SURVEILLANCE OF IMPORTED BANCROFTIAN FILARIASIS AFTER TWO-YEAR MULTIPLE-DOSE DIETHYLCARBAMAZINE TREATMENT

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Abstract. Myanmar migrants are at increased risk for nocturnally periodic *Wuchereria bancrofti* causing imported bancroftian filariasis. They have a significant influence on the effectiveness of diethylcarbamazine (DEC) mass treatment at the provincial level in the National Program to Eliminate Lymphatic Filariasis (PELF) during the fiscal years (FY) 2002-2006, in Thailand. Two oral doses of DEC 6 mg/kg are given twice a year to the eligible Myanmar migrants (≥2 years old). A 300 mg DEC provocation test is given once a year to all Myanmar migrants with work permits. Effectiveness evaluation parameters, such as cumulative index (CI) and the effectiveness ratio (ER), were obtained after 2 years of the multiple-dose DEC treatment program in Ranong Province, Southern Thailand. By cross-sectional night blood surveys at the end of FY 2003 in two districts of Ranong Province, the microfilarial positive rates (MPR) were 0.8% and 1.2% for Mueang Ranong and Kra Buri, respectively. The MPR in the agricultural (1.5%) and industrial (0.4%) occupations were not significantly different from each other. Our findings suggest that most untreated microfilaremics working in agriculture, with short-term residency in Thailand, may have delayed multiple-dose DEC treatment.

INTRODUCTION

Migrants play a role in disease transmission (MetaCentre, 2002). Foreign migrant workers in Thailand have been considered a source of potentially infectious diseases (BPHPP, 2001; CDC, 2001; Anonymous, 2004). Nocturnally periodic *Wuchereria bancrofti* causing imported bancroftian filariasis mainly exists in Myanmar migrants who acquired their infection outside of Thailand (Phantana *et al*, 1996; Swaddhiwudhipong *et al*, 1996; Phoopattanakool, 1997; Sitthai and Thammapalo, 1998; CDC, 2001; Bhumiratana *et al*, 2005). The disease affects people in some townships of Myanmar where it is spread by the vector, *Culex quinquefasciatus* (WHO, 2002). The point estimates of nocturnally periodic *W. bancrofti* infection prevalence do not accurately reflect the microfilaremic burden among Myanmar immigrants in Thailand due to the large number of migrants from Myanmar. The disease is expected to be an inter-border public health burden with critical health consequences (BPHPP, 2001; Anonymous, 2004).

The National Program to Eliminate Lymphatic Filariasis (PELF), for the fiscal years (FY) 2002-2006, in Thailand (Filariasis Division, 2000, 2001) uses a hierarchical process with two lines of approach to cope with the disease. The first line of approach is to interrupt the transmission of lymphatic filariasis in areas endemic for both *W. bancrofti* and *Brugia malayi*. The second line of approach is to prevent the transmission of nocturnally periodic *W. bancrofti* in transmission-prone areas. The management of imported bancroftian filariasis emphasizes mass drug administration (MDA) with diethylcarbamazine (DEC) to all eligible Myanmar migrants (Filariasis Division, 2000, 2001; CDC, 2001). DEC mass treatment, termed "multiple-dose DEC treatment", has been implemented through health care providers in target areas (Fig 1). Biannual mass treatment with DEC 300 mg orally given twice a year has long-term macrofilaricidal effects on *W. bancrofti* in Myanmar migrants (Koyadun *et al*, 2003). A single dose of DEC 300

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mg orally followed by a DEC-provocative day test has short-term effects on microfilaremia in Myanmar migrant workers (Bhumiratana *et al*, 2004). Although interventions available at the provincial level in the PELF have been considered to ascertain the geographical coverage of the Myanmar target population, there is little evidence that multiple-dose DEC treatment can be effectively used for treating the two major groups of Myanmar migrant workers: agriculture and industry.

In our study, in order to see whether treating Myanmar migrants with multiple-dose DEC was an effective measure, we conducted a longitudinal community survey of imported bancroftian filariasis in the Ranong Province.

MATERIALS AND METHODS

Study areas, populations, and definitions

This study was conducted in two separate districts of Ranong Province, approximately 60 km apart, Mueang Ranong and Kra Buri, where Myanmar migrants were given biannual mass treatment and DEC provocation testing (Fig 1). Ranong Province is located 568 km south of Bangkok, on the Thailand-Myanmar border. Ranong has a socially and economically diverse population (http://www.ranong.go.th/english/index.htm). One of the public health and socio-economic burdens in the area (BPHPP, 2001) is the illegal immigration of foreign migrant workers, who put at risk of disease prevention and control in the area (Fig 2). In the study, workers ≥10 years old were categorized as described below.

Agricultural practices were defined as activities in agriculture-related areas. The activities were in non-industry-scale production processes in agriculture, such as breeding, planting, watering, nourishing, pumping and aerating. Wages were based on their period of employment (monthly, weekly, or daily).

Industrial practices were defined as activities in agro-industry or industry related areas. The activities were in industry-scale production processes of agricultural products and other domestic goods. Similarly, wages were based on their period of employment.

Multiple-dose DEC treatment was defined as a year-round combined treatment with DEC provocation, biannual DEC mass treatment and supportive DEC treatment in the Myanmar migrants. These preventive measures, which covered 3 groups of Myanmar migrants, were implemented by both government and private sectors, between FY 2002 and 2003 (Fig 1). First, all the eligible Myanmar migrants (≥2 years old) residing in the district (referred to as a stratified area) were given twice a year treatment with a 6 mg/kg oral-dose of DEC. The stratified area of the Ranong Province has been in charge of the authorized health centers, belonging to the District Health Offices (DHO). The DHO belonged to the Ranong Provincial Public Health Office (RPHO), Ministry of Public Health (MOPH). The first round of biannual DEC mass treatment was done in February of the FY and the second round in August. Second, the eligible Myanmar migrant workers with work permits were given a 300 mg oral-dose DEC provocation test once. The DEC provocation test was carried in conjunction with a hospital-based health survey for infectious diseases and drug abuse at the hospitals, belonging to the RPHO. Third, during active case detection for malaria control through the Vector Borne Disease Control Unit (VBDU), those ≥2 years old, untreated within the same FY, were given treatment with 6 mg/kg oral-dose DEC. The sector belonged to the Vector Borne Disease Control Center (VBDC) of the Office of Disease Prevention and Control (ODPC) 11 Nakhon Si Thammarat, Department of Disease Control (DDC), MOPH.

Community surveys and data collection

In longitudinal cross-sectional community surveys between FY 2002 and 2003, the number of the Myanmar migrants that were given each round of biannual DEC mass treatment were recorded by the sectors (or the implementer, *f*) (Fig 1). Also, the numbers of registered Myanmar migrant workers with work permits, that were given DEC provocation, were recorded by the implementers, *d* and *e* (Fig 1). The data for the Myanmar migrants treated in the Mueang Ranong and Kra Buri with both preventive measures were collected, as well as in 3 other districts of the Ranong Province, namely La-Un, Kapoe and Suk Samran.

In cross-sectional community surveys at the end of FY 2003, samples of Myanmar migrant workers in both agriculture and industry were

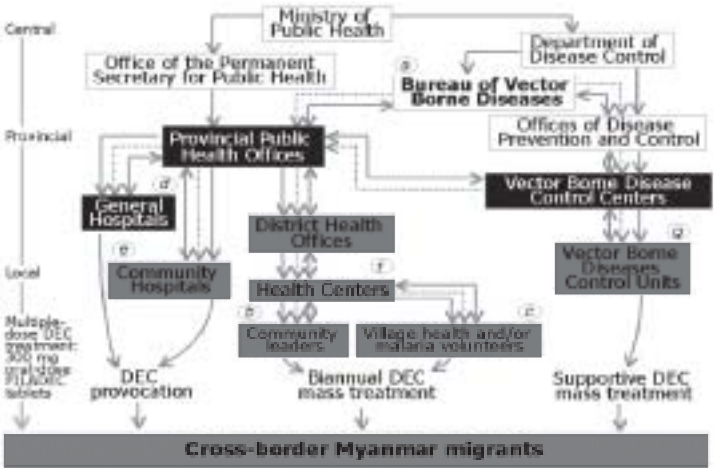

Fig 1–The scheme for the management of the PELF (descending arrows) at central (white boxes), provincial (black boxes), and local (gray boxes) levels of the governmental health sectors and private sectors. The Filariasis Section of the Bureau of Vector Borne Diseases as the PELF's coordinator (*a*) develops logistical line approaches to the management of the PELF which involve managerial, financial, and technical support (dotted arrows), information flow and integration (two headed arrows). Multiple-dose DEC treatment is a mainstay of treatment implemented by the public health sector as implementers (*d* to *g*), and private sectors (*b* and *c*). With a combination of DEC provocation, biannual DEC mass treatment and supportive DEC mass treatment, all eligible Myanmar migrants in the target areas are given annual doses of DEC 6 mg/kg or 300 mg orally.

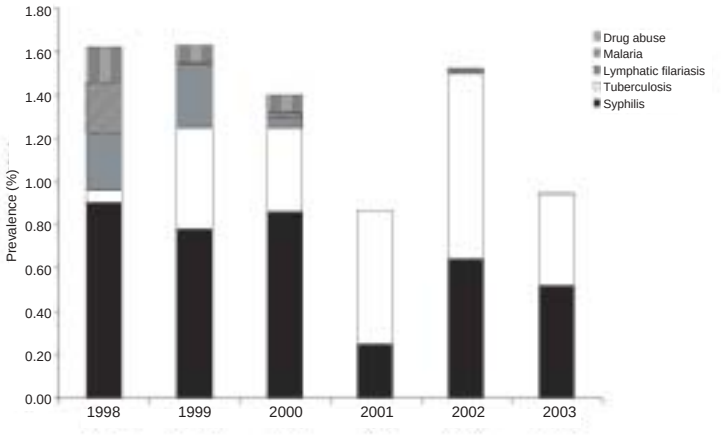

Fig 2–Health conditions of foreign migrant workers on longitudinal cross-sectional hospital-based health surveys for infectious diseases and drug abuse in Ranong Province. Point prevalences observed between FY 1998 and 2003 are shown. In the starting FY 1996, 24,745 people were treated by the DEC provocative test; a 1.39% microfilaremia rate was treated found.

randomly selected. In each study area (Table 1), a filarial survey team, including supervisors, local Myanmar translators, note takers, infection control personnel, laboratory technicians, and drivers, visited during the night time. The consented persons were informed about the purpose of the study and personal information was obtained by Myanmar translators. The demographic characteristics collected were: gender, age, marital status, migration patterns, months of residency, family members living in the Ranong Province (as well as in Myanmar), their domicile residence in Myanmar and previous history of DEC treatment in the study areas. Population migration patterns (daily, seasonal, periodic and long-term migrations) have been described elsewhere (WHO, 2000). They were interviewed by translators and the information was then translated into the Thai language, where it was then recorded by Thai note takers using a Performa.

After interviewing, night finger-prick blood samples were collected between 2100 and 2400 hours. Conventional thick smears were prepared for both microfilariae (Mf) examination (~60 μl per slide) and malaria examination (~10 μl per slide). These were done in duplicate, dried, and then transferred to the laboratories of the VBDU (Table 1). All positive Giemsa-stained blood samples for microfilaria or malaria were confirmed by a second observer. Regardless of work permit status, all microfilaremic persons were given a single oral dose of DEC citrate (300

Table 1
Selection of study subjects by their work and area of malaria and lymphatic filariasis control.

Site[a]	Work areas restricted to the study area	Malaria transmission area[b]			Samples surveyed	
		HE	LE	NE	Before[c]	Cross-sectional[d]
A	Wood production	-	-	+	NO	19
B	Wood production	-	-	+	NO	28
C	Milled seafood production	-	-	+	NO	17
D	Seafood production	-	-	+	NO	32
E	Parawood production	-	-	+	NO	73
F	Milled seafood production	-	-	+	NO	16
G	Chicken farm and production	-	-	+	NO	36
H	Ice production	-	-	+	NO	16
I	Parawood production	-	-	+	YES	55
J	Seafood production	-	-	+	NO	20
K	Civil and housing construction	-	-	+	YES	62
L	Ice and seafood production	-	-	+	YES	73
M	Shrimp farm	-	-	+	ND	38
N	Agricultural plantations	+	+	-	ND	182
O	Agricultural plantations	+	+	-	ND	97
P	Parawood plantation	-	+	-	ND	66
Q	Parawood plantation	-	+	-	ND	74

Abbreviation: ND – no data available.

[a]Sites, A to L, were located in Mueang Ranong district in which they worked in industry-scale production involving seafood, poultry, ice-making, and wood products, whereas in K they worked in industry-scale production of concrete materials and civil construction. In M, located in Mueang Ranong district, they worked in non industry-scale production of shrimp. N to Q, were located in Kra Buri district planting and harvesting mainly parawood and parawood products, N and O also involved tropical fruits, palm oil and coffee.

[b]Malaria endemicity: HE – highly endemic, LE – low endemic, and NE – non endemic, (present is denoted by a plus and absent is denoted by a minus), by the VBDU 11.5.1 (Ranong), and 11.5.3 (Kra Buri), belonging to the VBDC 11.5 (Ranong).

[c]Before sampling the study subjects in each site in pre-mass treatment, microfilaremic persons (YES) were previously recorded according to VBDC 11.5 (Ranong), whereas in mass treatment the selected samples obtained from each site of sampling were recruited into the study during [d]cross-sectional night blood surveys during July-September 2003.

mg FILADEC tablet, Pond's Chemical Thailand ROP, Bangkok, Thailand). The DEC was provided by the Filariasis Section of the Bureau of Vector Borne Diseases (BVBD), DDC, MOPH.

Data analysis

In order to evaluate the effectiveness of the multiple-dose DEC treatment, a majority of the eligible Myanmar migrants targeted for the biannual DEC mass treatment were used for calculating effectiveness evaluation parameters in this study. The number of DEC tablets distributed to the eligible Myanmar migrants were used to calculate the cumulative index (CI) for the biannual DEC mass treatment as follows:

CI=No. persons treated (first round + second round) + No. persons treated (first round – second round) / Total persons treated in a stratum in a fiscal year

OR

$CI = 1 - [(a - b) / (a + b)]$

Where *a* is a number of persons treated in the first round and *b* is a number of persons in the second round. The CI values were divided as follows:

CI>1.0, an increased target to be treated due to move-in persons ($a<b$);

CI=1.0, a static target to be treated ($a = b$);

Table 2
Demographic characteristics of the study subjects between the groups.

Variable	Surveyed Myanmar migrants		p-value
	Agricultural practices n = 457 (%)	Industrial practices n = 447 (%)	
Gender			
Male	299 (65.4)	254 (56.8)	0.01
Female	158 (34.6)	193 (43.2)	
Age: range = 10-78 yr, mean±SD = 29.0±10.6 yr			
<25 years	192 (42.0)	152 (34.0)	0.02
≥25 years	265 (58.0)	295 (66.0)	
Marital status			
Single	162 (35.4)	136 (30.4)	>0.05
Living with a partner	279 (61.1)	301 (67.4)	
Separated/divorced/widowed	16 (3.5)	10 (2.2)	
Migration patterns			
Seasonal	64 (14.0)	20 (4.5)	<0.001
Periodic	101 (22.1)	76 (17.0)	
Long-term	292 (63.9)	351 (78.5)	
Length of residency in the study area: range = 1-500 months, mean±SD = 45.0±52.9 months			
<12 months	165 (36.1)	96 (21.5)	<0.001
≥12 months	292 (63.9)	351 (78.5)	
Family members living in	(n = 440)	(n = 442)	
Ranong Province[a]: range = 1-9 persons, mean±SD = 2.8±1.6 persons			
<5 persons	366 (83.2)	390 (88.2)	0.041
≥5 persons	74 (16.8)	52 (11.8)	
Family members living in	(n = 417)	(n = 397)	
Myanmar[b]: range = 1-15 persons, mean±SD = 4.8±2.3 persons			
<5 persons	195 (46.8)	200 (50.4)	>0.05
≥5 persons	222 (53.2)	197 (49.6)	
Previous history of DEC treatment[c]			
Yes	155 (33.9)	276 (61.7)	<0.001
No	302 (66.1)	171 (38.3)	
DEC treatment frequency[d]:	(n = 155)	(n = 276)	
range = 1-7 times, mean±SD = 2.6±1.5 times			
<2 times	44 (28.4)	68 (24.6)	>0.05
≥2 times	111 (71.6)	208 (75.4)	
Domicile residence in Myanmar			
Mon[e]	217 (47.5)	99 (22.2)	<0.001
Taninthayi[f]	225 (49.2)	267 (59.7)	
Others[g]	15 (3.3)	81 (18.1)	

[a]Family members including accompanied persons or relatives of both a single family and a multiple family resided in the study areas during the study, whereas [b]their family members were living in their residence in Myanmar. [c]Previous history of DEC treatment between FY 2002 and 2003 and [d]persons with experience of DEC treatment (times) were recorded. [e]Their residences in Mon State were located in Moulmein (or Mawlamyine), Mudon, Thanbyuzayat and Ye Townships, whereas in [f]Taninthayi Division the hometowns were in Dawei (or Tavoy), Mergui (or Myeik) and Kawthoung Townships. [g]The others included townships in other parts of Myanmar such as Rangoon.

CI<1.0, a decreased target to be treated due to move-out persons (*a*>*b*).

The Myanmar migrants with work permits that were given the DEC provocation test were not used as a target population to calculate CI values. The CI values were used to describe the effectiveness of the multiple-dose DEC treatment via biannual DEC mass treatment in *pro rata*. Assuming that $CI_{District} = CI_{Total}$, the effectiveness ratio (ER) was computed as follows:

$$\text{Probability} \left| CI_{District}/CI_{Total} - (1 - CI_{Total}/CI_{District}) \right|$$

The ER (%) was used to describe the multiple-dose DEC treatment effectiveness that

Table 3
Myanmar migrants *pro rata* subjected to biannual DEC mass treatment (rounds I and II)[a] and DEC provocation (III) ordered by decreasing targets.

District	Treated Myanmars[b] (%)					
	FY 2002			FY 2003		
	I	II	III	I	II	III
Mueang Ranong	20,872	15,173	14,865	15,957	15,681	120,20
	(84.4)	(77.8)	(83.1)	(76.8)	(75.4)	(84.1)
Kra Buri	1,558	2,166	1,727	2,337	2,561	1,287
	(6.3)	(11.1)	(9.7)	(11.3)	(12.3)	(9.0)
La-Un	1,089	479	617	1,207	1,207	309
	(4.4)	(2.5)	(3.4)	(5.8)	(5.8)	(2.2)
Kapoe	764	895	403	788	879	456
	(3.1)	(4.6)	(2.2)	(3.8)	(4.2)	(3.2)
Suk Samran	449	788	278	479	475	217
	(1.8)	(4.0)	(1.6)	(2.3)	(2.3)	(1.5)
Total	24,732	19,501	17,890	20,606	20,803	14,289

[a]Persons treated in the first round (I) (= *a*) and the second round (II) (= *b*) that were used for calculating the CI values with the following formula: CI = 1 - [(*a* - *b*) / (*a* + *b*)].
[b]Percents of drug distribution in treated Myanmar migrants at the district level are shown in parentheses.

Table 4
Effectiveness of the multiple-dose DEC treatment via biannual mass treatment at the district level and point microfilaremia prevalences in the Myanmar target samples.

District	FY 2002		FY 2003		MPR
	CI	ER (%)	CI	ER (%)	(%)
Mueang Ranong	0.84	100	0.99	100	0.82[a]
Kra Buri	1.16	108	1.04	100	1.19[b]
La-Un	0.44	50	1.0	100	ND
Kapoe	1.08	104	1.05	100	ND
Suk Samran	1.27	113	0.99	100	ND
Total	0.88		1.0		

ND = not done. [a] 4 microfilaremics in 485 of the sites A to M. [b] 5 microfilaremics in 419 of the sites N to Q.

maximized the coverage of biannual DEC mass treatment in the target population, which was treated at the district level in order to contain imported bancroftian filariasis.

In the PELF, an arbitrarily quantitative level of imported bancroftian filariasis control was set at less than 1% of the microfilarial positivity rate (MPR) per annum (referred to as an impact indicator) (DDC, 2002). With the unidirectional effect of multiple-dose DEC treatment on the microfilaremics, containment of the infection (annual MPR) was achieved as a result of the two consecutive years (FY 2002-2003) of PELF implementation. In order to see whether multiple-dose DEC treatment had an effect on the containment of microfilaremia in the Myanmar migrant population, simple random samples of those working in both agriculture and industry, as well as their demographic characteristics, were used to present point microfilaremia prevalence by the end of FY 2003. The χ^2 test, or Fisher's Exact test where appropriate, were used for analyzing differences in the percentages between the groups. Statistical significance was set at $p<0.05$.

RESULTS

General description

The majority of subjects were males, age 25 years old or over, and natives of the townships in Taninthayi Division (Table 2). Most lived with a partner, had family members (of less than 5 persons) living in the Ranong Province, and lived in the study area for more than a year (long-term migration). In contrast to those working in industry, in whom only 38.3% had received prior treatment, 66.1% of the Myanmar migrants working in agriculture had received no previous DEC treatment. More than 70% of the groups with a history of DEC treatment were treated more than 2 times since FY 2002. There were significant differences ($p<0.05$) between the groups in gender, age, migration patterns, length of residency in the study area, previous history of DEC treatment, and their residence in Myanmar.

Multiple-dose DEC treatment effectiveness

In Mueang Ranong alone, more than 75% of the Myanmar target population received each round of biannual DEC mass treatment (Table 3). In Kra Buri, about 6% to 12% of the total Myanmar target population were treated. When the $CI_{District}$ and CI_{Total} values were derived (Tables 3 and 4), the ER values were more likely to show higher levels of DEC distribution in Ranong Province in FY 2002 (Table 4). However, in the FY 2003, the CI_{Total} value (=1.0) was similar to the $CI_{District}$ values, hence, 100% ER was shown for

Table 5
Microfilaremia and malaria prevalence ratios in the groups.

Prevalence	Surveyed Myanmar migrants		p-value
	Agricultural practices n = 457 (%)	Industrial practices n = 447 (%)	
Nocturnally periodic bancroftian filariasis[a]			
Positive	7 (1.5)	2 (0.4)	0.178[c]
Negative	450 (98.5)	445 (99.6)	
Vivax malaria[b]			
Positive	4 (0.9)	0	
Negative	453 (99.1)	447 (100)	

Infections with [a]*Wuchereria bancrofti* and [b]*Plasmodium vivax*.
[c]Fisher's exact test.

Table 6
Demographic characteristics of the Myanmar male microfilaremics.

Subject	Age (yr)	Residence in Myanmar (Township)	Residency (months)	Type of population migration	Work permits	History of DEC treatment	Mean Mf density[a]
K21	23	Moulmein	24	Long-term	YES	YES	24,32
L49	18	Moulmein	6	Periodic	No	No	24,43
M24	26	Rangoon	4	Periodic	No	No	4,10
M25	23	Rangoon	4	Periodic	No	No	1,6
N129	20	Kawthoung	3	Seasonal	No	No	7,11
O23	19	Kawthoung	24	Long-term	No	No	1,1
O50	42	Moulmein	4	Periodic	No	No	2,8
O55	26	Moulmein	7	Periodic	No	No	23,21
P11	20	Moulmein	7	Seasonal	No	No	30,63

[a]Prior to treatment, mean Mf counts (Mf/60 μl blood) at two time-point intervals between 2100 and 0100 on the next day.

all the districts.

Microfilaremia prevalence

By the end of FY 2003, 904 night finger pricks were parasitologically examined. Overall rates of microfilaremia in Mueang Ranong and Kra Buri were 0.8% and 1.2%, respectively (Table 4). In other words, there were 9 (1.0% MPR) male microfilaremic subjects aged 18 to 42 years, including 7 (1.5%) in agriculture and 2 (0.4%) in industry (Tables 5 and 6). The mean Mf densities (Mf/60 μl blood) were 1 to 30 (measured at 2100) and 1 to 63 at peak hour (0100). Point microfilaremia prevalences did not significantly differ between the groups (Table 5). In addition, two industrial sites, K and L, had MPR of 1.6% and 1.3%, respectively. Four agricultural sites, M, O, P and N, had MPR of 5.2, 3.5, 1.5, and 0.5%, respectively. Most microfilaremic subjects, excluding K21 and O23, had short-term residencies in the area, either periodic or seasonal (3 to 7 months), had no work permits, and had a history of DEC treatment (Table 6). In addition, 4 (0.9%) vivax malaria cases, which worked in agriculture in site O, were found (Table 5).

DISCUSSION

The principal challenge to achieve the PELF's goal was to prevent introduced transmission of nocturnally periodic *W. bancrofti* to the at-risk Thai population in transmission-prone areas. One underlying problem was that it was difficult to estimate the entire number of Myanmar migrants eligible for the DEC mass treatment per year. This information was critical for the PELF's program managers at the provincial level to design, implement, and evaluate the DEC mass treatment effectiveness. In our study, we tested a model for the risk of imported bancroftian filariasis in the Ranong Province, which centered on multiple-dose DEC treatment as a second line to the PELF's approach (Fig 1). Pre-existing data of point microfilaremia prevalences using the DEC provocative day test have been reported as having a zero baseline since FY 2001 (Fig 2). We hypothesized, if the theoretical values for biannual DEC mass treatment effectiveness are stable (*ie* $CI_{District} = CI_{Total}$) for a sufficient period of time during DEC delivery, a unidirectional effect of the two-year multiple-dose DEC treatment on reducing the number of microfilaremic persons would be seen.

In the study, the first year of PELF implementation was run by the health centers or the implementer *f* at the district level. Large movements in the Myanmar migrants influenced changes in the $CI_{District}$ and CI_{Total} values, as shown in Table 4. As a result, the Myanmar target population in 3 out of the 5 districts (Kra Buri, Kapoe and Suk Samran) had larger numbers needing to be treated, thereby causing $CI_{District} > CI_{Total}$. Fewer numbers were seen in the Mueang Ranong and La-Un districts, causing $CI_{District} < CI_{Total}$. This implied a decreased demand for DEC in these areas. By FY 2003, the theoretical $CI_{District}$ and CI_{Total} values were stable ($CI_{District} = CI_{Total}$). In other words, after 2 consecutive years of implementing multiple-dose DEC treatment, it could be presumed that DEC distribution was being carried out in an effective manner.

However, when night blood surveys were conducted in Mueang Ranong and Kra Buri, the impact indicator (0.95% overall MPR) was higher than expected. We observed point microfilaremia prevalences higher than the arbitrary level for the MPR, particularly in agriculture. The majority of the workers in agriculture had a two-fold higher risk of having no DEC treatment than those in industry. We believe the Myanmar migrants with the short-term residency (seasonal and periodic migration) played a role in the microfilaremics in the group. Also, those microfilaremic persons with no work permits had a delay in treatment. It is believed that they did not have access to DEC treatment, since *P. vivax*-infected persons were found in site O, on plantation area of Kra Buri, where malaria is endemic. Previous findings demonstrate that treatment with 6 mg/kg DEC has no effect on the blood stages of malaria parasites (Yamokgul and Thammapalo, 1997). Delayed treatment of malaria may be associated with delayed treatment of *W. bancrofti* in those who are not compliant with DEC mass treatment by implementer *g* (Fig 1). In the agriculture group with 66% having no history of DEC treatment, we could not rule out the possibility that the delayed treatment with DEC was due to rejection of the MDA campaign in the area. It was necessary for the village health and/or malaria volunteers, community leaders and public health workers to distribute the DEC

tablets to the eligible Myanmar migrants by direct distribution.

In the industry group, the DEC treatment frequency was rather high, but low levels of active *W. bancrofti* infection were seen in those with work permits. DEC provocative dose testing has a short-term effect on reducing microfilarial density after intake (Bhumiratana *et al*, 2004). However, with no prolonged treatment with DEC, recrudescence of *W. bancrofti*, occurs within a month after oral administration (Siriaut *et al*, 2005). This may be a reason why the subject K21, even with long-term residence in Thailand, still had Mf (Table 6). These levels may not reflect the levels of infection in those with no work permits in the industry. The DEC provocation test did not reflect accurately the MPR, because even higher numbers of Myanmar migrants with Mf were seen in FY 2004 (4-fold higher than in the FY 2003) in the Ranong (Kumpetch S, personal communication). The emergence of microfilaremics in the Myanmar migrant population will occur unless communication, resource mobilization, social marketing, community participation, and advocacy at all levels, are adequate for supporting multiple-dose DEC treatment.

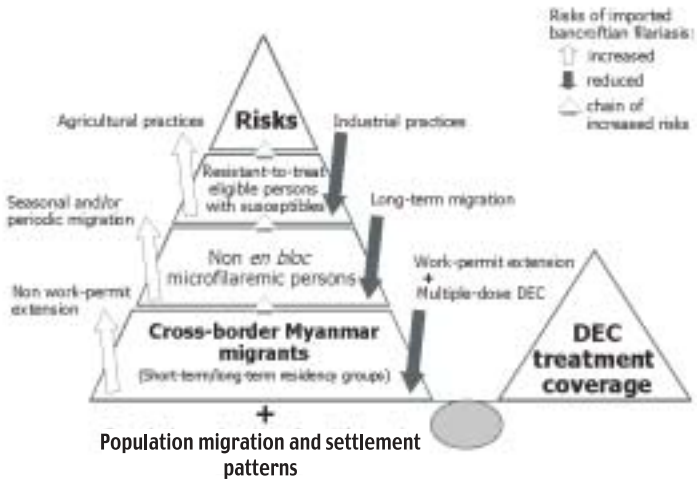

Fig 3–Model of of risks for imported bancroftian filariasis. Factors that favor both increased risks (opened arrow) and reduced risks (closed arrow) were influenced by DEC treatment coverage.

In conclusion, an explanatory model as summarized in Fig 3 formulates general concepts as to which factors contribute to the risk of imported bancroftian filariasis as a source of introduced infection in transmission-prone areas in Thailand. Increased risks were defined as complex factors, such as non-renewal of work permits, seasonal and/or periodic migration, and agricultural practices. Reduced risks were defined as complex factors, such as the renewal of work permits, long-term residence, and industrial practices. Myanmar migrants with short-term residency in Thailand become resistant to treatment. Industrial workers with work-permit extension and long-term residency have access to multiple-dose DEC treatment. Persons with short-term residency are more vulnerable and more likely to develop resistance. Besides existing multiple-dose DEC treatment in target areas, specific preventive measures emphasize the reduction of human-vector contacts and behavioral changes in the at-risk populations.

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