Am. J. Trop. Med. Hyg., 73(4), 2005, pp. 753–758

EVALUATION OF THE PROGRAM TO ELIMINATE LYMPHATIC FILARIASIS IN VANUATU FOLLOWING TWO YEARS OF MASS DRUG ADMINISTRATION IMPLEMENTATION: RESULTS AND METHODOLOGIC APPROACH

MARGARET FRASER,* GEORGE TALEO, FASIHAH TALEO, JAMES YAVIONG, MORRIS AMOS, MARK BABU, AND MORRIS KALKOA

Vector Borne Disease Unit, Vanuatu Ministry Of Health, Port Vila, Vanuatu

Abstract. This report presents the results of the Vanuatu mid-term evaluation of the lymphatic filariasis elimination program being implemented countrywide. Vanuatu is one of the first countries to initiate this program as part of the Global Program for Elimination of Lymphatic Filariasis, based on a five-year annual mass drug administration (MDA) of albendazole and diethylcarbamazine and complemented in Vanuatu by extensive coverage with bed nets. This paper reports results of 561 persons tested at eight sentinel sites following two years of MDA. Coverage was 72% and bed net use was more than 70%. Antigen prevalence was reduced by 63% (from 22% to 8%) and prevalence of microfilaremia prevalence was reduced by 93% (from 12% to 0.8%). Results of surveys of health workers and the community are also reported, and the methodology used for this evaluation is discussed.

INTRODUCTION

In 2000, the Ministry of Health in Vanuatu began a mass drug administration (MDA) campaign with the aim of eliminating lymphatic filariasis (LF) as a public health problem by the year 2004. This is being done under the umbrella of the Pacific Program for the Elimination of Lymphatic Filariasis (PacELF), working within the framework of the Global Program for the Elimination of Lymphatic Filariasis. The PacELF aims to achieve a formal declaration of elimination by 2010, 10 years ahead of the global goal of 2020.[1]

Lymphatic filariasis is a disabling, disfiguring disease caused by parasitic worms and is ranked globally as one of the most common cause of permanent disability.[2] It is estimated that 120 million people are infected in at least 80 countries throughout the tropics and sub-tropics.[3]

There is a body of evidence that suggests that elimination of LF is feasible; examples include Japan, Taiwan, South Korea, and the Solomon Islands using either vector control, diethylcarbamazine citrate (DEC), or a combination of them.[4] New tools are available now that make elimination of LF even more of a possibility: the development of single-dose, two-drug treatment regimens, capable of reducing microfilaremia (MF) to zero or near zero for periods of one year or more and a new antigen test that can be used at any time of day in the field to identify the decrease in circulating adult worm antigen of *Wuchereria bancrofti*.[5]

As long ago as 1927, a prevalence of 31% for lymphatic filariasis infection was reported in males more than 12 years of age in Vanuatu.[6] This is that last known survey in the country before a recent survey in 1997–1998 conducted by the Department of Health reported an MF prevalence of 2% and an LF antigen prevalence of 5% (Taleo G, unpublished data). Infection was higher in males than females and the province with the highest prevalence was Penama in the northern region of the country. An additional study in 1999[7] confirmed *W. bancrofti* as the parasite and *Anopheles farauti* as the main vector. This study also reported the peak microfilarial time as nocturnal, with two peak times of 10:00 PM and 4:00 AM. Furthermore, the timing of the vector activity was found to correspond with peak MF circulation time.

The purpose of this study was to conduct a midterm evaluation of the Vanuatu lymphatic filariasis elimination campaign and to present the methodology used.

MATERIALS AND METHODS

The Vanuatu filariasis elimination campaign is countrywide, based on a directly observed MDA of albendazole (one 400-mg tablet) and DEC (50-mg tablets based on age as follows: 2–9 years of age, 2 tablets; 10–19 years of age, 5 tablets; 20–29 years of age, 7 tablets; 30–59 years of age, 8 tablets; $\geq$ 60 years of age, 7 tablets) to be distributed annually for five years from 2000 to 2004 (pregnant women, babies less than two years of age, and sick and elderly individuals were excluded) and vector control. Vector control is based primarily on the use of bed nets in the intensified malaria control program. The filariasis program is also supported by a health education campaign that includes the training of health staff and of communities, and a political awareness program.

Study site. All fieldwork described was carried out in Vanuatu, an archipelago in a north-south chain of islands extending some 800 km in the southern Pacific Ocean. The population of Vanuatu is 186,678 (national census, 1999). Three-quarters of the population live in rural areas supported by subsistence agriculture. Men are the heads of household and every village has a chief. Local traditional healers play an important role in the communities, and perceptions of disease are often linked to cultural explanations. The official languages are English, French, and Bislama, but more than 113 distinct languages are used in the archipelago. Cultures and traditions also vary markedly between islands.

This study was reviewed and approved by the Liverpool School of Tropical Medicine Ethics Committee and the Vanuatu Ministry of Health, having been recommended by the World Health Organization Pacific Elimination of Filariasis Secretariat. Verbal consent was obtained from the village chiefs before blood surveys were carried out.

Parasitologic survey. The four provinces with the highest recorded prevalence of LF in the baseline survey were chosen for follow-up blood studies. Within each of these provinces, the two villages with the highest prevalence of filariasis were

* Address correspondence to Margaret Fraser, Vector Borne Disease Unit, Vanuatu Ministry of Health, Private Mail Bag 009, Port Vila, Vanuatu. E-mail: margaret.fraser@liverpool.ac.uk

selected as sentinel sites. These were Sola and Mosina in Torba Province, Wanur and Sakau in Penama Province, Orap and Unmet in Malampa Province, and Port Resolution and South River in Tafea Province. Two other villages, Redcliffe in Penama Province and Lingarak in Malampa Province, were selected for spot testing. Criteria for selecting the villages for spot testing were that they had not previously received intervention from research teams, as well as being areas of known high malaria prevalence. The reason for selecting areas of high malaria prevalence was that a previous study in Vanuatu had shown a positive correlation between malaria and filariasis prevalence (G. Taleo, unpublished data). All individuals more than 10 years of age in the villages were asked to come for a blood test (except in Port Resolution where the only first 300 only were examined). Furthermore, opportunistic testing of individuals coming to laboratories for malaria tests in the two urban areas of Vila (Efate Province) and Santo (Sanma Province) was also carried out.

All participants had a 100-μL blood sample taken during the day for the detection of *W. bancrofti* antigen using Binax (Portland, ME) immunochromatographic card tests (ICTs) and results were read at 10 minutes. All cases with a positive ICT result had an additional 60-μL night blood sample taken for detection of MF using the three-line blood smear method of Sasa.[4] Blood was taken from finger pricks between 9:00 PM and midnight to coincide with the peak circulation time of the MF.[7] Participants were also asked whether they normally used a bed net and whether they had used a bed net the previous night to ascertain the extent of bed net use. All participants testing positive in the antigen test were treated with albendazole and DEC.

Knowledge, attitudes, and practices (KAP) surveys. Two KAP surveys were carried out: one with health workers involved in distributing the medicine and another with the community. A structured written questionnaire was prepared and administered to all health workers attending the 2002 MDA workshop. Participants completed the questionnaires in writing anonymously. The questionnaire was designed locally based on results from semi-structured interviews carried out with heath workers earlier that year and was pre-tested.

A community KAP survey was carried out between April and June 2002. This questionnaire was prepared based on results from a baseline qualitative study on filariasis that was conducted in Vanuatu in 1999 before the start of the MDA (Secretariat of the Pacific Community, Anse Vata, New Caledonia, unpublished data). Questions were translated into Bislama and the questionnaire was pilot tested before implementation. The questionnaire was administered verbally to persons more than 16 years of age by health workers trained in administering the questionnaires and the results were recorded.

Statistical analysis. Statistical analysis was carried out using EpiInfo version 6 (Centers for Disease Control and Prevention, Atlanta, GA). Comparisons of prevalence of infection and the study population and general population were made using a chi-square test for significance. Mean MF density was compared using the Kruskal-Wallis test. The prevalence of MF and antigenemia in sentinel sites was standardized by age and sex using the total population of people tested in each village before and after the start of the MDA as the standard population. The KAP survey results were first analyzed by obtaining percentages and associations were tested using the chi-square test.

RESULTS

Parasitologic survey. The age and sex distribution of the sentinel sites population is shown in Figure 1. A larger number of people were tested in 2002. Male to female ratios were similar in 1998. The proportion of people tested across different age groups was also similar, although a higher proportion of people were tested in the 10–19-year-old age group during the 2002 survey. The distribution of persons tested in 2002 between the sexes was not significantly different compared with that in the general population ($P = 0.16$). Although the age distributions were similar, the age distribution in the sentinel populations was significantly different from that of the general population. However, this was not meaningful because of the sample sizes involved.

In this evaluation, following two MDAs and just prior to a third, the mean crude prevalence of antigenemia in sentinel sites was 8% (Table 1). When this was compared with standardized prevalence observed in the 1998 baseline survey, a statistically significant decrease of 63% was observed ($\chi^2 = 127$, degrees of freedom [df] = 1, $P < 0.001$) (Table 2). The mean crude prevalence of microfilaremia was 0.8% in sentinel sites (Tables 1 and 2). When compared with standardized prevalence observed in the same villages during the baseline survey, a statistically significant decrease of 93% was observed ($\chi^2 = 177$, df = 1, $P < 0.001$) (Table 2). The mean intensity of MF/mL of blood in positive slides was 98 (geometric mean = 53), which represented a reduction of 92% ($\chi^2 = 6.4$, df = 1, $P < 0.012$) from the mean of 1,248 (geometric mean = 284) found during the baseline survey in 1998 (this mean excludes Wanur village because MF in slides were not quantified there during the 1998 baseline survey). Nurses recorded coverage when the MDAs were conducted. During the first MDA in 2000, average coverage across all sentinel sites was 73% (range = 53–90%) and it increased the following year to 77% (range = 64–90%).

In the two villages where spot tests were carried out, antigen prevalence was 40% and 0% in Redcliffe and Lingarak,

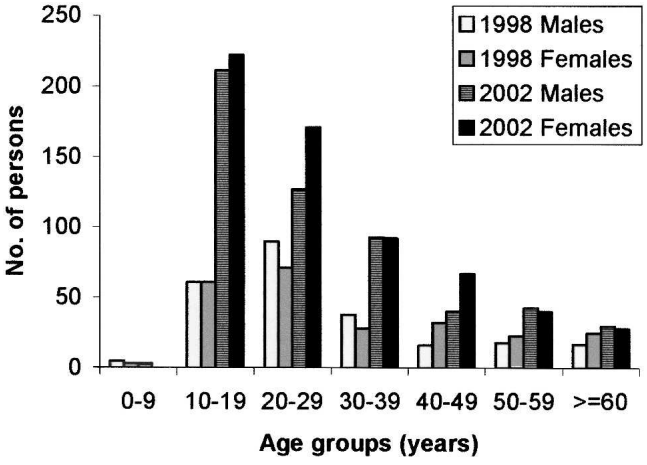

FIGURE 1. Number of people examined in sentinel villages, Vanuatu, 1998 and 2002.

TABLE 1
Comparison of crude prevalence of filariasis before and after two rounds of mass drug administration (1998 and 2002)

	1998 (baseline)			2002 (after two rounds)		
Village	Antigenemia Prevalence (%) (no. positive/ no. tested)	Microfilaremia Prevalence (%) (no. positive/ no. tested)*	Mean MF (geometric mean)/mL†	Antigenemia Prevalence (%) (no. positive/ no. tested)	Microfilaremia Prevalence (%) (no. positive/ no. tested)	Mean MF (geometric mean)/mL†
Sola	10 (3/31)	3 (1/31)	17 (17)	1 (2/168)	0 (0/168)	0
Mosina	11 (3/28)	7 (2/28)	232 (190)	4 (3/76)	0 (0/76)	0
Port Resolution	9 (11/127)	3 (3/127)	133 (83)	1 (4/300)	0 (0/300)	0
South River	14 (9/66)	6 (4/66)	112 (74)	11 (5/44)	0 (0/44)	0
Sakau	46 (22/48)	29 (14/48)	895 (461)	27 (25/92)	1 (1/92)	17 (17)
Orap	4 (4/100)	3 (2/100)	91 (88)	1 (3/224)	0 (0/224)	0
Unmet	53 (52/100)	27 (27/100)	19,288 (384.6)	22 (45/208)	3 (7/208)	109 (63)
Wanur	36 (22/61)	21 (14/61)	‡	8 (5/59)	2 (1/59)	405 (405)
Total	22 (126/561)	11 (67/561)	1,248 (284)	8 (92/1171)	0.8 (9/1,171)	98 (53)§

* The assumption is made that persons testing antigen negative are also microfilaremia (MF) negative based on the high sensitivity of this test.[21] This allows for comparison with other studies.
† Mean MF of total positive slides.
‡ No data available.
§ Mean does not include Wanur for comparative purposes.

respectively (Table 3). The researchers who carried out this survey reported finding several cases of symptomatic disease in Redcliffe. Self-reported participation in the MDAs ranged from 84% to 98% in these villages. An antigen prevalence of 2% was recorded from opportunistic testing at the Port Vila Malaria Laboratory and 3% at the Santo Laboratory.

Infection status was evaluated both directly by microscopic enumeration of MF and indirectly by measuring the presence of circulating adult worm antigen with the ICT. Of the 143 people who were positive in the antigen test, 6 (5%) reported not to have taken part in either MDA; 22 (15%) in only one MDA; and 115 (80%) in both rounds. Of the 24 people that were MF-positive, 2 (8%) indicated that they had not taken drugs during either of the MDAs; eight (33%) took part in one MDA; and 14 (58%) took part in both rounds. A total of 74% of the persons surveyed in sentinel sites responded that they had used a bed net the previous night. There was little difference in response to whether one normally uses a bed net compared with whether a bed net was used the previous night.

Knowledge, attitudes, and practices survey. *Health workers component.* A total of 106 questionnaires were completed. Some problems were reported by health workers in receiving the right amount of medicine, registration books, health education material, and receiving funds on time. However, the health workers involved in the program believed that the program was run well. Approximately 50% of the nurses interviewed reported encountering the following problems with the community during the MDA: 1) people feel healthy and do not see why they need to take medication; 2) false rumors make people afraid of taking the medicine; 3) people express concern over the large number of tablets that they have to swallow, which can be up to 10 in some cases; 4) people are afraid of the side effects; and 5) people want to take the medication home to have after they have eaten and before going to bed at night.

A total of 74% of nurses interviewed reported observing people take their medicine in 2000 and 94% reported this in 2001. Approximately 22% of nurses reported conducting the MDA house-to-house survey in 2000 and 29% in 2001, while approximately 65% in 2000 and 82% in 2001 gathered the community together in one place within the village. Nurses occasionally combined these methods of distribution.

Community survey component. A total of 1,632 questionnaires were completed by the community across all six provinces. Eight hundred nineteen of these were completed in South Ambae Island in Penama Province, which was previously identified as having the highest prevalence of filariasis in the country (Taleo G, unpublished data).

A total of 93% of the people surveyed said that they were given the drugs and 99% of all people given drugs swallowed

TABLE 2
Comparison of standardized prevalence of filariasis before and after two rounds of mass drug administration (MDA) (1998 and 2002)

			Antigenemia prevalence (%)				Microfilaremia prevalence (%)*			
Village	Used a bed net the previous night (%)	Coverage in MDA (2001/2001) (%)†	1998	2002	% Reduction in prevalence	P‡	1998	2002	% Reduction in prevalence	P‡
Sola	63	90/74	15	1	92	< 0.0001	10	0	100	< 0.0001
Mosina	100	78/64	12	4	67	0.045	7	0	100	0.012
Port Resolution	69	83/86	10	1	87	< 0.0001	0.6	0	100	0.610
South River	55	64/89	13	11	15	0.663	6	0	100	0.038
Sakau	30	77/78	48	27	44	< 0.0001	31	1	96	< 0.001
Orap	88	53/82	3	1	47	0.543	1	0	100	0.132
Unmet	87	73/74	52	22	59	< 0.0001	31	3	90	< 0.0001
Wanur	81	73/75	31	8	73	< 0.0001	19	2	91	< 0.0001
Total	74	73/77	22	8	63	< 0.0001	12	0.8	93	< 0.0001

* In the 1997–1998 survey, all participants were tested by the immunochromatographic test (ICT) and for microfilaremia (MF); in the 2002 survey, participants were screened with the ICT (reliability = 97.2% in baseline survey report) and positive cases were then tested for MF.
† Coverage as registered by nurses during MDAs = no. treated/no. registered (all residents present and absent as well as visitors on the day are registered).
‡ Probability measured using chi-square test.

TABLE 3
Results of cross-sectional blood surveys, Vanuatu, 2002*

Village	No. surveyed	Coverage as self reported during evaluation		Antigenemia Prevalence (%) (no. positive)	Microfilaremia Prevalence (%) (no. positive)	Mean MF (Geometric mean)/mL†
		2000	2001			
Redcliffe	129	89	86	40 (51)	12 (15)	181 (98)
Lingarak	218	98	95	0 (0)	0 (0)	0
Northern District Hospital malaria laboratory	168	–	–	2 (8)	NT	–
Vila District Hospital malaria laboratory	254	–	84	3 (8)	NT	–

* NT = not tested.
† Mean microfilaria = total no. with microfilaremia (MF)/total positive slides.

them. A total of 98% of the people surveyed said they were happy to continue taking part in the MDA for another three years. The main reason (87%) people took the drugs was to protect themselves from LF. Few people said they took the drugs to stop the spread of it in the community, or to eliminate transmission. Only a small minority (4%) did not know why they were taking the medicine. The most common reason (37%) given by people not taking part in the MDA was that they missed the drug distribution. Reasons for missing the distribution included being on the home farm, traveling at the time of distribution, and because the nurse did not come to their house. Only 3% reported not taking part in the MDA because they were afraid of the drugs and their side effects.

Overall, 85% of people said they were aware beforehand of the date the drugs were to be distributed in their area, usually having been informed by a health worker. Other means whereby this information was communicated included the church, chief, word-of-mouth, posters, the radio, the Rotary Club, the police, and schoolteachers. Within the main town of Port Vila, 37% of the people interviewed heard about the program on the radio, whereas in other areas surveyed this was not an important means of communication. Those who had heard in advance of the drug distribution were significantly more likely to also report having taken part in the MDA ($\chi^2 = 29$, df = 1, $P < 0.001$).

A total of 56% of the people surveyed knew that filariasis was transmitted by mosquitoes and 26% said they did not know how it was transmitted. Other answers included through malaria, by sexual transmission, through the MDA drugs, by swimming in dirty rivers, through food, and cultural-related beliefs such as stepping in someone's footprint or sleeping by a certain stone. Persons who knew that the infection was transmitted by mosquitoes were significantly more likely to also report taking part in the MDA than persons who did not understand how the infection was transmitted ($\chi^2 = 10$, df = 1, $P = 0.001$). When asked what was the best way to avoid getting filariasis 72% of people responded, "to take the medicine" This answer was also significantly associated with having taken part in the MDA ($\chi^2 = 15$, df = 1, $P < 0.001$). Only 14% of the people mentioned using a bed net as a form of prevention for filariasis. When asked what you can do once someone has symptoms of LF, the most common answer (35%) was that they did not know. There were also many people (34%) who thought the disease could be treated with western medicine. Less than 1% responded that hygiene was important. Other answers included using traditional medicine, isolating the infected person, and the use of prayer and faith.

DISCUSSION

This study reports the impact in eight sentinel sites in Vanuatu of two years of single annual MDA of DEC plus albendazole targeted at the elimination of *Anopheles*-transmitted *W. bancrofti*. Coverage nationwide was reported as more than 80% (Taleo G, unpublished data) in both rounds and 73% and 77% in 2000 and 2001, respectively, in sentinel villages tested.

Prevalence of microfilaremia was shown to have decreased by 93% to 0% in villages with a baseline prevalence of less then 8% and to between 4% and 1% in villages with a baseline prevalence between 20% and 30%. This is a clear indication that the intervention is working and that Vanuatu is on track to eliminate LF as a public health problem. Diethylcarbamazine alone or in combination with ivermectin has been demonstrated to be effective in significantly reducing prevalence and density of microfilaremia in other south Pacific countries: in Samoa three annual treatments of DEC achieved an estimated 80% reduction in the prevalence of microfilaremia.[8] Similar results were obtained after a five-year annual treatment program in Fiji[9] and in the Dreiker district of Papua New Guinea[10] where a four-year MDA campaign using DEC alone or DEC plus ivermectin resulted in a reduction of microfilaria prevalence by 86–98%. The study carried out in Papua New Guinea, which is also an area where *Anopheles* is the main vector, similarly reported that transmission of LF decreased substantially following four rounds of MDA in a test population of 2,500 residents, and that new infections in children were almost completely prevented.

In this study, 74% of persons surveyed in sentinel sites responded that they had used a bed net the previous night. The government of Vanuatu has vigorously pursued malaria control and in the last decade effort has concentrated on the provision of permethrin-treated bed nets, resulting in a sharp decrease in reported malaria cases. It is believed that bed nets also play an important role in reducing filarial transmission. Since filariasis is transmitted by the same anopheline mosquito throughout the archipelago, a valuable control synergy, in the form of bed net use, has been established.

Evidence for the usefulness of vector control as an adjunct to chemotherapy is increasing. House spraying with DDT has led to complete interruption of the transmission of *W. bancrofti* by mosquitoes of the *An. punctualatus* complex in the Solomon Islands.[11] The use of polystyrene beads in *Culex*-transmitted filariasis has been shown to increase the impact of LF control programs when combined with mass drug distribution in both Zanzibar and India.[12–14] Studies in Kenya showed that when treated bed nets were introduced into 6 of

the 12 villages studied, the number of bites per villager per year was reduced 23% and the annual transmission of lymphatic filariasis was reduced 92%.[15] Similarly, a study of the impact of untreated bed nets on the prevalence of *W. bancrofti* infection and disease in the human population of Bagabag Island, Papua New Guinea, where filariasis is transmitted by *An. farauti,* found that bed net users had a lower prevalence of *W. bancrofti* microfilaremia, antigenemia, and hydrocele than non-users.[16]

The use of the *W. bancrofti* antigen ICT has simplified the diagnosis of LF. These tests are highly sensitive when compared with thick blood films, can be used at any time of day, are simple enough for field use by people with minimal training, and results are available within 10 minutes.[17] This has made them the test of choice for community surveys. The drawback is that it is not known for how long filarial antigenemia will persist in the absence of microfilaremia and ICTs give no indication of parasite load. The call has already been made for alternative tests that are easy to use and more accurately reflect the amount of ongoing transmission.[18] The method used in this evaluation survey sought to make the best of available tests: surveying the whole population first during the day using ICTs and then following-up positive cases only with night blood film tests. For the purpose of a mid-term evaluation in which the objective is to assess whether prevalences of filarial infection are decreasing as expected and not to look for evidence of elimination of transmission, the method used in this survey of first screening with ICTs and following-up positive cases with MF tests is proposed for discussion and further research.

Including measures of process as well as outcome in this mid-term evaluation allowed program managers to ascertain the strengths and problem areas of the program. The program thus benefits from learning from experience and program delivery is continually improved. Several nurses reported receiving insufficient drug supplies to complete the MDA. However, this problem was partly overcome by health centers sharing drugs and with top-up supplies available at the provincial and national level.

Reported coverage by nurses during the MDA in villages ranged from 53% to 90% and self-reported coverage during this survey ranged from 77% to 98%. There are various possible reasons for the difference between these reported coverages. Nurses included people absent from the village and children less than two years of age in the denominator, but these people were not included during this survey. Also, interviewees may have been inclined to give a positive answer to please the health staff conducting the interviews. This potential bias in the reporting system might be overcome by using interviewers who were not from the Ministry of Health. However, results should ensure program managers that coverage results being reported by nurses after MDAs are not being greatly overestimated.

The Vanuatu program showed high levels of community participation with more than 90% of people questioned reporting that they had received the drugs during the last MDA. Previous research on filariasis MDA control programs in the Philippines, Thailand, Malaysia, and Indonesia show that to achieve high levels of coverage it is important to have easy access to the program and to have health education that increases understanding of the program, therefore minimizing fear of side effects.[19] These findings support this conclusion, which shows that persons with knowledge of the disease and with prior knowledge of the date for distribution were more likely to take part in the MDA.

Although nurses in Vanuatu reported that they face problems with people being afraid of taking the medicine because of the large number of pills or because of side effects, this survey suggests that the percentage actually refusing treatment because of this reason is small (3% of those interviewed). In some areas, rumors circulated that the drugs would give you filariasis or that the government was trying to sterilize the population through the distribution of the drug. This was also encountered during mass distribution of ivermectin for onchocerciasis in Guatemala.[20] Easy access to the program in Vanuatu was achieved through taking the drugs to the communities and by working together with the village chiefs and religious leaders to ensure that people were aware of the program. Ingestion of drugs was also maximized through the use of directly observed therapy.

The Vanuatu program is based on a strategy of directly observed therapy at the community level and complimented by the use of bed nets; a strong research-based information, education, and communication campaign; strong political support; and commitment from partners. The results of this mid-term evaluation show high coverage was maintained for the first two years of this campaign and resulted in a significant decrease in antigen prevalence, as well as MF prevalence and intensity of microfilaremia due to *W. bancrofti.*

Received December 9, 2004. Accepted for publication May 25, 2005.

Acknowledgments: We thank the Vector Borne Disease Control Unit staff, malaria supervisors, microscopists and laboratory technicians, nurses, and the community who all willingly gave of their time and effort to enable this study. We are also grateful to Kazuyo Ichimori and the PacELF team for their assistance, the Japanese International Cooperation Agency for supplying ICT kits, and several colleagues for their constructive comments on the drafts of the manuscript.

Financial support: This study was supported by GlaxoSmithKline.

Disclosure: Margaret Fraser currently works for the Liverpool Lymphatic Filanasis Support Centre, which is supported by grants from GlaxoSmithKline, the Department of International Development (United Kingdom), and the Bill & Melinda Gates Foundation. This statement is being made in the interest of full disclosure and not because the author considers this to be a conflict of interest.

Authors' address: Margaret Fraser, George Taleo, Fasihah Taleo, James Yaviong, Morris Amos, Mark Babu, and Morris Kalkoa, Vector Borne Disease Unit, Vanuatu Ministry Of Health, Private Mail Bag 009, Port Vila, Vanuatu, E-mail: margaret.fraser@liverpool.ac.uk.

REFERENCES

1. Ichimori K, 2000. PacELF: Elimination of lymphatic filariasis in the Pacific. *Filarial Update 2:* 12.
2. World Health Organization, 1995. *The World Health Report: Bridging the Gap*. Geneva: World Health Organization.
3. World Health Organization, 1999. *Building Partnerships for Lymphatic Filariasis: Strategic Plan September 1999*. Geneva: World Health Organization. Document FIL/99.198.
4. Sasa M, 1976. *Human Filariasis: A Global Survey of Epidemiology and Control*. Tokyo: University of Tokyo Press.
5. Ottesen EA, Duke BO, Karam M, Behbehani B, 1997. Strategies and tools for the control/ elimination of lymphatic filariasis. *Bull World Health Organ 75:* 491–503.
6. Buxton PA, 1927. *Malaria and Filariasis in the New Hebrides. Researches in Polynesia and Melanesia. Appendix II.* Memoirs

of the London School of Hygiene and Tropical Medicine, 225–237.
7. Abe M, Yaviong J, Taleo G, Ichimri K, 2003. Microfilarial periodicity of *Wuchereria bancrofti* in Vanuatu. *Trans R Soc Trop Med Hyg 97:* 498–500.
8. Kimura E, Mataika J, 1996. Control of lymphatic filariasis by annual single dose diethylcarbamazine treatments. *Parasitol Today 12:* 240–244.
9. Mataika J, Kimuar E, Koroivueta J, Shimada M, 1998. Efficacy of five annual single doses of diethylcarbamazine for treatment of lymphatic filariasis in Fiji. *Bull World Health Organ 76:* 575–579.
10. Bockarie MJ, Tisch DJ, Kastens W, Alexander NDE, Dimber Z, Bockarie F, Ibam E, Alpers MP, Kazura JW, 2002. Mass treatment of lymphatic filariasis in Papua New Guinea. *N Engl J Med 327:* 1841–1848.
11. Webber RH, 1979. Eradication of *Wuchereria bancrofti* infection through vector control. *Trans R Soc Trop Med Hyg. 73:* 722–724.
12. Maxwell CA, Curtis CF, Haji H, Kisumku S, Thalib AI, Yahya SA, 1990. Control of *Bancroftian* filariasis by integrating therapy with vector control using polystyrene beads in wet pit latrines. *Trans R Soc Trop Med Hyg 84:* 709–714.
13. Reuben R, Rajendran R, Sunish IP, Mani TR, Tewari SC, Hiriyan J, Gajanana A, 2001. Annual single-dose diethylcarbamazine plus ivermectin for control of filariasis: comparative efficacy with and without vector control. *Ann Trop Med Parasitol 95:* 361–378.
14. Sunish IP, Rajendran R, Mani TR, Munirathinam A, Tewari SC, Hiriyan J, Gajanana A, Satyanarana K, 2002. Resurgence in filarial transmission after withdrawal of mass drug administration and the relation between antigenaemia and microfilaraemia—a longitudinal study. *Trop Med Int Health 7:* 59–69.
15. Pedersen EM, Mukoko DA, 2002. Impact of insecticide-treated materials on filaria transmission by the various species of vector mosquito in Africa. *Ann Trop Med Parasitol 96 (Suppl 2):* S91–S95.
16. Bockarie MJ, Tavul L, Kastens W, Michael E, Kazura JW, 2002. Impact of untreated bed nets on prevalence of *Wuchereria bancrofti* transmitted by *Anopheles farauti* in Papua New Guinea. *Med Vet Entomol 16:* 116–119.
17. Melrose WD, 2002. Lymphatic filariasis: new insights into an old disease. *Int J Parasitol 32:* 947–960.
18. Burkot TR, Taleo G, Toeaso V, Ichimori K, 2002. Progress towards, and challenges for, the elimination of filariasis from pacific-island communities. *Ann Trop Med Parasitol 96:* S61–S69.
19. Rauyajin O, 1995. Socio-cultural and behavioural aspects of mosquito-borne lymphatic filariasis in Thailand: a qualitative analysis. *Soc Sci Med 41:* 1705–1713.
20. Richards FO Jr, 1995. Knowledge, attitudes and practices during a community-level ivermectin distribution campaign in Guatemala. *Health Policy Plann 19:* 404–414.
21. Weil JG, Lammie PJ, Weiss N, 1997. The ICT filariasis test: a rapid format antigen test for diagnosis of bancroftian filariasis. *Parasitol Today 13:* 401–404.