Introduction of an integrated community-based bancroftian filariasis control program into the Mt Bosavi region of the Southern Highlands of Papua New Guinea

DIMITRI PRYBYLSKI[1], WILLIAM A. ALTO[2], SIMUL MENGEAP[3] AND SOSOLO ODAIBAIYUE[4]

Division of Health, Mendi and Fogomaiyu, Southern Highlands Province and Faculty of Medicine, University of Papua New Guinea, Port Moresby

SUMMARY

In mid-1987 a baseline microfilarial prevalence survey was conducted among five villages in the Mt Bosavi region of the Southern Highlands Province of Papua New Guinea. Through use of the Nucleopore filtration technique, it was determined that 48% of villagers had detectable microfilaraemia. The highest prevalence was documented in Fogomaiyu, where the microfilaraemia rate was 92%. On the basis of this initial survey and the expressed interest of the community, the Division of Health in the Southern Highlands Province undertook an integrated community-based pilot control program. The project used two principal control methods: (a) drug treatment with low-dose diethylcarbamazine citrate (DEC) distributed to the community weekly and (b) vector control with permethrin-impregnated bednets. Results six months after the intervention indicate that the program was successful in reducing microfilaraemia at Fogomaiyu village from 92% to 6%. The reduction is principally related to the effects of DEC, although the bednets, by limiting vector-person contact, are expected to reduce the incidence of both filariasis and malaria.

Introduction

Filariasis is endemic throughout the lowland areas of the island of New Guinea and is responsible for considerable morbidity in highly infected areas in the Sepik and Fly river basins, where up to two-thirds of the human population (1) and one-half of the population of the chief vector, *Anopheles punctulatus*, are infected (2). Mass treatment with diethylcarbamazine (DEC) is the recommended control strategy in areas of high endemicity. DEC is currently the most widely used drug for the reduction and prevention of morbidity from filariasis, as it effectively eliminates microfilariae and is safe and inexpensive (3). However, DEC by itself has not always led to complete success in eradicating filariasis (4, 5). When DEC is administered in large doses over a relatively short period of time, for example the standard 12-day course of 6mg/kg for a total of 72mg/kg, unacceptably severe systemic side-reactions are common, leading to disruption of village life and subsequent poor compliance with the treatment plan (6). Ivermectin is more efficacious per single dose (7) but may be prohibitively expensive for most developing countries unless provided on a compassionate basis (8).

Mass administrations of lower doses of DEC to communities over a longer period have been implemented successfully in Indonesia, Kenya and Trinidad for timorian and bancroftian filariasis (9–12). The use of DEC medicated salt has demonstrated that low-dose DEC schedules can be effective in controlling and even eradicating filariasis (13, 14).

1 Division of Health, PO Box 63, Mendi, SHP, Papua New Guinea
Present address: Maricopa County Department of Public Health, Division of Epidemiology, 1825 East Roosevelt St, Phoenix, AZ 85006, USA
2 Division of Health, PO Box 63, Mendi, SHP, Papua New Guinea
Present address: Maine Dartmouth Family Practice, PO Box 341, Fairfield, ME 04937-0341, USA
3 Faculty of Medicine, University of Papua New Guinea, PO Box 5623, Boroko, NCD, Papua New Guinea
4 Fogomaiyu Aid Post, Private Mail Bag, Fogomaiyu, SHP, Papua New Guinea

Bednets may be an important adjunct intervention. Permethrin-treated bednets effectively reduce the incidence of clinical attacks of malaria (15). Treated bednet trials in Papua New Guinea have significantly reduced the incidence of *Plasmodium falciparum* infections in humans (16); while untreated nets have been demonstrated to reduce filarial infection rates, there has not always been a similar decrease in malaria parasite rates (17). Impregnated bednets appear to deter the entry of anopheline mosquitoes into houses and thus protect even those occupants who sleep outside of the net (18). Treated bednets are well suited for community-based programs because they are well accepted (18), have few side-effects and have other beneficial effects such as protecting against *Pediculus humanus* var. *capitis* (headlice) and *Cimex hemipterus* (bedbugs).

The necessity of incorporating primary health care and community participation into lymphatic filariasis control programs has been recognized (19). The community should be involved in planning and implementing the control measures and have an understanding of the nature of the disease and the means by which DEC and vector control can reduce morbidity and transmission of filariasis. When possible, community needs should be addressed and integrated into a comprehensive primary health care program. This combination of services can be the most cost-effective way of managing a control program (20). Ideally, multiple activities should be combined so that they act in a complementary manner. Hence a filarial control project can serve as an entry point for additional primary health care interventions in the village.

Materials and Methods

Study population

The Mt Bosavi region of the Southern Highlands Province is located on the Papuan Plateau at an elevation of approximately 700 metres above sea level. The Kaluli people who inhabit this area are subsistence farmers (sago is the staple diet); there is no cash economy and the purchase of trade store goods is minimal. The only access to the Mt Bosavi region is by aeroplane or on foot, as the area is not linked to the provincial road system.

Fogomaiyu is a village of approximately 200 residents in the Mt Bosavi region. The village aid post, with minimal medical supplies (which do not include DEC) to treat common outpatient ailments, is administered by the aid post orderly (APO). The nearest health subcentre is an 11-hour bush walk away at Ludesa Mission, the regional headquarters of the Evangelical Church of Papua (ECP). The ECP is a strong bonding force throughout the Mt Bosavi region, and there is a village pastor in Fogomaiyu who coordinates community activities and events.

Parasitological surveys

A baseline parasitological survey was conducted in June 1987 in 5 villages in the Mt Bosavi region (Table 1). Villages assessed were Mt Bosavi station, Waragu, Begoro, Wabimisan and Fogomaiyu, with a total population of 490. All villagers six years of age and older were examined by a physician (WA) for signs of lymphatic obstruction, and a sample of venous blood was drawn. The prevalence and intensity of microfilaraemia was determined by Nucleopore filtration of 2ml of blood obtained between 2200 and 2400 hours. This is because *Wuchereria bancrofti* shows nocturnal periodicity in Papua New Guinea. Blood was passed through a 5-micrometre Nucleopore filter placed in a filter holder (Medos Co. Pty Ltd). The filter was washed twice with water, fixed with methanol, positioned on a glass slide and stained with Giemsa. Microfilarial counts were determined microscopically.

The malaria parasite rate was determined by finger prick through routine thick blood smears with Giemsa staining. This was conducted in children under six years old as well.

Repeat parasitological surveys were conducted after six months using the thick blood film method for the determination of the prevalence of malaria and microfilaraemia.

Pilot project to control filariasis

Because filariasis has long been recognized as a significant health problem within the Mt Bosavi region, the District Council expressed interest in a community-based control program at the time of the initial parasitological survey. Based on the high prevalence of

TABLE 1

SEX-SPECIFIC MICROFILARIAL CARRIER RATES IN FIVE VILLAGES IN THE MT BOSAVI REGION OF THE SOUTHERN HIGHLANDS PROVINCE

	Microfilarial carrier rates*					
Village	**Male**		**Female**		**Total**	
Bosavi	29/99	(29)	13/62	(21)	42/161	(26)
Waragu	52/75	(69)	43/85	(51)	95/160	(59)
Bengoro	11/31	(35)	3/32	(9)	14/63	(22)
Wabimisan	6/11	(55)	4/16	(25)	10/27	(37)
Fogomaiyu	42/44	(95)	31/35	(89)	73/79	(92)
Total	140/260	(54)	94/230	(41)	234/490	(48)

* Number with parasitaemia/number examined; numbers in parentheses give the percentage of individuals with microfilaraemia

microfilaraemia at Fogomaiyu, it was agreed that a pilot project should be initiated and expanded to surrounding areas once it had been successfully put into operation. The control priorities expressed by the village were a reliable source of clean water and the introduction of gambusia fish (*Gambusia affinis*), which eat mosquito larvae and thereby reduce breeding intensity (20).

Support and supervision

The Primary Health Care Officer of the Division of Health in Mendi coordinated the integrated intersectoral program to control filariasis in Fogomaiyu village. Parasitological surveys and bednet insecticide treatment were conducted by the Provincial Malaria Section. The Water Supply and Sanitation Section installed a roof-catchment water tank, and the Fisheries Division introduced gambusia fish into stagnant pond and creek water around the village's perimeter. DEC administration and compliance was monitored by the Disease Control Officer.

Health education

Village meetings, with both women and men in attendance, were conducted by the APO and the village pastor to discuss the signs and symptoms of filariasis and potential side-effects of DEC. The life-cycle of the parasite was described, with an emphasis on how treated bednets and DEC act to reduce the prevalence of disease. This was followed by an extensive question and answer session.

Community health worker training

A week-long workshop was conducted by the primary health care coordinator for the village pastor, aid post orderly and six motivated young men from surrounding communities interested in starting the program in their respective villages. Training included techniques to map villages, compile and update family household registries, recognize the signs and symptoms of filariasis and malaria, record DEC side-effects, and monitor weekly DEC compliance, chloroquine prophylaxis for pregnant women and children under five years of age and treatment of bednets with insecticide (21).

DEC mass administration

DEC therapy was tested in the field by administering a single 50mg tablet to 74 adult volunteers. 38% suffered minor side-effects, mainly headache and myalgia, which were relieved with aspirin and promethazine respectively.

DEC was mass administered by the village pastor and aid post orderly on a weekly basis during Sunday church services. Compliance with DEC therapy was recorded. Children aged 1–10 years received a weekly dose of 25mg, and those above 10 years of age received 50mg. Infants and pregnant women were excluded from treatment. Side-effects were uncommon except with the initial dose. A log of date and dose received was maintained on each individual. The mass treatment began in April 1989 and is still continuing.

Vector control measures

A demographic survey (name, name of father, age, sex and house location) was conducted in Fogomaiyu. All 24 houses were mapped and subsequently numbered and each occupant was assigned an identification code. Household family forms allowed for the efficient monitoring of the condition of the bednets.

Family-size bednets from the National Health Department were made available, and part of their cost was met by the community at a subsidized price of K1.00 (US$0.89). The nets were impregnated in bulk at Fogomaiyu with full community participation. Treatment of the nets was repeated at six monthly intervals. Each family required at least two nets, one for the mother, female children and young male children and a second for the father and older boys who slept in the men's house. Houses were traditionally elevated off the ground, which probably decreased mosquito contact.

Results

At baseline

The initial 5-village parasitological survey of 490 people aged 6–65 years determined that the prevalence of detectable microfilaraemia was 48% (Table 1). Prevalence ranged from 22% in Begoro to 92% in Fogomaiyu. Fogomaiyu has the highest filariasis prevalence rate reported from Papua New Guinea. The prevalence of parasitaemia increased with age from 33% in children less than 10 years of age to 79% in adults aged 31–40 years (Table 2). The geometric mean intensity of microfilaraemia was 551 parasites per ml of blood in the survey population (Table 3). The highest levels of microfilaraemia, mean 1549 microfilariae (mf) per ml, were also observed in the 31-40 year old age group. Microfilarial rates were higher in males than in females ($\chi^2 = 8.24$, $p = 0.004$) (Table 2); 31–40 year old males were characterized by an 88% prevalence rate and a mean microfilarial level of 1749 parasites per ml of blood.

At Fogomaiyu, parasitaemia levels were high in all age groups (Table 4). 97% of males and females over 30 years of age had detectable microfilariae in their blood. 41 out of 79 subjects surveyed (52%) had ≥1000 parasites per ml of blood. The geometric mean intensity was 2419 mf/ml in the population and the highest was in 31–40 year olds (2936 mf/ml) (Table 5).

In Fogomaiyu, 147 villagers were questioned about a history of symptoms compatible with filariasis and underwent clinical examination. A history of acute lymphangitis or lymphadenitis was obtained in 23% of the population, with the highest prevalence in the older age groups. Among those over 30 years of age, 50% had a history of filarial symptoms (Table 6). 26% of males older than 20 years had regional lymphadenopathy and hydroceles. Of the females older than 30 years, 10% had asymmetric breast enlargement from lymphatic obstruction and 10% had elephantiasis of an extremity.

Results from the baseline mass blood survey indicated that the malaria parasite rate was 10% in the population and 18% in children under 5 years old. 79% of the positive cases were attributable to *Plasmodium falciparum* and the remaining 21% to *P. vivax*.

Six months post intervention

DEC compliance was over 90% for every week of administration in Fogomaiyu and all villagers purchased and received treated bednets. The prevalence of microfilaraemia decreased to 6% ($\chi^2 = 154.0$, $p < 0.000000001$). Only qualitative data were available, and no quantitative assessment of the density of microfilaraemia was made. The malarial parasite rate decreased to 8%, which was not a statistically significant change; 50% of the cases resulted from infection with *P. falciparum* and 50% with *P. vivax*.

Discussion

A high rate of filarial infection exists thoughout the Mt Bosavi region. The rate of microfilaraemia in Fogomaiyu village was extremely high, with 92% prevalence in

TABLE 2

AGE- AND SEX-SPECIFIC MICROFILARIAL CARRIER RATES IN FIVE VILLAGES WITH A HIGH PREVALENCE OF LYMPHATIC FILARIASIS

Age group (years)	Microfilarial carrier rates* Male		Female		Total	
≤10	29/81	(36)	16/55	(29)	45/136	(33)
11 – 20	25/69	(36)	22/66	(33)	47/135	(35)
21 – 30	32/44	(73)	18/49	(37)	50/93	(54)
31 – 40	29/33	(88)	25/35	(71)	54/68	(79)
≥41	25/33	(76)	13/25	(52)	38/58	(66)
Total	140/260	(54)	94/230	(41)	234/490	(48)

* Number with parasitaemia/number examined; numbers in parentheses give the percentage of individuals with microfilaraemia

TABLE 3

AGE- AND SEX-SPECIFIC INTENSITIES OF MICROFILARAEMIA IN FIVE VILLAGES WITH A HIGH PREVALENCE OF LYMPHATIC FILARIASIS

Age group (years)	Geometric mean intensity of microfilaraemia* Male		Female		Total	
≤10	294	(81)	346	(55)	315	(136)
11 – 20	428	(69)	162	(66)	298	(135)
21 – 30	703	(44)	376	(49)	531	(93)
31 – 40	1749	(33)	1360	(35)	1549	(68)
≥41	700	(33)	363	(25)	555	(58)
Total	635	(260)	456	(230)	551	(490)

*Parasites per ml of blood; numbers in parentheses give the number of individuals in each group

TABLE 4

AGE- AND SEX-SPECIFIC MICROFILARIAL CARRIER RATES IN FOGOMAIYU VILLAGE

Age group (years)	Microfilarial carrier rates* Male		Female		Total	
≤10	5/6	(83)	6/8	(75)	11/14	(79)
11–20	10/11	(91)	5/5	(100)	15/16	(94)
21–30	10/10	(100)	4/5	(80)	14/15	(93)
31–40	12/12	(100)	14/15	(93)	26/27	(96)
≥41	5/5	(100)	2/2	(100)	7/7	(100)
Total	42/44	(95)	31/35	(89)	73/79	(92)

* Number with parasitaemia/number examined; numbers in parentheses give the percentage of individuals with microfilaraemia

TABLE 5

AGE- AND SEX-SPECIFIC INTENSITIES OF MICROFILARAEMIA IN FOGOMAIYU VILLAGE

Age group (years)	Geometric mean intensity of microfilaraemia* Male		Female		Total	
≤10	2974	(6)	2075	(8)	2460	(14)
11 – 20	1711	(11)	1071	(5)	1511	(16)
21 – 30	2370	(10)	2483	(5)	2421	(15)
31 – 40	3252	(12)	2683	(15)	2936	(27)
≥41	2458	(5)	2282	(2)	2410	(7)
Total	2453	(44)	2263	(35)	2419	(79)

* Number of microfilariae per ml of blood; numbers in parentheses give the number of individuals in each group

TABLE 6

AGE- AND SEX-SPECIFIC PREVALENCE OF REPORTED CLINICAL HISTORY OF LYMPHATIC FILARIASIS IN FOGOMAIYU VILLAGE

Age group (years)	Male		Female		Total	
≤10	2/26	(8)*	1/24	(4)	3/50	(6)
11 – 20	3/14	(21)	1/14	(7)	4/28	(14)
21 – 30	13/32	(41)	8/25	(32)	21/57	(37)
31 – 40	3/4	(75)	1/4	(25)	4/8	(50)
≥41	2/3	(67)	0/1	(0)	2/4	(50)
Total	23/79	(29)	11/68	(16)	34/147	(23)

* Number with a history of filarial symptoms/number questioned; numbers in parentheses give the percentage of individuals with a clinical history of lymphatic filariasis

villagers 6 years of age and older. Even in the highly endemic regions of the East Sepik Province, the microfilaraemia rate was only 68% (1). As is common in other geographic areas, the prevalence and intensity of microfilaraemia increased with age until it reached a plateau in adult life.

While microfilaraemia is endemic in the region, the baseline survey indicated a low rate of filarial disease symptomology considering the high rates and densities of microfilaraemia. We found that half of the villagers over the age of 30 years had evidence of lymphatic obstruction, somewhat lower than the 64% reported by Kazura et al. (1). A possible explanation for this is the under-representation of subjects more than 30 years of age because of the high mortality of older individuals in an isolated region of Papua New Guinea. The average age of Fogomaiyu residents is only 26 years. The data fit an epidemiologic model which suggests the recent importation of filariasis or an increase in transmission (3). The latter interpretation is more plausible because filariasis has been recognized within the area for decades.

Microfilarial burdens were highest in men 31–40 years of age. Males are more likely to sleep in their gardens in temporary bush material huts than females and therefore have a greater exposure to the mosquito vector.

The observed decrease in the prevalence of microfilaraemia from 92% to 6% is believed to be a result of the DEC treatment. DEC has been demonstrated to cause a rapid decrease of microfilariae from the circulatory system (20). Malaria parasite rates did not decrease significantly. This may be due to high sporozoite inoculation rates existing even after the

introduction of treated bednets as well as the small population size (17). Vector control with bednets is expected to reduce the incidence of filariasis and malaria, but this will require a longer time to observe. A measurable impact in microfilaraemia rates would not be expected for at least several years (22). The mechanism of further change in microfilaraemia rates will be difficult to evaluate because a comparison group, in which DEC was used alone, was not included as part of this intervention study; such an option was not acceptable to local villagers and the aim was to optimize the intervention from the beginning in this remote area.

Other filariasis control programs have been implemented in Papua New Guinea which have successfully used DEC therapy delivered by medical teams on a semiannual schedule (23). The Fogomaiyu control program emphasizes the management of day-to-day activities in the hands of the villagers themselves, thus encouraging self-reliance, which is a necessity for a region with minimal access to medical services. The following advantages are offered over traditional control methods.

1. All members of the community are involved in promoting self-empowerment and participation in health care. For example, the community has been mobilized to reduce mosquito breeding sites. The control program adheres to the principles of Primary Health Care and puts responsibility in the hands of the people, not some outside health agency.

2. Distribution of DEC on a weekly basis is more effective per milligram compared to administering the same dose on a daily basis (6).

3. Side-reactions are less likely to occur or to be as severe as from the short-term DEC regimen (3). Thus compliance is enhanced.

4. By integrating the control program into a community-based system, the cost of delivering DEC to the people is markedly reduced (9).

5. Linkage of DEC administration to a universal and positive village activity (church attendance) ensures compliance.

In order to maximize the efficiency of the support and supervision of the program, an intersectoral approach was undertaken whereby a team of health workers representing different sections within the health division could work together to promote various primary health care projects. This is a drastic change from the isolated manner in which different sections implemented programs in the past.

The project took full advantage of the ECP village pastor and aid post orderly infrastructures. Sunday church service is an ideal time to administer DEC to the community because there is nearly total community attendance; the village pastor uses this setting to provide health education and encourage community participation and compliance with DEC and the use of bednets.

The public health importance of filariasis in Papua New Guinea has been largely ignored (6), overshadowed by the more immediate concerns of malaria control. This survey conducted in the Papuan Plateau region of the Southern Highlands Province has demonstrated the significant burden of illness caused by *Wuchereria bancrofti* in an area not previously reported to be seriously affected. In one village nearly every inhabitant had circulating microfilariae in their blood with the highest intensities of microfilaraemia reported from Papua New Guinea. A number of children had signs of lymphadenitis and limb oedema.

With the enthusiastic support of the villagers and the local church, the Division of Health was able to initiate a primary health care program to control and perhaps eventually eradicate filariasis. After six months of a weekly dose regimen of DEC, the parasitaemia rate was dramatically reduced. Side-effects were minimal and did not interfere with the villagers' commitment to continue their treatment.

It is uncertain if the regimen of DEC used in this program will actually be macrofilaricidal and lead to the eradication of the adult worms and thus the disease. A diagnostic test is currently under investigation that may answer this question (24) and follow-up of the people of Fogomaiyu is required. Nevertheless, a weekly DEC dose coupled with permethrin-treated bednets has been shown to be an effective and acceptable approach to the control of filariasis.

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