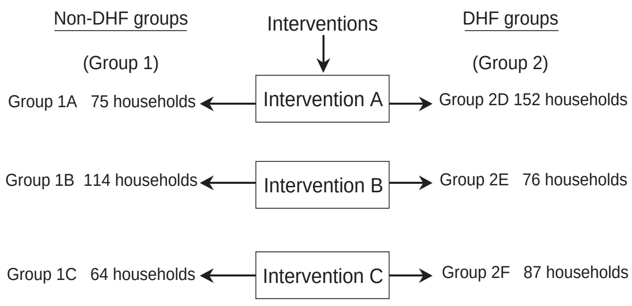

Fig 1–Larvicidal interventions.

Leangpibul and Thongcharoen, 1993), (ii) the dengue vector indices HI, CI, and BI, and (iii) the costs of the implementation of the treatments. The data were collected via a survey form and research volunteers assessed the basic knowledge of the local population regarding dengue vector and DHF control by the administration of a multiple choice questionnaire (MCQ) (Romoska *et al*, 1981).

Statistical analysis

Data were analyzed by descriptive statistics including frequencies, means, SD, percentages. The comparisons of BI values of different interventions in both non-DHF and DHF groups were analyzed using ANOVA repeated measure and logistic regression analysis.

RESULTS

The results of surveying 568 households over 7 months showed that there were 4 DHF cases reported among 3,714 population (Table 1).

It was found that the cost of treatment B (1% w/w temephos sand granules every month) was cheaper than the use of insecticide fogging (treatment A) and the combination treatment (C) (Table 2).

The results showed that the BI values of treatment B (1% w/w temephos) continually decreased over the 7 months period compared to other treatments. It also showed that there was a statistically significant difference among three treatments (ANOVA test; $p = 0.001$) (Fig 2).

Comparisons of the means of BI values with different treatments within non-DHF groups showed treatment B (1% w/w temephos) obviously decreased BI values more efficiently than other treatments. It also showed that there was a statistically significant difference among these three treatments (ANOVA test; $p=0.001$). Similar results were also obtained in DHF groups (ANOVA test; $p=0.001$) (Figs 2 and 3).

In relation to the effectiveness of each treatment within groups in terms of the vector

Table 1
Sample data by intervention and household (n = 568).

Intervention	Group	No. of households	No. of population	DHF cases in 2007
A	1A	75	520	1
	2D	152	1,112	3
B	1B	114	625	0
	2E	76	487	0
C	1C	64	516	0
	2F	87	554	0

Group 1 is non-DHF group; Group 2 is DHF group

Table 2
Means and standard deviations of dengue vector index, DHF cases, and costs of different interventions (*n* = 568).

Interventions	Groups	Mean ± SD				
		HI (%)	CI (%)	BI (%)	DHF cases (per 100,000 population)	Cost (baht/house/time)
A	1A	72.7 ± 6.8	42.4 ± 9.5	215.8 ± 56.9	0.2± 0.4	21.4
	2D	66.7 ± 10.1	26.7 ± 9.3	182.7 ± 52.7	0.5± 0.6	21.3
B	1B	38.0 ± 26.8	18.9 ± 16.9	107.3 ± 106.0	0	16.3
	2E	39.1 ± 21.8	15.3 ± 11.4	87.4 ± 62.5	0	16.6
C	1C	47.3 ± 9.9	19.0 ± 6.0	94.6 ± 27.8	0	38.0
	2F	47.3 ± 7.8	17.6 ± 6.5	100.5 ± 44.9	0	35.0

Table 3
The relationship between interventions and BI values by logistic regression analysis.

Variables	β Unstandardized coefficients	β Standardized coefficients	*t*	p-value[a]
1. Comparison of each intervention				
Intervention A				
Constant value	119.76			
BI (average)	101.49	0.111	1.65	0.012
Intervention B				
Constant value	89.45			
BI (average)	11.72	0.027	3.48	0.001
Intervention C				
Constant value	87.45			
BI (average)	16.33	0.045	0.55	0.001
2. Comparison between interventions A and B and C				
Constant value	0.705			
BI (average)	1.539	0.095	2.64	0.008

[a]Logistic regression analysis was implemented ($p<0.05$)

index (BI), the results indicated no statistically significant differences between groups 1 and 2 ($p \geq 0.05$); treatment 1A *vs* 2D: p= 0.54; treatment 1B *vs* 2E: p = 0.67; treatment 1C *vs* 2F: p = 0.57).

The results showed that most of the participants still had a low level of basic knowledge regarding DHF prevention and control (64.4%). Most of participants completed primary school level and had an average age between 31 and 40 years (66.2%, and 42.5%, respectively). They stated that they gained most basic knowledge about DHF prevention and control from public health workers, followed

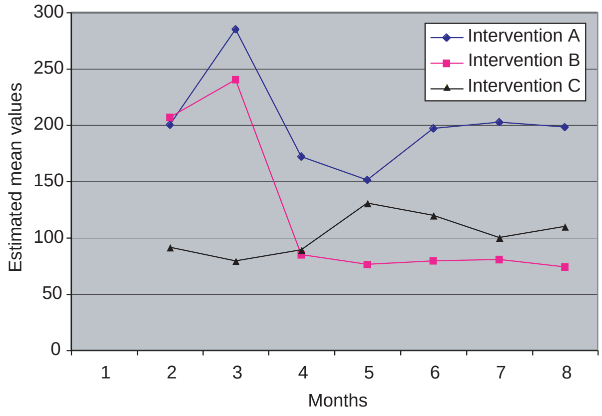

Fig 2–The comparison of Breteaux Index (BI) values of different treatments (*n*=568).

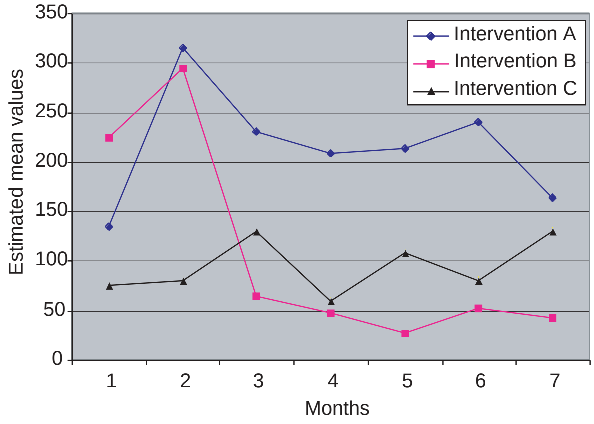

Fig 3–The comparison of Breteaux Index (BI) values in different treatments within non-DHF groups (*n*=253).

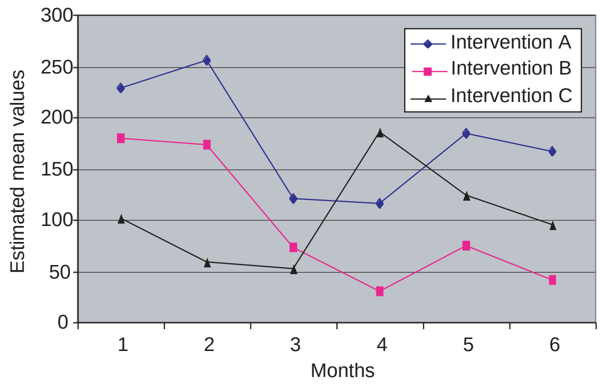

Fig 4–The comparison of Breteaus (BI) values in different interventions within DHF goups (n=315).

by television, and printed media from the government such as posters, brochures, and handouts (*n* = 669, 564, and 463, respectively). The findings indicated a statistically significant relationship between basic knowledge and index vector (BI) among different treatments (p=0.008). This illustrated that the level of basic knowledge is positively related to a decrease of BI values regardless of the interventions. However, there was no statistically significant relationship between non-DHF and DHF groups in the use of each treatment (Table 3).

DISCUSSION

The findings indicated that treatment B [1% w/w (0.05 mg/l AI) temephos sand granules every month] was the best option for dengue vector and DHF control due to its low cost and an index vector (BI) decrease (Table 2 and Fig 1). Similarly, comparison of BI values and different treatments in both non-DHF and DHF groups found that 1% w/w (0.05 mg/l AI) temephos was also more effective for DHF control compared to treatment C (combination) and treatment A (pyrethroid ULV space fogging) (Figs 2 and 3). Some previous studies supported the similar benefits of 1% w/w temephos sand granules (treatment B) in DHF prevention and control (Romoska *et al*, 1981; Thavara *et al*, 2004). Noticeably, the original plan of using 1% w/w temephos in both treatment B and C was the public health workers stopped by at the local houses and put sand granules in the containers. It was well conducted for treatment B. However, we were informed there was a limited number of workers in treatment C groups, as they had to conduct two treatments at the same time. Instead, we asked local people to get the sand granules from the worker's house and use them at homes. Thus, it might be possible that some local people of treatment C did not put the sand granules in the containers, because health workers used to do it for them. Consequently, a DHF control index (BI values) was less effective comparing to treatment B. Another possible explanation of the superior effectiveness of treatment B compared to treatments C and A is the limitations of the insecticide fogging including: low product quality of insecticidal action, inappropriate method of fogging, and frequency of action (Chansaeng, 1993). Moreover, one of the findings of this study was that most participants had a low level of knowledge of DHF prevention. It is suggested that these factors may lead to poor DHF controls. Additionally, the findings illustrated in table 3 indicated the positive relationship between basic knowledge and a decrease of BI values regardless of the intervention treatments, suggesting that an increase in the knowledge of the local population and community can improve DHF prevention and control. Government concerns about this situation have recently been expressed and, as a result, financial assistance has been provided to the Department of Disease Control and local communities to control the disease by the enhancement of basic knowledge and skills. Despite these efforts results show that indices are still high indicating the need for further study. Besides, due to a small number of DHF cases identified (Table 1), it was difficult to evaluate vector control treatments of dengue transmission or to draw definite conclusions, thus adding to the need for further study.

Regarding the evaluation of the effectiveness of each treatment within non-DHF and DHF groups, the results showed no statistically significant difference of BI values between non-DHF and DHF groups for each treatment. This may explain that the susceptibility of the host population in different areas plays an important role in DHF spread and control.

It appeared that public health workers were the key personnel to deliver basic knowledge about DHF to village populations, indicating that the government must supervise and utilize these personnel in dengue vector and DHF control activities. Other methods of enhancing people's knowledge of health issues also need to be investigated to improve the effectiveness of dengue vector and DHF control. Currently, there are a number of new treatments to control *Aedes aegypti*, for example, the new chitin synthesis inhibitor called "novaluron" that acts as a long-term deterrent of the mosquito in water-storage containers and causes little contamination (Mulla *et al*, 2003). Also, there has been a new formulation of zeolite granular of 1% w/w temephos that has a similar larvacidal effect on dengue larvae as the traditional 1% w/w temephos sand granules but without its odor and turbidity (Mulla *et al*, 2004). Other studies have also indicated the benefits of new solutions of dengue vector and DHF control (Phan-Urai *et al*, 1995; Lerdthusnee *et al*, 1996; Thavara *et al*, 2004). Further studies are required to compare the effectiveness of dengue vector and DHF control of established and new methods.

Overall, the integration of a number of different treatments is probably the most effective, economical, and safe way to maintain vector populations at acceptable levels. The use of these treatments must be combined with health education and public health communication conducted by local health care workers, such as health personnel training school teachers and other community members to be aware of DHF management and to implement programs to reduce the number of *Aedes aegypti* breeding habitats. The recognition of the local population regarding the importance of the cooperation also needs to be addressed.

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