

# COST-EFFECTIVENESS ANALYSIS OF LAMBDCYHALOTHRIN-TREATED NETS FOR MALARIA CONTROL : THE PATIENTS' PERSPECTIVE

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**Abstract.** The present study was undertaken to evaluate the cost-effectiveness of lambda-cyhalothrin-treated nets in comparison with conventional DDT-spraying as a method of malaria control according to the patients' perspective among migrant populations in a high-risk area along the Thai-Myanmar border in Thailand. Ten hamlets comprising 243 houses with 948 inhabitants were given only treated nets. Twelve hamlets comprising 294 houses and 1,315 inhabitants represented the DDT-treated area and another six hamlets with 171 houses and 695 inhabitants served as controls. Information as to consumer costs was obtained by interviewing 3,214 patients seeking care at all levels of the health care system in the study area. Analysis showed that the impregnated-net program was more cost-effective than the DDT-spraying program or surveillance alone (US\$ 0.59 vs US\$ 0.74 vs US\$ 0.79 per 1 case of prevented malaria). We conclude that in a high-risk area such as along the Thai-Myanmar border in western Thailand, integrating the use of impregnated nets with large-scale primary health care programs is likely to constitute the most cost-effective method for controlling malaria according to the patients' perspective.

## INTRODUCTION

Malaria has been recorded as a primary cause of death in Thailand since 1912 with a mortality rate of 286/100,000 population in 1947 (Malaria Division, 1968). Although malaria incidence has been reduced, it is still considered one of the major public health problems in the country, especially among the high-risk groups of migrant populations along international borders (Malaria Division, 1997). Migration has become important for the indigenous populations of forested areas as well as for those who are seeking new land for cultivation. Most of these people are poor and uneducated.

The control of malaria vectors by residual DDT indoor spraying has encountered serious setbacks for various reasons. Locally appropriate malaria control must be developed, with a higher emphasis on innovative cost-effective control measures for use by communities as part of a primary health care strategy. Among the available control measures,

vector control using impregnated nets has increasingly attracted attention (WHO, 1989; Rozendaal, 1989; Bermejo and Veecken, 1992; Curtis, 1992). It is simple to apply throughout the frontier area because the inhabitants can perform the treatment under the direction of local health workers and can take the treated nets with them into the forest. It is feasible and acceptable in Thailand, since nets are already available and widely used in most of its malaria areas (Kamolratanakul and Prasittisuk, 1992; Kamolratanakul *et al*, 1993a; Aramrattana, 1993; Luxemburger *et al*, 1994)

The present study was undertaken to evaluate the cost-effectiveness of lambda-cyhalothrin-treated nets in comparison with conventional DDT-spraying as a method of malaria control according to the patients' perspective among migrant populations in a high-risk area along the Thai-Myanmar border in western Thailand.

## MATERIALS AND METHODS

The details of this study have been described elsewhere (Kamolratanakul *et al*, 1999). In brief, the study was conducted according to a quasi-experimental design at six villages in two sub-dis-

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tracts of the Mae Ramard district, Tak Province, between February 1994 and January 1995. The study site is located at the western border of Thailand with Myanmar, in the forest fringing several small valleys and hills. It represents a government conserved forest area inhabited by Karen hill tribes. The area consists of houses and huts, scattered in the form of hamlets, some 2-5 km apart. The criteria for site selection were chosen on the basis of high endemicity of malaria (annual parasite incidence > 200/1,000 population), similarity of malaria vectors, ecology, topography and terrain of each hamlet.

Twenty-eight hamlets of similar malaria incidence were divided into 3 groups. Ten hamlets of 243 houses with 948 inhabitants were given only lambda-dacyhalothrin-treated nets. Twelve hamlets of 294 houses and 1,315 inhabitants were designated as the DDT-treated area and another six hamlets with 171 houses and 695 inhabitants constituted the controls.

Baseline epidemiologic, social and entomologic parameters were collected. Informed consent was obtained from all subjects. At the net area, the community was prepared by encouraging the villagers to wash their own nets and allow them to dry properly for 1-2 days before impregnation with lambda-dacyhalothrin in the form of an emulsifiable concentration containing 2.5% active ingredient. The method of impregnation reported by Shreck and Self (1985) was applied. DDT spraying was carried out indoors as a residual spray cover in the 12 hamlets with 2 g a.i./m<sup>2</sup>. The spraying operations were implemented similarly to the normal practice of malaria control. Malaria surveillance in terms of passive case detection (PCD) was carried out in the control area, by using health care facilities at all levels of the health care system (provincial hospital, district hospital, 5 local health centers, malaria sector and 3 malaria clinics) in the study area.

The number of subjects in the study area who could be protected from contracting malaria was used as an indicator to evaluate the program's effectiveness. Due to the unequal population number in the three study groups, we had to calculate the expected number of subjects with malaria by adjusting the number of subjects received from observations for the standard population (number of subjects in the DDT spraying group).

Consumer costs can be classified as direct medical costs usually charged by the health care facilities, direct non-medical costs (*ie* transportation and food) and indirect costs (time absent from work)

(Kamolratanakul *et al*, 1993b). Data were obtained by interviewing 3,214 patients seeking care at all levels of the health care system in the study area. A semi-structured questionnaire had been revised by a group of experts and was pretested with the inhabitants annexed to the area before being used in the main study.

Cost-effectiveness analysis (CEA) was calculated by comparing the cost of each program required to achieve a common outcome (effectiveness) which is the cost of each program divided by its effectiveness (Drummond *et al*, 1987). Therefore, the result that we obtained is the cost per 1 case of malaria prevented.

For statistical evaluation of effectiveness, the level of significance was calculated by the chi-square test.

## RESULTS

### The effectiveness of impregnated nets and DDT spraying

Among the 1,034 individuals who used impregnated nets, 61 persons got malaria compared with 68 persons in the DDT-spraying group and 97 persons in the control group ( $p < 0.0001$ , by chi-square test) with 115, 136 and 275 episodes, respectively ( $p < 0.0001$ ). Hence, the expected number of subjects protected from malaria can be calculated by subtracting the number of subjects in each program who contracted malaria infection with the expected number of subjects with malaria (Table 1).

### Costs according to the patients' perspective

(a) **Direct medical cost:** Total direct medical costs are presented in Table 2. The patients in the control group have higher expected expenses than patients in the DDT-spraying and impregnated-net group due to more disease episodes in need of medical care.

(b) **Direct non-medical costs:** The results of direct non-medical costs presented in Table 3, are quite similar to direct medical costs. The expected total direct non-medical costs were highest among the control group, while they were lowest in the impregnated-nets group.

(c) **Indirect costs:** The expected indirect costs due to absence from work are presented in Table 4. It shows these costs to be highest among the DDT-spraying group.

### Cost-effectiveness analysis

Regarding the control of malaria in western

Table 1  
Incidence of malaria in DDT spraying group, impregnated nets group and control group.

	DDT spraying	Impregnated nets	Control
No. of subjects	1,423*	1,034	757
No. of subjects with malaria (observed)	68	61	97
No. of malaria episodes	136	115	275
Expected no. of subjects with malaria (at rate in standard population)	68	84	182
Expected no. of subjects protected from malaria	1,355	1,339	1,241
No. of episodes in need of medical care (observed)	976	1,034	1,177
Expected no. of episodes in need of medical care	976	1,423	2,213

\* standard population

Table 2  
Comparison of direct medical cost accrued in three programs.

	DDT spraying	Impregnated nets	Control
Total direct medical cost	14,365.00	8,940.00	7,880.00
Cost/episode	14,365.00/976 = 14.72	8,940.00/1,034 = 8.65	7,880.00/1,177 = 6.69
Expected total direct medical cost (cost/episode) x expected no. of episodes	14.72 x 976 = 14,366.72	8.65 x 1,423 = 12,308.95	6.69 x 2,213 = 14,804.91

Table 3  
Comparison of direct non-medical cost accrued in three programs.

	DDT spraying	Impregnated nets	Control
Cost of transportation	3,605	2,005	2,185
Cost of food	4,381	2,521	2,241
Total direct non-medical cost	7,986	4,526	4,426
Cost/episode	7,986/976 = 8.18	4,526/1,034 = 4.38	4,426/1,177 = 3.76
Expected total direct non-medical cost (cost/episode) x expected no. of episodes	8.18 x 976 = 7,983.68	4.38 x 1,423 = 6,232.74	3.76 x 2,213 = 8,320.88

Thailand, the impregnated-net program was more cost-effective than the DDT-spraying program or surveillance alone (Table 5). DDT spraying was found to be more cost-effective than malaria surveillance alone.

## DISCUSSION

It is very difficult to control malaria in forested areas along international borders. However, the present study revealed that the use of lambda-cyhalothrin-treated nets was found to be more promising. It is more cost-effective and appropriate for

personal protection. A very high acceptance of mosquito net utilization obtained from this study suggested that it could be of effective use in this type of situation. However, certain measures are required to ensure affordability and sustainability of the program. Therefore, these antimalaria activities should be integrated into the primary health care system under various local conditions. The affordability of a bed net will depend in the first place on the perceived need to use a net. The willingness to pay the local market price for mosquito nets increased markedly after the inhabitants of several villages were given nets and thus learned to appreciate them. Appreciation of mosquito nets could be

Table 4  
Comparison of indirect cost accrued in three programs.

	DDT spraying	Impregnated nets	Control
No. of days absent from work (due to seeking medical care)	1,376	1,053	418
Expected no. of days absent from work	1,376	1,053 (1,423/1,034) = 1,449.15	418 (1,423/757) 785.75
Salary/day*	9.13	6.17	14.16
Expected indirect cost	12,562.88	8,941.26	11,126.22

\* Children excluded

Table 5  
Cost-effectiveness analysis of DDT-spraying, impregnated nets and control group (according to the patients' perspective).

Cost components	DDT spraying	Impregnated nets	Control
	(in Baht)	(in Baht)	(in Baht)
Direct medical cost	14,366.72	12,308.95	14,804.97
Direct non-medical	7,983.68	6,232.74	8,320.88
Indirect cost	12,562.88	8,941.26	11,126.22
Total cost	34,913.28	27,482.95	34,252.07
Expected no. of subjects protected from malaria	1,355	1,339	1,241
Cost (฿) / 1 case of malaria prevented	25.77	20.52	27.60
	(US\$ 0.74)	(US\$ 0.59)	(US\$ 0.79)

(US\$ 1 = ฿35)

enhanced as much as possible by adapting material, model and size of the mosquito net to local preferences. A mosquito net fund should be set up at the village level under the management of the Village Development Committee. A villager can thus buy a net at a reasonable price and can extend payment. For those villagers unable to pay, mosquito nets may be provided in return for labor. Labor can be used to benefit the community, *eg* construction of roads, planting of trees, etc. Impregnation of the nets can be a community activity. Such activity demonstrates that the nets are not ordinary ones but that they have received a special treatment to enhance their protective efficacy. The impregnation could be carried out annually on the day when the people of that community usually assemble, *eg* Songkran Day (Thai New Year), by several members of the community to make the community participate as much as possible. This is likely to enhance sustainability at a later stage.

Although compared with the control group receiving only malaria surveillance, the effect of DDT was apparently more cost-effective. However

administration of DDT for vector control operations in Thailand should be terminated because of the public's increased concern with environmental contamination and toxicity to humans and animals.

We conclude that in a high-risk area such as that along the Thai-Myanmar border in western Thailand, integrating the use of impregnated nets into large-scale primary health care programs will likely be the most cost-effective method for controlling malaria according to the patients' perspective.

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