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*Vector Biology  
and Control Project*

**Report of an External Review of the  
Pakistan Malaria Control Program**

**August 28 - September 17, 1991**

**by**

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**VBC Report No. 82244**

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## **Executive Summary**

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For most of the past three decades the United States has supported the Government of Pakistan (GOP) in its long, productive efforts to contain malaria. Commodity support under the current project, Malaria Control II, begun in 1982, is scheduled to end in 1992, and technical assistance to the Pakistan Malaria Control Program (MCP) is scheduled to end in 1994. Both partners want to make certain now that the many gains made against a disease that is resilient and capable of sudden resurgence are sustained.

At the request of the GOP, USAID/Islamabad sponsored an external review of the MCP from August 12 to September 17, 1991. A team of six experts selected by the GOP, USAID and the World Health Organization (WHO) spent a total of 28 person-weeks assessing the many aspects and achievements of the MCP and the requirements for successful continuation of its efforts to contain malaria. More specific objectives were to determine the overall status of malaria in Pakistan, the adequacy of current control strategies and the disease surveillance system on which they are dependent, and whether in-country training and operational research activities were sufficient to meet future needs.

The current strategy has been very successful. Using case detection to carefully focus insecticide spraying has reduced insecticide usage and dependency. Malaria has been contained: levels in Punjab are very low, and though they are higher than previously recorded in Baluchistan because of neighboring political unrest, cases are not widely distributed. Although sufficiently high in Northwest Frontier Province (NWFP) and Sindh to cause concern, especially since many cases are falciparum malaria, malaria incidence is not greatly different than when insecticide use was much higher.

There are challenges. Since intensive post-World War II studies of malaria and its mosquito vectors provided the knowledge necessary for effective disease control, many social and environmental changes in Pakistan have rendered current control measures less

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potent. New, effective measures for future malaria control operations are dependent on an understanding of how these changes have altered malaria transmission dynamics. What is necessary now to minimize host-parasite contact.

The team was impressed by the available human resources and talent. If experienced health and malaria staff are organized to collect the necessary data on disease transmission and mosquito species and populations, if more staff are given the necessary training, and if operational research is given sufficient priority and support, malaria foci and the factors that influence transmission can be fully identified and this knowledge employed for its control. Then problems, such as the recent findings suggesting that drug-resistant forms of falciparum malaria are spreading, can be confronted without the need for widespread therapy with expensive drugs.

Integration of MCP activities into the basic health services (BHS) is well along; 25 percent of all blood slides and 60 percent of all cases now come from health, not malaria, posts. Microscopy services are becoming more widespread and the area under passive case detection (PCD) is gradually being expanded.

Conditions are not so favorable for entomological services and research. Issues such as the importance of *Anopheles stephensi* as a vector, adequate information on anopheline breeding sites and densities, and evidence linking vectors and malaria outbreaks receive much less attention than needed. Entomology is currently one of the least effectively organized elements in the MCP. Because of the shortage of evidence about current vectors and the extent of insecticide resistance, this must be corrected.

Microscopist training and training of spraymen in safe handling of insecticides has been emphasized recently, but a shortage of funds for trainee travel and per diem remains a constraint to more widespread and effective training programs. Finally, there are some encouraging developments in the operational research program at the NIMRT, but that institution continues to be handicapped by a shortage of scientific staff.

**The sense of the recommendations is that:**

- 1. Gains in malaria control can be sustained but external assistance must be continued.**
- 2. Districts are a critical operational level. District health officers (DHOs) must be better indoctrinated on malaria. District and sub-district disease surveillance and reporting and entomological monitoring must be strengthened.**
- 3. Training and operational research deserve much higher priority in the future.**

## 1. Introduction

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For three decades there have been cooperative efforts to control malaria in Pakistan. Much has been achieved and much has been learned through these efforts, including a realization that malaria is resilient and capable of sudden resurgence. For this reason, the principal objectives of the GOP/USAID Malaria Control Project II since 1982 have been to reduce the incidence of malaria using cost-effective, sustainable methods. This project is scheduled to end in 1992, and technical assistance is expected to end in early 1994. The overall purpose of this evaluation was, therefore, to assess the ability of the Pakistan Malaria Control Program (MCP) to continue the containment of malaria without substantial outside assistance.

The more specific objectives were to assess the overall and provincial status of malaria, the adequacy of the disease surveillance system, current strategies and measures used to control the disease — particularly its mosquito vectors — the state of falciparum malaria resistance to chloroquine, and the adequacy of in-country training and operational research activities.

The team concluded that these objectives and an understanding of the impact of USAID project support for such a large and long-standing malaria control program could be achieved only by an overall study of the national MCP, rather than a review restricted to the Malaria Control II Project. Therefore, we have given only limited attention to specific project benchmarks in this evaluation. It was possible to attempt an overall evaluation of the MCP because of extended duty by WHO team members and a larger than usual team: 28 person-weeks of effort went into this evaluation.

## **2. Status of Malaria**

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The principal objective of Malaria Control Project II, signed in May 1982 and extended in 1987, is to assist the GOP in maintaining the Annual Parasite Incidence (API) at or below 0.5 cases per 1,000 population annually. This was to be done while integrating the four provincial MCPs, (which, with the federal Directorate of Malaria Control, or DOMC, constitute the national MCP), into the general health services of the country, shifting malaria surveillance from active to passive case detection (ACD to PCD) methods and reducing the amount of insecticide used through more judicious application.

The quantity of insecticide used has been greatly reduced and malaria has been contained, but the case rates have not decreased. The number of cases per 1,000 population has been satisfactory in Baluchistan, where it is currently rising, and in Punjab (except during several rainy years in the mid-1980s), but the rate is uncomfortably high in Sindh and North West Frontier provinces. Annual case levels of malaria in Pakistan from 1975 to 1990 are summarized in Table 1.

### **a. Changes during 1990**

Last year's evaluation report (VBC Report No. 81126) expressed concern over the sharp rise in malaria cases in Pakistan. This year, the overall situation has improved, as indicated in the table below. In 1990 the number of malaria cases was down more than 20 percent from 1989 — from 104,447 to 79,689. The reason for the decline may be lower rainfall in the southern part of the country for the past several years. Because the decline predates the annual spraying cycle, it could not be a result of increased use of insecticides, which was recommended in last year's annual evaluation report.

**Table 1**  
**Malaria in Pakistan: 1975-1990**

<b>Year</b>	<b>Population</b>	<b># Slides</b>	<b>Positive</b>	<b>SPR</b>	<b>API</b>
1975	48,305,324	3,205,689	238,315	7.43%	4.93
1976	49,799,303	2,857,854	122,219	4.28%	2.45
1977	51,279,670	2,667,315	47,571	1.78%	0.93
1978	52,737,019	2,588,257	16,160	0.62%	0.31
1979	53,929,411	2,686,624	12,318	0.46%	0.23
1980	55,103,689	3,006,624	17,707	0.59%	0.32
1981	56,934,577	3,018,468	37,923	1.26%	0.67
1982	58,067,409	3,303,067	56,360	1.71%	0.97
1983	58,468,028	2,587,920	51,596	1.99%	0.88
1984	60,746,320	3,255,853	73,996	2.27%	1.22
1985	62,133,283	3,119,695	77,607	2.49%	1.25
1986	63,997,281	2,919,894	91,289	3.13%	1.43
1987	65,917,199	2,943,178	63,948	2.17%	0.97
1988	67,894,715	3,094,198	57,811	1.87%	0.85
1989	69,931,557	3,098,759	104,447	3.37%	1.49
1990	72,029,503	2,608,398	79,689	3.06%	1.11

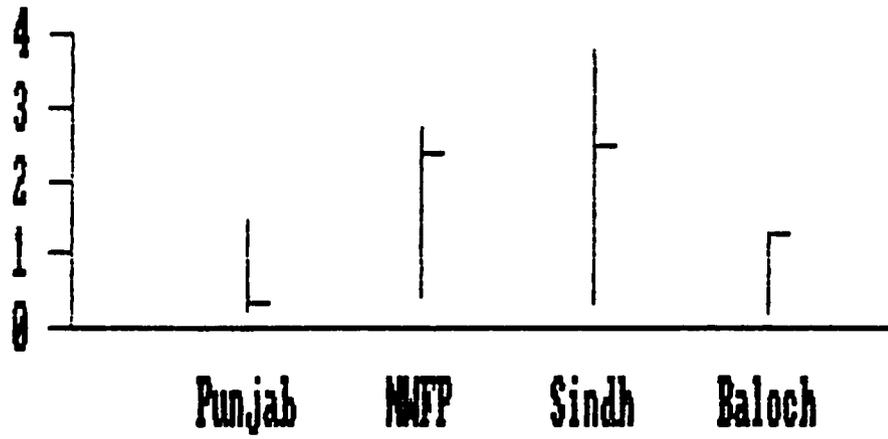
This generally favorable condition, however, does not prevail in every province. The API in Pakistan was 1.11 for 1990. It is well down in Punjab, but in the other provinces the API exceeds the target of 0.5 cases per 1,000 (Figure 1). Moreover, annual fluctuations range considerably higher than the figure below suggests. An increase in the slide positivity rate (the proportion of blood smears found to be infected with one of the species of malaria) reflects rising levels of malaria in a population. The SPR for malaria in the four major provinces of Pakistan during 1990 are presented in Table 2.

**Table 2**  
**Slide Positivity Rate in Pakistan Provinces, 1990**

<b>Province</b>	<b>Slides Taken</b>	<b>Positive</b>	<b>SPR</b>
Punjab	1,611,750	15,743	0.98
Sindh	455,967	29,956	6.57
NWFP	448,536	29,120	6.49
Baluchistan	92,145	4,870	5.29
<b>Totals/Mean</b>	<b>2,608,398</b>	<b>79,689</b>	<b>3.06</b>

To provide some perspective, the annual SPR in the problem provinces, Sindh and NWFP, during 1985-1990 are listed in Table 3. Although the current SPR and number of malaria cases in both of these provinces are excessive, it appears that the number of cases in Sindh may be starting to decline while the number in NWFP is on the increase.

**Figure 1.**  
**Malaria Cases/1,000: High, Low and Current (-)**  
**1980-1990**



**Table 3**  
**Slide Positivity Rates in Sindh and NWF**  
**Provinces, 1985-1990**

<b>Sindh Province</b>			
<b>Year</b>	<b>Slides Taken</b>	<b>Positive</b>	<b>SPR</b>
1985	465,787	14,265	3.06%
1986	474,063	17,089	3.60%
1987	518,201	17,807	3.44%
1988	520,407	15,120	2.91%
1989	511,771	44,168	8.63%
1990	455,967	29,956	6.57%

<b>NWFP</b>			
<b>Year</b>	<b>Slides Taken</b>	<b>Positive</b>	<b>SPR</b>
1985	473,193	16,728	3.54%
1986	516,240	26,234	5.08%
1987	488,107	18,809	3.85%
1988	471,830	20,353	4.31%
1989	666,763	24,279	3.64%
1990	448,536	29,120	6.49%

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It should be noted that the SPR, like all indices, must be viewed in context. As long as the number and source of blood slides remains nearly constant every year, it is very useful. But the MCP's emphasis on shifting from ACD to PCD — taking fewer slides from randomly selected people and more from patients visiting a clinic for relief from a febrile illness — tends to raise the SPR in the absence of an increase in malaria incidence. For this reason, the percent of PCD slides found positive during the last six years, which represents the proportion of fever in the population caused by malaria, is listed below.

**Table 4**  
**PCD in Pakistan: 1985-1990**

<b>Year</b>	<b>Total Slides</b>	<b>#PCD</b>	<b>%PCD</b>	<b>#PCD +</b>	<b>%PCD +</b>
1985	3,119,695	404,737	12.97	26,598	6.57
1986	2,919,894	478,942	16.40	38,833	8.11
1987	2,961,881	555,711	18.76	28,274	5.09
1988	2,960,786	528,052	17.83	30,422	5.76
1989	3,098,757	691,424	22.31	62,404	9.03
1990	2,608,398	666,124	25.54	48,850	7.33

It is evident that the number and proportion of slides from PCD is increasing as planned and that, in general, the number of PCD slides found positive for malaria is also higher now than it was a few years back.

These same data for the provinces with the highest rates of malaria, Sindh and NWFP, are given in Table 5. The SPR and PCD+ (positive cases identified through PDC) indices tell essen-

tially the same story for Sindh province. For NWFP, the PCD data present a slightly less troubling picture of the malaria situation than the SPR data. The recent substantial increase in the proportion of slides derived from PCD in Sindh has boosted the SPR without a corresponding increase in malaria incidence. In both provinces an understanding of the precise state of affairs depends on the availability and study of data derived from smaller reporting units.

**Table 5**  
**Positive Case Detection in Sindh and NWF**  
**Provinces, 1985-1990**

**Sindh Province**

<b>Year</b>	<b>Total Slides</b>	<b># PCD</b>	<b>% PCD</b>	<b># PCD +</b>	<b>% PCD +</b>
1985	465,787	115,867	24.88	5,204	4.49
1986	474,063	118,068	24.91	7,050	5.97
1987	518,201	148,331	28.62	7,049	4.75
1988	520,407	153,459	29.49	8,857	5.77
1989	511,771	245,925	48.05	30,881	12.56
1990	455,967	191,429	41.98	18,817	9.83

**NWFP**

<b>Year</b>	<b>Total Slides</b>	<b># PCD</b>	<b>% PCD</b>	<b># PCD +</b>	<b>% PCD +</b>
1985	473,193	90,716	19.17	9,100	10.03
1986	516,240	139,305	26.98	17,832	12.80
1987	488,107	160,918	32.97	11,626	7.22
1988	471,830	150,066	31.81	13,830	9.22
1989	666,763	167,436	25.11	17,609	10.52
1990	448,536	212,970	47.48	21,201	9.95

### b. Falciparum malaria

There is an additional dimension to the malaria problem in Pakistan, particularly in Sindh and NWFP, where there are unusually large numbers of *Plasmodium falciparum* cases. Falciparum malaria is the most severe form of the disease and causes death, particularly among young children. Falciparum malaria has been increasing in Pakistan for several years, as indicated in the table below.

**Table 6**  
**Falciparum Malaria in Pakistan: 1985-1990**

Year	Number of <i>Plasmodium</i> cases			Percent
	vivax	falciparum	Total*	falciparum
1985	48,556	29,327	77,607	37.79
1986	61,685	29,884	91,289	32.74
1987	41,650	22,821	64,271	35.51
1988	37,407	22,030	59,386	37.10
1989	49,437	55,125	104,447	52.78
1990	36,583	43,175	79,689	54.18

\*Includes mixed infections

Cases of falciparum malaria are far above the project target of limiting them to less than 20 percent of all cases, and have risen for the past four years to its current rate of 54 percent of total cases.

Falciparum malaria is not found uniformly throughout Pakistan, but it is a substantial part of the problem of increased malaria transmission in Sindh and NWFP. *P. falciparum* has become alarmingly common in Sindh and appears to be increasing rapidly in NWFP. The evidence of this is presented in Table 7.

**Table 7**  
**Falciparum Malaria in Sindh and**  
**NWF Provinces, 1985-1990**

**Sindh Province**

<b>Year</b>	<b>vivax</b>	<b>falciparum</b>	<b>Total</b>	<b>Percent falciparum</b>
1985	5,988	8,417	14,265	59.00
1986	6,775	10,444	17,089	61.12
1987	8,745	9,195	17,807	51.64
1988	6,794	8,361	15,120	55.30
1989	10,123	34,114	44,168	77.24
1990	6,862	23,130	29,956	77.21

**NWFP**

<b>Year</b>	<b>vivax</b>	<b>falciparum</b>	<b>Total</b>	<b>Percent falciparum</b>
1985	13,616	3,139	16,728	18.76
1986	22,400	3,918	26,234	14.93
1987	13,489	5,365	18,809	28.52
1988	15,150	5,212	20,353	25.61
1989	16,524	7,785	24,279	32.06
1990	18,056	11,081	29,120	38.05

In Sindh, three out of four cases of malaria are caused by *P. falciparum*. Falciparum malaria accounts for 38 percent of all cases in NWFP — but its level has doubled during the past five years.

This increase in falciparum malaria is a severe setback for several reasons — it is life-threatening and is becoming more resistant to treatment with chloroquine. There is an urgent need to investigate the cause of its appearance and the extent of falciparum malaria's distribution in Pakistan. Unfortunately, the means for investigating this emerging problem — a changing pattern of malaria for which current control strategy and practices appear inadequate — are currently lacking in Pakistan.

### c. Chloroquine resistance

Drug sensitivity studies were started in Pakistan as early as 1976, when baseline data were collected on the sensitivity of *P. falciparum* strains to chloroquine. Detection of the first two cases of R-I level of resistance occurred during 1981 in Punjab's Sheikhpura district, in a village called Tarey-da-Kot.

The most recent study conducted in Punjab province was in 1990. As in 1981, the village of Tarey-da-Kot in Sheikhpura district was investigated. The results of the study were as follows:

No. of Cases	Sensitive	R-I	R-II	R-III
57	36	17	4	0

In Baluchistan, a resistance study conducted during December 1990-January 1991 revealed the following:

No. of Cases	Sensitive	R-I	R-II	R-III
23	18	5	0	0

In Sindh Province two tests were conducted in December 1990-January 1991. The results were as follows:

<b>Village</b>	<b>No. of Cases</b>	<b>Sensitive</b>	<b>R-I</b>	<b>R-II</b>	<b>R-III</b>
Goth Kumb Dehroom	32	14	9	9	0
Goth Garho Sachla Mektale	55	30	22	3	0

These cumulative results indicate that the resistance to date is associated with R-I and R-II only; R-III resistance has not yet been detected in Pakistan. All these studies used *in vivo* tests. *In vitro* tests have not been conducted in recent years. One *in vitro* study was conducted in 1976, and two others in October and December 1984. Data from these tests revealed sensitivity to chloroquine. R-I resistance was implicated in only one study.

More chloroquine resistance studies should be conducted in all the provinces. *In vitro* tests of sensitivity as well as *in vivo* tests should be performed.

No tests of sensitivity to the antimalarial drug Fansidar have been conducted, but cases of malaria that failed to respond to treatment with Fansidar have been reported. Further investigation is needed to confirm resistance to this drug.

Table 8 presents the results of the *in vitro* tests, as well as the *in vivo* studies conducted since January 1990.

**Table 8**  
**Plasmodium Falciparum Sensitivity to Chloroquine**

<b>Date</b>	<b>District</b>	<b>Locality</b>	<b>Sensitive</b>	<b>RI</b>	<b>RII</b>	<b>RIII</b>	<b>Total</b>	<b>Test Type</b>
Jan 76	Khan, Jhang & Muzaffargahr		50				50	In vitro
Oct 84	Lahore	Gajju Matta	6	10			16	In vitro
Dec 84	Karachi	Hub-Dam-Colony	2				2	In vitro
Jan 84	Mohamand Agency	Yakka Ghund	9	23	6		38	In vivo
Nov 90	Sheikhupura	Tarey-da-Kot	36	17	4		57	In vivo
Dec 90	Dera Alah, Yar	Dera Alah, Yar	18	5			23	In vivo
Dec 90	Sanghar	Goth Kumbdah	14	9	9		32	In vivo
Dec 90	Sukkar	Goth Garho, S. Mectla	30	22	3		55	In vivo

### 3. Status of Malaria Control

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#### a. Integration

The management and operations of federal and provincial MCPs are being integrated into Pakistan's general health services (GHS). In most cases, the process of integration is well underway. At the federal level, management, research and training are funded and supervised by the federal Ministry of Health through the DOMC and NIMRT. The Malaria Control Coordinating Committee, a high-level policy group, has met twice during the past year. The provincial MCPs are all now part of the provincial health programs and field malaria control staff are responsible to the District Health Officers (DHOs).

Integration of surveillance is also advancing through the shift from ACD to PCD. Progress toward this objective, measured by the number of PCD posts in comparison to the number of Union Councils (the level of the basic health unit) lags most in Baluchistan (Table 9).

**Table 9**  
**Number of PCD Posts, 1990**

	Punjab	Sindh	NWFP	Baluch.	Totals
PCD Posts	17,260	621	733	6	18,620
U. Councils	2,377	642	631	192	3,842

PCD posts are sites where a patient with a fever can be tested and treated for malaria. They are not yet as uniformly distributed or permanent as Ministry of Health (MOH) health posts, but many are a cooperating basic health unit (BHU) or rural health center (RHC). Other posts are staffed by malaria workers to extend malaria surveillance activities and help people with fevers. With the

cooperation of health officials, all established health posts will soon serve as sites for malaria slide collection and treatment, leading to dissolution of the numerous interim "activated PCD posts."

This transition will be hastened by the continued shift of microscopic services from malaria and district offices to RHC and BHU sites. The shift will require that additional microscopists be trained and the availability of suitable antimalarial drugs improved. Because early treatment of infected individuals and accurate recording of case onsets and location are critically important to the success of the vector control measures discussed below, health officials should give full integration of the malaria diagnostic, treatment and surveillance system highest priority.

#### **b. Patterns of malaria**

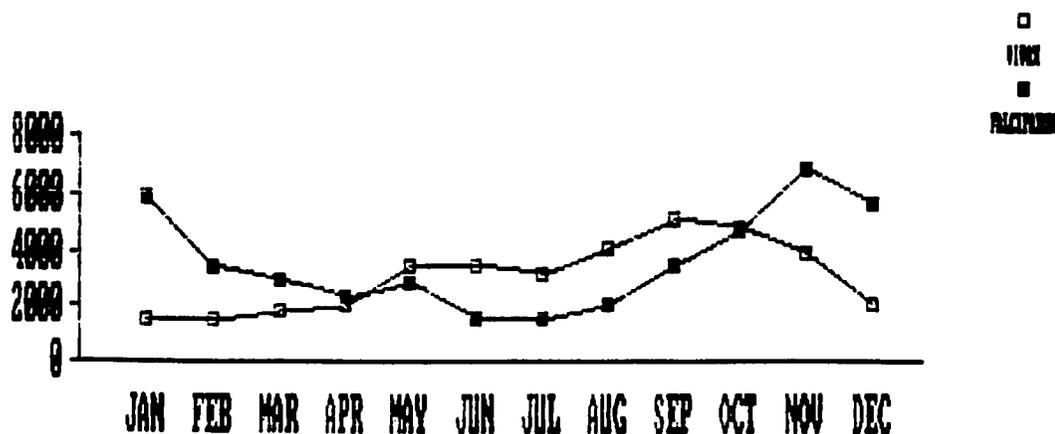
Information on the frequency and distribution of a disease, or surveillance, is the cornerstone of any malaria control program. Only widespread, accurate surveillance can identify the sites of outbreaks, lead to the identification of vector mosquitoes and allow the application of effective control measures.

The decentralization and integration of malaria control in Pakistan has complicated surveillance. Case detection data must make their way from health officials to malaria officials and from the village or Union Council level to district, provincial and federal levels. Changes in the reporting base from ACD (done by malaria staff) to PCD (done by health staff) are now well underway. Mechanisms for the rapid flow of surveillance data still need to be developed.

The objective of the surveillance system should be to record and collate malaria case data at locality levels. Currently it is difficult for decision makers to obtain recent malaria surveillance data even in district aggregates.

The seasonal pattern of malaria (Figure 2) consists of a rise in vivax malaria in early summer and a decline in early winter. Falciparum malaria cases peak in the autumn and do not decline until after the new year.

Figure 2. Monthly Malaria: Pakistan, 1990



Malaria distribution within the provinces is somewhat clarified by data from the 83 districts (Table A, Annex 2). There were 22 districts with an API exceeding 2.0 in 1990, compared to 24 in 1989. Twelve of these are in NWFP (11 in 1989), seven in Sindh (seven in 1989) and three in Baluchistan (four in 1989). The two districts in the Punjab with an API exceeding 2.0 in 1989 dropped below this level in 1990. The most malarious district is Khairpur, Sindh, and there have been large increases in several NWFP districts, notably Swat and Karrak. There were also substantial increases in Quetta and Turbat in Baluchistan. In Quetta the increase is attributable to malaria associated with unregistered refugees, but in Turbat, an area where numerous tube wells are used for irrigation, the cause is unknown.

From the data available, the malaria problem areas in Pakistan might be summarized as follows. First, the largest focus of malaria is in irrigated agricultural lands in lower parts of the Punjab and adjoining areas of Sindh and, to a lesser degree, Baluchistan. Somewhat less intensive transmission is common in similar sites throughout the Indus River drainage system. Second, much of the malaria in parts of NWFP and Baluchistan is associated with Afghan refugee movements and settlements. Third, there is an additional problem area in upper NWFP that may be associated with refugees or agricultural practices. There is no clear evidence that malaria is, or is likely to be, a problem in any large urban areas in the near future.

What is known about malaria in Pakistan — its distribution and patterns of occurrence, its vectors and their habits — is still largely based on studies done during the pre-eradication era. With the many social and environmental changes that have occurred over the past 30 years in Pakistan, the current validity of this information about malaria should be reassessed. Epidemiologic evidence in recent years suggests that changes in agricultural practices in rural Pakistan may have altered both human and mosquito populations in a way that contributes to ever-increasing levels of malaria, especially *P. falciparum* malaria. The extent to which rice cultivation and its associated irrigation practices might be responsible for the increase deserves special attention. Like mosquitoes, rice depends on extensive water supplies. Malaria linked with rice production might be controlled with water management methods once vector dynamics were better understood.

It should be noted that the common practice of linking the presence of many bothersome mosquitoes with malaria is misleading. Many of the nuisance mosquitoes in the country breed in polluted water unsuitable for *Anopheles* breeding and could be controlled only by improving drainage and sanitation systems.

### **c. Chemotherapy**

The DOMC's malaria treatment protocol, as reviewed by the WHO, is shown in the supervisor's manual and on plastic laminated treatment cards that are distributed to MCP and BHS workers. No relapses of vivax malaria have been reported following the recommended five-day treatment. Therefore, the treatment regimens for both vivax and falciparum malaria are still valid.

When a microscopist is not on site, it can take one to four weeks to receive a laboratory diagnosis of a blood film taken from a fever case (presumptive treatment given). Such a delay would be particularly dangerous if the case were caused by chloroquine-resistant *P. falciparum*, which could lead to many additional cases before radical treatment was given. Therefore, primaquine must be added to the presumptive dose of chloroquine if drug-resistant falciparum malaria is suspected. In Pakistan, this treatment regimen is currently practiced only in Punjab province.

The current recommended adult dose is 30 mg (4 tablets of 7.5 mg) of primaquine with 600 mg of chloroquine. It is clear from the treatment sheet that primaquine is not given to pregnant women or children younger than three.

Because chloroquine resistance is suspected to be widely spread among falciparum cases and mefloquine is not available in most situations, it is recommended that positive falciparum cases be handled in the following manner:

After the radical treatment is given, a follow-up slide must be collected by the malaria supervisor (or CDC supervisor) five to seven days after the beginning of the radical treatment. If the slide is positive for asexual parasites, chloroquine-primaquine treatment should be given, but under the best supervision possible. Another slide should be obtained five to seven days after the beginning of the second course of treatment. If this sample proves positive, then an alternative drug — preferably Fansidar — should be used. This drug should be used with caution and not given again.

If a patient is still ill seven days after taking the Fansidar, a blood film should be examined. Mefloquine should be given as directed below if malaria parasites are still present.

If a slide collected from a positive case five to seven days after radical treatment is negative for asexual parasites, a second follow-up slide must be collected three weeks after the radical treatment began. If this second slide is positive, then the radical treatment with chloroquine and primaquine should be repeated, but under strict supervision. An alternative drug should be used as above if a blood slide taken after three weeks from the beginning of the second radical treatment proves positive.

If radical treatment with chloroquine and primaquine is not effective against a case of chloroquine-resistant falciparum malaria, an alternative drug should be used.

At the end of 1989, the WHO's Malaria Action Program formulated the following recommendations for treating chloroquine-resistant falciparum malaria.

## 22

### Lariam tablets containing 250 mg mefloquine-base

For adults:

15 mg per Kg body weight taken in two doses. Drug should not be taken on an empty stomach. Maximum dose: 1,000 mg (four tablets).

Example: 60 Kg and above — four tablets of 250 mg, two taken immediately and two taken eight hours after the first dose.

For children:

15 mg per Kg body weight. Drug should not be taken on an empty stomach.

Example: about one tablet for 15 Kg to be taken in two doses — first dose 1/2 tablet, second dose 1/2 tablet eight hours later.

These are the preferred treatment regimens if mefloquine is available. It should be complemented with the usual dose of primaquine against *falciparum* gametocytes. As Fansidar is available with the DOMC and already distributed throughout the country, it could be used. However, Fansidar should be used with great care, and a second dose should be avoided because of problems of sensitization, which can be dangerous.

#### d. Vector control strategy

Residual application of the malathion at a target dosage of 2 g/m<sup>2</sup> continues to be the method of choice throughout all areas of the country where malaria vector control operations are undertaken. While resistance to malathion has appeared in *An. stephensi* populations in a substantial number of districts, adequate transmission control is still being achieved through control of the main vector, *An. culicifacies*. Until the vectorial status of *An. stephensi* is clarified, no changes in application practice are recommended. However, it is advised that late-season applications be considered to reduce the transmission of *falciparum* malaria.

Criteria for insecticide spraying remain the same as those recommended in the 1987 external review report. Where epidemiological surveillance detects a locality with two or more cases of *P. falciparum*, or five or more cases of *P. vivax*, the locality will be considered for spraying, especially if drug-resistant *P. falciparum* is present.

Where the above criteria result in a decision that a locality is to be sprayed, the extent of spray coverage is determined by the following guidelines established by the MCP:

- o in localities of 400-600 houses, 50 percent of the houses;
- o in localities of 600-1,000 houses, 25 percent of the houses;
- o in localities of 1,000 to 2,000 houses, 20 percent of the houses;
- o in localities of more than 2,000 houses, 10 percent of the houses.

This approach has resulted in a decrease of insecticide usage from a total of 4,000 metric tons in 1985 to 1,900 metric tons in 1990.

In 1990, 1,769,015 houses with 10,003,726 inhabitants, or 15.04 percent of the population, were covered by insecticide spraying. A total of 1,635 and 1,858 metric tons of malathion wdp were applied in 1990 and 1991, respectively, with the following distribution:

**Table 10**  
**Insecticide Use 1990 - 1991**

	<b>Malathion (tons)</b>	
	<b>1990</b>	<b>1991</b>
Punjab	705	722
Sindh	385	547
NWFP	475	483
Baluchistan	70	106
<b>Total</b>	<b>1,635</b>	<b>1,858</b>

Approximately 40 to 45 tons of insecticide are held for Azad Kashmir.

In 1991, USAID spent \$4 million to buy malathion to supplement stocks remaining from 1990. In addition, seven ULV fogging machines were purchased for use by urban vector control programs.

The practice of selective spraying based on the criteria described above and more effective malaria surveillance through the PCD program seem to be bringing the government closer to the possibility of self-reliance or sustainability.

Despite the progress that has been made, the basic malariogenic potential of the country has not changed. Where uncontrolled, vector densities remain high due to extensive irrigation. If the MCP continues to use the criteria described above, at least 1,000 tons of insecticide per year will be required for vector control. Because of this continued need to use at least a minimal quantity of residual insecticides to prevent a significant recrudescence of transmission, further donor support for the MCP will be sought for the period following the scheduled termination of USAID support in 1992.

A number of problem areas remain where transmission is not being satisfactorily reduced. Among these areas is Sindh province, where the security situation prevents adequate house spraying from being carried out. In the NWFP a number of factors appear to have combined to prevent adequate control, including a high level of insecticide resistance in *An. stephensi* populations (see below) and difficulties in gaining entrance to houses. The high levels of insecticide resistance in the NWFP have raised many uncertainties about the vector role of *An. stephensi*, its relation to the transmission of *P. falciparum* and its response to residual spraying. Operational research to resolve these problems is an urgent priority.

## **e. Insecticide applications**

### **Residual**

The team observed 12 spraying squads at work in the provinces of Punjab, NWFP, Baluchistan and Sindh. Malathion 50% wdp was being applied at a target dosage of 2 g/m<sup>2</sup>.

In general the quality of application was satisfactory, but the team's impression was that the dosage tended to be lower than the target of 2 g/m<sup>2</sup>. Patchy application was fairly frequent, and some surfaces were being missed, particularly in homes where the occupant's cooperation in moving furniture was poor. Ceilings were treated in all cases, although the deposit tended to be light. Extension lances were not used because ceilings could generally be reached with a single-length lance.

Walls were generally made of mud, though some were composed of whitewashed brick and plaster. Ceilings, particularly in Punjab and NWFP, were mostly of reed thatch and wooden beams, providing a good surface for malathion residual persistence. The wall applications would be expected to have a lower residual life.

Mixers often complained of gritty or sandy material in the powder (April 1991 Marman formulation). They attempt to filter it off as the mixture is poured into the pump. Only two squads complained that nozzle-tips were being clogged.

The insecticide is not weighed, but is measured out by volume in cans yielding roughly 1 Kg. This is added to water to make 10 liters, resulting in one pump charge of 5% active ingredient.

In the municipalities, ULV applications are conducted against non-malarious biting mosquitoes approximately every 30 to 45 days. This practice has relatively little effect on the biting population because of the infrequency of application, but may be of value for public relations.

## Larval

Larviciding is exclusively carried out by municipal corporations in urban areas. The larvicides used, fenthion, temephos (Abate) and pyrimiphos-methyl (Actellic), are supplied mainly by DOMC but are also acquired through local purchases.

Besides larviciding, source reduction methods such as filling, draining and clearing obstructed drains are also carried out by the municipalities.

The team was informed that larviciding and source reduction is also being considered in certain rural areas of Baluchistan where isolated water sources, such as korez and tube wells, may be causing a problem of anopheline production and subsequent malaria transmission.

### f. Insecticide resistance in anopheline vectors

The problem of insecticide resistance was reviewed in detail in the report of the external review for 1990 (VBC Report 81126); the situation has not fundamentally changed since then.

In the Punjab, 147 susceptibility tests were conducted on *An. culicifacies* in 1990-91; 96 percent of the tests showed that this species, the main vector of malaria in the province, remained susceptible to malathion. Four percent (eight) of the tests showed tolerance, which was detected in the districts of Sheikhpura, Rawalpindi, Sargodha, Phanewal and Bahawalpur. Susceptibility tests on *An. stephensi* showed this species to be resistant to malathion virtually throughout the entire province. Results of a small number of tests show that both species retain their high level of resistance to chlorinated hydrocarbons. A total of 135 tests were carried out with fenitrothion — 68 on *An. culicifacies* and 67 on *An. stephensi* — and no resistance to this compound was detected. The number of susceptibility tests undertaken in the province has remained at the same level for the last 10 years, providing a reasonably comprehensive picture of the status of susceptibility to the insecticides tested.

Since the provincial API in the Punjab fell to 0.36 during 1990, and there is no evident change in the ratio of *P. vivax* to *P. falciparum*, the high level of malathion resistance in *An. stephensi* populations appears to be having no effect on malaria transmission in the Punjab.

Survival in diagnostic tests of *An. culicifacies* against malathion was also seen in Sindh and Baluchistan.

In the NWFP, only 48 susceptibility tests were conducted during 1990 despite the uncertainty of the effect of malathion-resistant *An. stephensi* populations on the relatively high level of continued malaria transmission in the province. Of these tests, 43 were with malathion, four with fenitrothion and two with DDT. No resistance or tolerance to malathion was shown by any *An. culicifacies* populations. On the other hand, 24 tests of *An. stephensi* showed high levels of resistance with mortalities ranging from 48 percent to 60 percent and, in the Mardan district, only eight to 11 percent. Six populations, all in the Abbottabad district, were completely susceptible, showing 100 percent mortality after one hour of exposure to malathion test papers.

#### **g. Training and research**

Training activities are conducted at the provincial and federal levels to provide initial and advanced skill levels. At Lahore, the National Institute of Malaria Research and Training (NIMRT) conducts a variety of courses for students from Pakistani agencies and from countries in WHO's Eastern Mediterranean region. The second national workshop on drug-resistant malaria and the WHO entomology course were conducted at NIMRT in 1990. Two junior courses, two senior courses and an entomology technician course have been held during the last 18 months. Seven courses held since the last review have been directed to training microscopists for the PCD program at the district and rural health center levels; more than 120 microscopists received this training. Because of the demand for microscopists, five master trainers from each province have been trained at NIMRT. They are conducting training for microscopists at the provincial level to supplement those trained at NIMRT.

Training of spraymen (temporary employees) on safe methods of handling and applying insecticides is conducted by officers of the provincial staffs. Spraymen working for the United Nations High Commission for Refugees are trained independently by the High Commission staff.

A continuing constraint on training is the shortage of funds for travel and per diem for trainees. Without support for subsistence during the training periods, which last several weeks, qualified staff members are unable to take advantage of training opportunities.

The research output at NIMRT continues to suffer from a shortage of personnel. The principal research officer, a position abolished some time ago, would normally provide leadership for program direction, preparation of competitive grant proposals, selection of research assignments and other related matters. In the absence of this position, the two officers in NIMRT's Research Division fall under the supervision of the director, whose efforts are divided between the training, research and administrative responsibilities of the institute.

The research program is conducting operational village-scale field trials with chlorpyrifos-methyl (Reldan) and carbosulfan under a grant from WHO. A second round of applications and parasitological assessments is scheduled for 1992. A review of past NIMRT research on residual and larval control agents has provided the information necessary for future decisions on operational usage of pyrimiphos-methyl, fenitrothion and bendiocarb, and most of the potential larvicides. Studies on lambda-cyhalothrin and a pyrethroid are being scheduled. When these studies have been completed, information will be available on all the materials currently suitable for consideration in Pakistan's malaria control program.

The research program also includes a search for indigenous pathogens of anopheline mosquitoes and a proposal for funding for a bed net study is in the final stage of preparation. A one-year study of *Anopheles stephensi*, planned to begin in 1992, will address the continuing need for information on vectorial capacity of indigenous anophelines.

## **4. Future Program Strategies**

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### **a. External support**

The level of external support to the MCP has been generous. USAID has provided about \$113 million in U.S. or local currency support since 1963; more than half of this has been provided since 1982. The support has been used for commodities, equipment, supplies and technical assistance. WHO has provided technical support and supplies of high quality reagents, drugs and specialty items manufactured abroad.

Long- and short-term advisors have been funded by both USAID and WHO. These technical alliances are critically important to a program devising new control strategies and adapting to changing circumstances. However, there has been no resident advisor to the MCP from either USAID or WHO since early 1988. The need for such an advisor is great, and one should be provided by either agency. The supply of essential reagents, drugs and other supplies from abroad should be maintained.

It is essential to Pakistan's malaria program that external aid continue. Although the steady flow of malathion is the major element of USAID support, the other forms of assistance provided to the provincial programs — scarce supplies, occasional allowances, quality reagents, vehicles, technical advice and training — have been critical. Without a source of assistance and advice, the provincial MCPs would have great difficulty meeting program goals. Now is the time to prepare the program for changes in donor commitments with bridging mechanisms and early negotiations.

### **b. Program management**

The decentralized Pakistan MCP's strategy makes effective use of limited resources. Limited quantities of insecticide are used judiciously, applied according to the occurrence of malaria during the previous transmission season, and in some instances according

to the current season's transmission pattern. However, the strategy is increasingly handicapped by dependence on dated technical knowledge and a degree of inflexibility. It is dependent on external assistance and cannot be sustained without continued technical and commodity support.

The limited research and investigative capabilities within the MCP are a severe problem. The federal government must strengthen the ties between the management, investigative and operational elements of the program. Stronger support for provincial programs is essential. Technical assistance in organizing and conducting investigations of outbreaks, vector dynamics, and drug and insecticide resistance problems is badly needed. The level of support from provincial governments should, in most cases, be increased: not by large increments of money but by fairer practices, with allowances, career pathways, improved relations with curative health programs - in short, with greater integration and acceptance.

### **c. Surveillance-based information system**

To improve the effectiveness of limited control measures, rapid, detailed information of malaria patterns is essential. An improved surveillance system based on case information derived from health posts — not malaria program sources — is needed, as this system will soon be the entire reporting base.

Responsibilities for disease surveillance programs are always widely dispersed, and success is dependent on carefully planned, well-coordinated efforts. Efficiency is possible if only essential data are requested; ideally this should be obtainable from existing records. The critical operational levels are where the cases are detected, and where the data are initially compiled. Surveillance programs must therefore be developed at local, district and provincial levels — not at headquarters.

In Pakistan, malaria case data are generated at the local level and flow sequentially through district, provincial and national offices. Consequently, PCD malaria surveillance data should be compiled at the district level. Operational procedures in the clinics and hospitals

must be monitored and essential changes in data collection and reporting made.

A PCD-based malaria surveillance system can be expected to function most effectively where the basic health services are most developed, and where integration of the MCP into the GHS is well advanced. These criteria are critically important to selecting a project site. It appears that the integration of the MCP into the BHS is most advanced in Punjab and NWF provinces; it is less well advanced in Sindh, and the least so in Baluchistan. PCD is most advanced in NWF and Sindh provinces. NWF and Sindh provinces have numerous malarious districts. In most respects, NWFP appears to be the province of choice for starting a new surveillance-based malaria information system.

#### **d. Entomological monitoring**

##### **Anopheline distribution**

Anopheline distribution is a biological phenomenon that is continually influenced by ecological changes resulting from water development projects, deforestation, shifts in agricultural patterns (such as introduction of rice cultivation or cattle-raising), and climatic changes.

Added to the above, migration can take place over large distances, and there is an ever-increasing number of cases involving the introduction of non-local species of anophelines by air (often accompanied by "airport malaria"). As such, traditional species distributions can no longer be considered valid. Up-to-date distribution maps must be established and maintained if accurate epidemiological assessments are to be made and effective vector control measures devised.

Maps should be established at the district level, based, in the first instance, on material identified in the course of regular operational monitoring. This information should be supplemented by faunal surveys carried out by provincial headquarters personnel to fill in any gaps. A useful basis for recording faunal distribution is the quarter degree square statistical format.

Both *An. stephensi* and *An. culicifacies* are members of species complexes known to exist in the country. Therefore, accurate taxonomic determination is essential because individual taxa can differ in behavior and vectorial competence, and possibly in insecticide resistance levels.

### **Seasonal densities**

Anopheline densities, particularly in areas where people live or work, are an important factor in estimating vectorial capacity at any given time. A knowledge of season densities and their fluctuations is an important element of a monitoring program if operational decisions are to be based on sound epidemiological principles.

To establish and monitor seasonal density fluctuations, regular monthly checks should be initiated in selected representative indicator localities. Regularity in observation is essential to avoid any gaps that would reduce the epidemiological significance of the data, therefore affecting operational decisions.

### **Insecticide susceptibility**

The susceptibility of the two major endophilic anophelines (*An. culicifacies*, *An. stephensi*) is monitored year-round in all provinces. In some provinces, other species (*An. subpictus*, *An. pulcherrimus*) are assessed when available. Exposure to malathion and fenitrothion make up more than 90 percent of the observations, with the remainder being on DDT and BHC or dieldrin.

When conducted systematically in conformity with standard practices, these studies provide early warning of tolerance to pesticides in use, and can be used to assess the potential efficacy of alternate pesticides. However, the demonstration of tolerance in these studies does not necessarily indicate that the insecticide in question will not be effective in the field.

This complex issue is of major concern to Pakistan's malaria program. As such, it should command a high priority for provincial-level staff training to assure uniformity of assessment and interpretation of results.

## Operational research

### Vectorial capacity and vector incrimination studies

The Malaria Control Program considers that there are two malaria vectors in Pakistan, *An. culicifacies* and *An. stephensi*. Of these, *An. culicifacies* is regarded as by far the most important vector. *An. stephensi* was earlier thought to be essentially an urban vector of malaria but is now widely reported to be a secondary vector in rural areas. There is little definite information available on the relative importance of the two species in different parts of the country. Furthermore, almost no information is available on other species of anophelines that may be secondary vectors in Pakistan; some of these are relatively important vectors in other countries.

*Anopheles stephensi* is known to be one of the most important vectors of malaria in India, Iran and Iraq. The species probably consists of two subspecies, the type form *An. stephensi* and *An. stephensi mysorensis*. It is thought that both are present in Pakistan. Studies on the relative vectorial importance of the two subspecies generally conclude that the type form is the more important vector, but form *mysorensis* has also been incriminated as a vector in southeast India.

In 1987, the staff of the National Malaria Research and Training Center in Lahore (NIMRT) found a variant subspecies that they believed could not be assigned to either the type form or form *mysorensis*. No follow-up studies have been conducted to clarify this finding.

*Anopheles stephensi* was considered the main vector of malaria in the Karachi epidemic of 1966. Yet in a study carried out from 1947 to 1951 in Karachi, when 76 percent of the anophelines caught were *An. stephensi*, 23,223 females were dissected and none were positive for gut infections. At the same time, the sporozoite rate in *An. culicifacies* was 0.8 percent, and the authors (Hussain & Talibi, 1956) considered it to be the vector, relegating *An. stephensi* to the status of a possible vector. Nevertheless, *An. stephensi* continued to be regarded as the main vector in Karachi city (Rehman and Muttalib, 1967)

and Mujahid (1967) reported the finding of positive glands. Densities of *An. stephensi* in that city now appear to be dropping, probably due to ecological changes that do not favor survival.

DeZulueta (1989) believed that *An. stephensi* was the vector responsible for the high incidence of malaria in the Afghan refugee camps, particularly those in the North West Frontier Province. More recently, Parvez and Shah (1989) in the Punjab, found a high natural rate of gut infection in *An. stephensi* and a 1.5 percent sporozoite rate. They concluded that this species was not less important a vector than *An. culicifacies* in the area.

The uncertainty about the relative importance of *An. stephensi* as a vector of malaria, especially in rural areas in Pakistan, is hardly an academic question. *An. stephensi* populations in Pakistan have developed widespread, high levels of resistance to malathion. Residual spray applications with malathion often result in the disappearance of *An. culicifacies*, leaving only *An. stephensi* present in the villages and the NWFP refugee camps. This occurrence may be causing the persistence of malaria transmission in areas where control is proving difficult to achieve.

It is apparent that a comprehensive study of the vectorial capacity or status of *An. stephensi* as a vector of malaria, particularly of *P. falciparum*, must be given a very high priority in Pakistan. It is, in fact, long overdue. As donor support for the MCP lessens or is withdrawn, it will be all the more important to ensure that control operations, especially residual spray applications, are made as selectively as possible. This means efforts must concentrate on targeting the correct vector species in areas where persistent transmission appears to require continued insecticide use.

The study should be carried out in an area that has active malaria transmission and substantial populations of *An. stephensi*. Adequate baseline studies of the population densities of anopheline species in the study area should be conducted and

insecticide resistance levels in all species established. Equally detailed studies should establish the status of malaria in the study area.

The team was informed that there is an understanding between NMIRT in Lahore and USAID for the implementation of a study on the relationship of *An. stephensi* to the failure of malathion to control transmission. It is also understood that USAID will provide a consultant to assist in planning, implementing and evaluating this study. The planning for the study should include the following issues:

- o the species composition of the *An. stephensi* complex in Pakistan, or at least in those areas where problems have been encountered in controlling malaria vectors;
- o the bionomics of the species, including longevity, host preferences, resting sites and seasonal variations in population densities;
- o the insecticide resistance status of the species present in relation to malaria transmission and the effect of insecticide applications on population densities;
- o the vectorial capacity and vectorial role of each species for *P. falciparum* and *P. vivax*;
- o making recommendations for malaria vector control based on the findings of the above investigations; and
- o making recommendations for future entomological surveillance of *An. stephensi* and other vector or potential vector species.

### **Environmental aspects/habitat**

The annual use of over 1,500 metric tons of malathion presents situations in which environmental hazards may occur. The major hazards are related to spills during transport, storage and mixing. Previous assessments have concluded that the

training provided in the safe handling of pesticides adequately addressed these issues; this team's review revealed no serious lapses in this responsibility.

The safe application of malathion represents little or no environmental hazards for a number of reasons, including the fact that the pesticide degrades rapidly outdoors and has a very low level of toxicity to mammals. In addition, because the program is directed to spraying the inside walls and surfaces of houses and shelters, little should be deposited outdoors.

No efforts are being made to modify the habitat in which anopheline breeding occurs. For most of the breeding areas such modifications are currently impractical. In some circumstances, however, source reduction or habitat modification might be considered for isolated breeding sites where control would reduce local dependency on residual applications. Opportunities for such activities are most likely to be associated with riverine breeding, subterranean breeding, container breeding and low annual rainfall.

#### **Field trials of alternative insecticides**

Vector resistance to pesticides has been a problem for the MCP in Pakistan for a considerable period. Resistance to the chlorinated hydrocarbon insecticides DDT, dieldrin and HCH is very widespread, and a high level of malathion resistance is present in most populations of *An. stephensi*. Now resistance has also been detected at low levels in some populations of *An. culicifacies*. As a consequence, a number of insecticide efficacy trials have been carried out on alternative compounds against anopheline vectors in Pakistan.

USAID has informed the NIMRT in Lahore of its readiness to support the costs involved in a field trial of four candidate-compounds, such as fenitrothion, bendiocarb, lambda-cyhalothin, and pirimiphos-methyl. This support was discussed at USAID, MCP and the NIMRT.

The NIMRT, with financial support from the WHO, is currently in the first year of a two-year trial of chlorpyrifos-methyl (Reldan), an OP compound, and carbosulfan, a carbamate. A single round of these insecticides was applied in villages in the Punjab in July 1991 and is now being evaluated. At 42 days, Reldan applied at 1 g/m<sup>2</sup> had reduced *An. culicifacies* populations by 98 percent and no *An. stephensi* had been found in treated houses for 60 days. Human/vector contact also remained at zero 60 days after application. Carbosulfan, which was also applied at a dosage of 1 g/m<sup>2</sup>, has effectively reduced vector populations and no vectors have been found resting in treated houses 60 days after the application.

The staff of the NIMRT was prepared to carry out the field-trials proposed by USAID on the condition that additional temporary staff be provided to assist the NIMRT entomologist, Mr. S.D. Parvez, in conducting the study. It is understood that such additional assistance has been agreed to.

However, Dr. Shah and Mr. Parvez raised the question of the necessity of further field trials on compounds they believe have already been adequately studied in Pakistan. They speculated as to whether other pesticides might be considered. Examination of the literature and unpublished reports shows that their question is valid. A number of trials have been conducted that probably provide enough information for making a valid decision on whether bendiocarb, fenitrothion and pirimiphos-methyl might be effective replacements for insecticides to which resistance has developed. The results of major trials of candidate pesticides that have already been carried out in Pakistan are summarized in the table below, though it should be noted that there were probably other insecticide trials from which information was not available to the team:

**Table 11**  
**Results of Major Pesticide Trials in Pakistan**

Year	Pesticides	Source	Results
1973	malathion 2 g/m <sup>2</sup> fenitrothion 1 g/m <sup>2</sup> BHC 2 g/m <sup>2</sup> ?	1	effective 52-66 days very effective 70 days ++ effective
1981	pirimiphos-methyl 2 g/m <sup>2</sup> (Actellic) 1 g/m <sup>2</sup>	2	very effective to 8 months 1 g/m <sup>2</sup> as good as 2 g/m <sup>2</sup>
1982	Propoxur 1 g/m <sup>2</sup> fenitrothion 1 g/m <sup>2</sup>	3	effective 2 1/2 months effective about 2 months
1982	bendiocarb 0.038 g/m <sup>2</sup> fenitrothion 1.09 g/m <sup>2</sup> malathion 1.89 g/m <sup>2</sup>	4	effective about 2 months effective about 2 months effective about 1 month
1988	malathion 1 g/m <sup>2</sup> malathion 2 g/m <sup>2</sup>  lambdacyhalothrin 0.03 g/m <sup>2</sup>  chlorpyrifos-methyl 0.5 g/m <sup>2</sup> (Reldan)  1.0 g/m <sup>2</sup>	5	less effective than others due to resistant <i>An. stephensi</i>  140 days for <i>culicifacies</i> , less against <i>stephensi</i> . Retest @ 0.04 g/m <sup>2</sup>  up to 100 days but density not reduced to zero  effective 100+ days vs. <i>stephensi</i> , 90+ days vs. <i>culicifacies</i>

In view of the extent of these earlier trials, it was suggested that in 1992 lambda-cyhalothrin (Icon) be tested at 0.04 g/m<sup>2</sup> using pirimiphos-methyl at 1 g/m<sup>2</sup> as a standard, with either permethrin or deltamethrin as a second experimental insecticide.<sup>1</sup> Additional professional and sub-professional staff would be required to assist the NIMRT and Mr. Parvez in supervising and evaluating the study.

Soon the NIMRT will prepare a revised budget submission and revised protocol, but it needs advice on selecting pyrethroids that should have priority for testing. This is urgent, as a decision must be made on procurement of the insecticide in the near future to ensure its availability for the 1992 spray season.

The NIMRT has submitted a protocol to USAID for a permethrin-impregnated bed net trial to be carried out in the vicinity of Lahore in the Punjab. The trial will be supervised by an NIMRT entomologist. The bednets will be impregnated and distributed to the selected test villages for the 1992 season.

In discussions with Dr. Rowland (MSF-Holland, entomologist consultant attached to the UNHCR in Peshawar), the team was also informed of insecticide field trials that he is conducting or planning in the Afghan refugee camps in the NWFP. A permethrin-impregnated bed net trial is currently underway; the bed nets were put in place in a camp in July 1991 and the first epidemiological evaluation of their impact will be carried out in November 1991.

Additional trials being organized by Dr. Rowland include a comparison of the effects of fenitrothion at 1 g/m<sup>2</sup>, pirimiphos-methyl at 1 g/m<sup>2</sup>, lambda-cyhalothrin at 0.3 g/m<sup>2</sup> and one vs. two rounds of malathion.

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<sup>1</sup> Editor's note. The NIMRT and DOMC plan to test pirimiphos - methyl, bendiocarb, lambda-cyhalothrin and deltamethrin in 1992 pending the outcome of an environmental assessment.

Dr. Rowland pointed out that insecticide-resistant *An. stephensi* populations in the NWFP are transmitting malaria for at least four months of the year, whereas the residual efficacy of malathion is no longer than approximately one month.

Nevertheless, two rounds of malathion may provide control in those areas where the level of resistance is not too high. In addition, two rounds of malathion would be less expensive than a single round of several of the alternative insecticides.

The considerable problem of intoxication of UNHCR spraymen who applied fenitrothion in 1990 appears to have been due to their lack of training in the safe use of pesticides. In addition, there was little supervision of their spraying in the camps. A possible solution to the problem of poorly trained spraymen using fenitrothion might be to pack the wdp concentrate in single pump-charge sachets.

## **e. Training**

### **Continued human resource development**

Here the basic need is for career development. The team encountered personnel who had been in the same grade for 20 years. Such lack of career mobility leads to stagnation and poor morale.

The situation may be improved by appropriate selection of candidates for training courses and study tours. Maximum impact of training opportunities would be ensured by linking them to clear prospects for career advancement.

The expertise and experience gained during the malaria eradication era will soon start to disappear from the present cadre of malaria workers. This makes it imperative that replacements be recruited and trained in time if malaria control capability is to be maintained. Obviously, training should be both theoretical and practical, including a period of in-service training for experience-transfer.

To maintain professional competence, there is an obvious need for frequent access to state-of-the-art workshops and seminars to acquire knowledge of new techniques and approaches.

### **Strengthening entomological activities**

Basic entomological services in vector-borne disease control programs are expected to contribute to the following activities:

- o supply of basic planning information, such as vector identity and distribution, seasonal densities, behavior patterns;
- o epidemiological investigation of refractory situations that obstruct the smooth running of the control program;
- o regularly monitoring the impact of control operations; and
- o operational research aimed at improving existing control methods and devising new cost-effective operational approaches.

While the position varied somewhat from province to province, the team found that, on the whole, the basic entomological activities suffered due to:

- o a shortage of entomological staff at provincial and district levels;
- o the need for career development training of existing staff; and
- o a chronic shortage of suitable transportation.

Future program strategies should be aimed at improvement in the areas listed above. Each province should have an operational research capability for rapid reaction to provincial operational requirements.

**Diagnostic capabilities**

To achieve the objective of reducing the use of imported insecticides, it is important to adopt an early method of diagnosing and treating all positive malaria cases. To achieve this, there should be continued emphasis on the plan for training the required number of malaria microscopists, especially in the established health posts. Availability of the proper drugs for malaria in all the health institutions is of vital importance.

The policy of the Government of Pakistan is to decentralize the laboratory services at RHC and BHU. The present number of microscopists is far less than that required. Some of the malaria provincial headquarters have started to conduct refresher courses for laboratory technicians and assistants in microscopic diagnosis of malaria. This is well established in the Punjab province.

The DOMC should aim at establishing malaria diagnostic laboratories in all the RHCs as soon as possible, and then gradually covering the BHUs with trained malaria microscopists. Previously it was suggested that all new malaria microscopists be trained in the NIMRT at Lahore, but due to the enormous numbers of microscopists needed, this appears impossible. Therefore, the NIMRT should concentrate on training senior malaria microscopists as well as conducting master trainers courses. The master trainers should be able to conduct refresher courses for laboratory technicians and assistants, and provide the proper training courses for malaria microscopists in their province. By relieving them of this training burden, the master trainers can free NIMRT researchers to conduct other courses and carry out operational research.

Sindh province has 13 senior malaria microscopists in charge of the district headquarter laboratories, as well as one in charge of the provincial reference laboratory in Hyderabad. In addition, 104 microscopists are working in different districts, and a new center for refresher courses in malaria microscopy has been established for training laboratory technicians and assistants in the province.

In Punjab province the planned expansion should increase the number of microscopists from about 300 to 2,374 if each RHC and BHU receives a malaria microscopist. This goal seems to be very ambitious. The laboratory assistants and technicians of all the health institutions are to attend courses on malaria microscopy at the training center of the provincial directorate, which was established with the assistance of the Federal Government and USAID. Six courses have been conducted through June 1991. Baluchistan province has two senior malaria microscopists and 19 malaria microscopists. The aim is to establish a malaria diagnostic laboratory at each district headquarters.

Recently, during August 1991, it was announced by the GOP that community health workers (CHWs) would be introduced gradually into the country. If they are used properly, they could be an excellent tool for PCD, as the community health workers will be recruited to work in the villages. The malaria directorate should ensure that CHWs are taught how to take a blood film from a suspected case of malaria and administer the presumptive treatment.

## 5. Recommendations

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### **District Health Officers**

We recommend that the provincial directors-general of health, with the assistance of the NIMRT and DOMC, sponsor workshops for district health officers on malaria and current control measures. This action would help reduce the occasional lack of understanding of malaria epidemiology and control principles observed on the part of some district health officers, and enhance recognition of the key role played by DHOs in the supervision and support of anti-malaria activities.

### **Microscopists**

For prompt diagnosis and treatment of the positive malaria cases, it is recommended that more malaria microscopists be trained and placed at all RHCs and, gradually, the BHUs.

### **Training**

It is recommended that Malaria Control Coordination Committee review the current syllabus of training at NIMRT and suggest revisions where warranted to meet current provincial and national needs. Of particular concern is the vulnerability of the passive case detection system if it is not adequately staffed with qualified personnel who have received relevant, current training.

Refresher courses for provincial malaria control staff should also receive high priority. To assure attendance, adequate travel/per diem funds should be made available.

### **Plasmodium sensitivity testing**

Because of the increasing number of drug-resistant cases of falciparum malaria, it is recommended that routine *in vivo* as well as *in vitro* tests be conducted in all the provinces and numerous districts by provincial malaria staff trained at NIMRT. Because mefloquine, Halofantrine and Fansidar are used by private practitioners, the testing for sensitivity of *P. falciparum* should be extended to include these drugs.

### **Malaria treatment**

Chloroquine is still the drug of choice for the treatment of all malaria cases, unless a specific case proves resistant. Additional drugs such as Fansidar and mefloquine should be available to treat resistant case. We recommend that the MCP and BHS ensure that primaquine is given with chloroquine in presumptive treatment if drug-resistant falciparum malaria is suspected. Follow-up of positive falciparum cases of malaria is also vitally important to ensure that treatments are effective.

### **Vector incrimination**

In many areas of Pakistan the vector species of primary importance remains uncertain. To resolve this question, we recommend that NIMRT establish ELISA screening facilities as soon as possible to process anopheline samples that can be sent from malaria foci throughout the four provinces. The resulting information will help clarify the epidemiological background of malaria transmission in many areas of the country, and establish or confirm the role played by various anopheline species in transmission. Ultimately this knowledge will lead to more appropriate operational interventions. Since there may be seasonal changes in transmission, the investigation should be carried out for at least one year and the insecticide susceptibility status of the populations studied should also be determined.

Besides the NIMRT at the federal level, suitable arrangements for ELISA screening could be made with H.E.J. Research Institute of Chemistry, University of Karachi, and the Institute of Biochemistry, University of Baluchistan. Both of these institutes are conducting studies on malaria immunology.

### **Vector identity**

Parallel to ELISA screening for sporozoites, identification and distribution of the members of the species complexes present in Pakistan, such as *An. culicifacies*, *An. subpictus*, *An. stephensi*, should be established. Information about the vectorial competence of these taxa and their seasonal distribution, behavior and susceptibility status will provide a better understanding of the epidemiology of malaria in different parts of Pakistan. It is recommended that the investigations described above be undertaken by the NIMRT, possibly in collaboration with other institutions.

### **Entomological services**

In view of the important support that should be provided to malaria control activities in the areas of a) basic information on vector identity, distribution, seasonal densities, bionomics and insecticide susceptibility status, b) clarification of refractory situations, c) operational monitoring, and d) operational research, the team recommends that entomological activities be appropriately strengthened at the federal, provincial and district levels to provide increased support for program planning decisions and adjustments. Access to vehicles to conduct field studies is particularly important.

### **Insecticide resistance**

To determine the presence of resistance mechanisms in *An. culicifacies* that survive diagnostic exposures, we recommend that NIMRT, in cooperation with international collaborators, conduct susceptibility tests and biochemical analysis of the progeny of the survivors.

## **Insecticide testing**

In view of the widespread resistance in *An. stephensi* populations to malathion and the possibility that such resistance may develop in *An. culicifacies*, field trials of alternative residual insecticides should be given a high priority.

Because of the urgent need to complete trials of new compounds, the team recommends that there be no repetition of trials on insecticides for which adequate information is already available from earlier studies in Pakistan. We recommend that the 1992-1993 NIMRT/USAID trials on residual insecticides include only lambda-cyhalothrin (0.04 g/m<sup>2</sup>), pirimiphos-methyl (1 g/m<sup>2</sup>) as a standard, and one of two candidate pyrethroids (deltamethrin or permethrin). (See footnote, page 39.)

## **UNHCR**

Close cooperation and coordination should exist between the various refugee agencies involved and the Directorate of Malaria Control. Currently, it appears that the DOMC is not informed of the progress or results of refugee-related malaria control activities, including spraying operations, case detection, treatment and operational research on vector control. For their mutual benefit, we recommend increased coordination between DOMC and UNHCR in targeting high-risk areas or populations, collecting and analyzing malariometric data, developing treatment strategies and conducting operational research.

## **Surveillance-based information system**

Malaria programs are experienced in surveillance methods, but the integration of the MCP into the health services is making traditional methods of malaria surveillance obsolete. Substantial revisions are needed to adapt from ACD to improved PCD methods of case detection and to make data flow rapid and reliable. Such revisions could provide the basis for surveillance of clinical conditions, including pyrexia of unknown origin (PUO), malaria and

other diseases. We recommend that the MOH and DOMC give high priority to developing an improved malaria recording and reporting system, and that it be structured and tested in a province where integration is well advanced.

### **Sustainability and donor support**

For 10 years the strategy of the MCP has been to develop and employ alternative control measures while reducing the use of residual insecticides. Malaria is now less contained than when this strategy was employed, but is still at manageable levels. External support has declined over this period in proportion to reductions in insecticide use, but remains substantial. Although the MCP is less dependent on residual insecticides and the GOP might now be able to purchase the necessary quantities, the provincial programs are still very dependent on other forms of donor support: technical assistance, foreign purchases of critical supplies, equipment such as vehicles and microscopes, and meeting unanticipated needs for special operations and research. We therefore recommend that the MOH, with the help of USAID, make every effort to find an alternative donor, and build bridging mechanisms to maintain continuous support should USAID support end as scheduled.

## **Annex 1. Officials Interviewed**

### **Islamabad**

#### **USAID/Islamabad**

Ms. Nancy Tumavick, Acting Director of Mission  
Ms. Anne Aarnes, Chief, Office of Health, Population and Nutrition  
Dr. Rifaq Ismail, Project Officer, O/HPN  
Mr. Virgil Medima, Chief, O/PRO  
Mr. Richard Steelman, Acting Chief, O/PDM  
Mr. Joseph Ryan, O/PRO  
Mr. Waldemar Albertine, O/Environment  
Mr. Shahabuddin Kahn, O/PDM  
Mr. Mark Ward, Regional Legal Advisor  
Mr. Ilyas, O/CC  
Mr. Kahn, O/FM

#### **Ministry of Health**

Dr. Ali Mohamad Ansari, Director General of Health  
Mr. Faries Rehman, Joint Secretary, Health  
Dr. Azharmahmood, D/D-G of Health, Public Health

#### **Ministry of Health, Directorate of Malaria Control**

Mr. Chaudhary A. A. Mujahid, Director  
Dr. G. Hashim, Epidemiologist  
Mr. Aslam Khan, Health Education Officer

**Punjab**

**Director General Health Office, Lahore**

Dr. Mazhir Ali Hashmi, Director General Health  
Dr. Aftab A. Chaudhary, Director CDC  
Dr. Mohsin Abbas Naqvi, Assistant Director Malaria  
Mr. M. Ashraf Chaudhary, Senior CDC Officer  
Mr. M. Azam Chaudhary, CDC Officer  
Mr. Matin-ul-Haq, CDC Officer  
Mr. Sana A. K. Mahmood, CDC Officer  
Mr. Mukhtar Ahmed Shah, Parasitologist

**National Institute of Malaria Research and Training, Lahore**

Dr. Imtiaz Hussain Shah, Director  
Dr. M. Pervez Mahmood, Medical Officer  
Mrs. Ghazala Nadeem, Entomologist  
Mr. S. D. Pervez, Assistant Entomologist  
Mr. Mushtaq Ahmed Rai, Assistant Scientific Officer

**Municipal Corporation, Lahore**

Dr. M. Hanif Shaikh, Director Health  
Dr. Asad Khan, Epidemiologist

**District Health Officer's Office, Sheikhpura**

Dr. Kaleem Ahmad, District Health Officer  
Mr. Azam Azhar Chaudhary, CDC Officer  
Mr. Naeem Ullah Khan, Assistant Entomologist

**NWFP****Secretariat (Health), Peshawar**

Dr. Prof. M. Shafiq Khan, Health Secretary  
Dr. Maj. M. Yakoob Khan, Deputy Director (Admin)  
Dr. M. Sharif Khan, Deputy Director (School Health Services)

**Directorate of Health Services, Peshawar**

Dr. Nadir Khan, Director Health Services  
Dr. M. Iqbal Khan, Assistant Director (Malaria)  
Mr. A. Aziz Khan, Sr. Malaria Superintendent  
Mr. Murtaza Khan, Malaria Superintendent  
Mr. M. Hashim Khan, Malaria Superintendent  
Mr. Shaukat Pervez, Assistant Entomologist  
Mr. Waris Khan, Health Education Officer

**Civil Hospital, Matta**

Dr. M. Azim Khan, Medical Superintendent  
Mr. M. Ayub, Microscopist  
Mr. M. Bashir, Microscopist  
Mr. Mohib Gul, Laboratory Assistant

**Health Division, Islamabad**

Mr. Faris Rehman Khan, Secretary Health  
Dr. Azhar Mahmood, Dy. Director General (PH)  
Dr. A. Rashid Qureshi, Dy. Director General

**Directorate of Malaria Control, Islamabad**

Chaudhary A. A. Mujahid, Director/SSO  
Dr. Ghulam Hashmi, Epidemiologist  
Mr. Mohammad Aslam Khan, Health Education Officer  
Dr. Mrs. Shireen Ansari, Medical Officer  
Mr. M. Noor Alam, Statistical Officer

**UNHCR Islamabad**

Dr. Nicholas Cossidis, A Com (Prog.)  
Dr. B. R. Swaid, Health Coordinator

**Sindh**

**Secretariat (Health), Karachi**

Mr. Saiyed Siddiqui, Health Secretary  
Mr. Aftab A. Qureshi, Additional Secretary  
Dr. Ommer Baloch, Deputy Secretary (Tech)

**District Health Officer's Office, Karachi**

Dr. Allah Rakhio Bhuggio, District Health Officer  
Mr. Asmatullah, N.M.E.  
Mr. Naveed A. Hashmi, Assistant Entomologist  
Mr. M. Khalid Siddiqui, Malaria Superintendent

**Mango Pir**

Mr. Ishrat Hussain, Malaria Supervisor Farsi Para.  
Mr. M. Yasin Bhatti, Malaria Supervisor T.B. Sanit.

**Malaria Control Programme, Hyderabad (at Karachi)**

Dr. Ghulam Rasul Sheikh, Director (Malaria)  
 Mr. Sumar Sadaruddin, Epidemiologist  
 Mr. Majid Khan, Senior Malaria Superintendent  
 Mr. Shariful-Hussain, Senior Evaluator

**Karachi Metropolitan Corporation, Karachi**

Dr. Sikandar Ali Panhwar, Director Health Services.  
 Chaudhary Altan Ahmed, Entomologist  
 Mr. Abdul Jabbar, Malaria Superintendent

**Sarfraz Rafique Shaheed Hospital, Karachi**

Dr. Arif Jamil Khan, Pathologist  
 Mr. Nisar Haider Malik, Laboratory Technician  
 Mr. Salim Raza, Assistant Laboratory Tech.  
 Mr. Naeeduddin, Laboratory Assistant

**Baluchistan****Secretariat (Health), Quetta**

Dr. M. Iqbal Khan, Health Secretary  
 Dr. A. Rehman Khan, Director General Health

**Provincial Headquarters (Malaria), Quetta**

Dr. Mohammad Hussain Khan, Provincial Chief  
 Mr. Abdul Sattar, Senior Malaria Superintendent  
 Mr. Ali Ahmad, Assistant Entomologist  
 Mr. Hafiz Mehmood, Assistant Entomologist  
 Mr. Noorullah Khan, Health Education Officer  
 Mr. M. Sadiq Khan, Malaria Superintendent

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**Municipal Corporation, Quetta**

**Dr. Javed Ahmad Baloch, Health Officer  
Mr. Mohammad Afzal, Sanitation Officer**

**Project Director Health - Afghan Refugees, Quetta**

**Dr. M. Yousuf Bazenjo, Project Director  
Dr. Taj Mohammad Khan, Deputy Director (Malaria & TB)  
Dr. Mohammad Shah, Deputy Director (PHC)  
Dr. Mohammad Akhtar, Medical Officer (Lab.)  
Dr. Israr Ahmad Khan, Medical Officer Dalbandin**

**Field**

**Sheikhupura**

**Mr. Ibrar Ahmad, CDC Supervisor  
Mr. Tahirul Hassan, CDC Supervisor  
Mr. Asghar Ali, CDC Inspector  
Mr. Shamsher Ali, CDC Supervisor**

**Jhang**

**Mr. M. Arif, CDC Supervisor  
Mr. M. Yousuf, CDC Supervisor  
Mr. M. Nawaz Siddiqui, CDC Supervisor**

**Sargodha**

**Mr. Ghulam Yasin, CDC Supervisor  
Mr. Naqsh-i-Mohammad, CDC Supervisor  
Mr. Riaz Ahmad, CDC Supervisor**

**Okara**

Mr. M. Mansha, CDC Supervisor  
Mr. Khurshid Ahmad, CDC Supervisor  
Mr. Ali Akbar, CDC Inspector

**Peshawar**

Mr. Ghulam Sarwar, Malaria Supervisor  
Mr. Sher Afzal, Malaria Supervisor

**Mardan**

Mr. Ghulam Mohammad, Malaria Supervisor  
Mr. Aurang Zeb, Malaria Supervisor  
Mr. Fazle Elahi, Assistant Malaria Superintendent

**Swat**

Mr. Usman Ghani, Malaria Supervisor  
Mr. Fazle Mahmood, Assistant Malaria Superintendent

**Karachi**

Mr. M. Yasin Bhatti, Malaria Supervisor  
Mr. Ishrat Hussain, Malaria Supervisor

**Quetta**

Mr. M. Ibrahim, Malaria Supervisor  
Mr. H. Saifuddin, Malaria Superintendent  
Mr. Rasul Bukhsh, Malaria Supervisor  
Mr. Shabbir Haider, Assistant Malaria Superintendent

**Annex 2.  
Pakistan Malaria Cases by District**

**Table A**  
**Pakistan District Malaria Cases: 1990**

<b>Slides and Results</b>							
<b>Province</b>	<b>District</b>	<b>Population</b>	<b>Taken</b>	<b>Pos.</b>	<b>SPR</b>	<b>ABER</b>	<b>API</b>
Sindh	Khairpur	862,085	56,113	10,231	18.23	6.51	11.87
NWFP	Swat	931,470	43,326	7,010	16.18	4.65	7.53
NWFP	S. Wazi.	328,105	32,272	2,316	7.18	9.84	7.06
NWFP	Mohmand Ag.	74,600	1,382	450	32.56	1.85	6.03
NWFP	Karrak	343,754	27,710	2,070	7.47	8.06	6.02
Sindh	Dadu	923,137	44,448	4,740	10.66	4.81	5.13
NWFP	Malakand	306,338	12,521	1,523	12.16	4.09	4.97
NWFP	Bajaur Ag.	350,000	13,062	1,703	13.04	3.73	4.87
Baluch	Quetta	370,372	10,306	1,651	16.02	2.78	4.46
NWFP	N. Wazi.	266,914	7,789	1,163	14.93	2.92	4.36
Sindh	Larkana	801,272	34,521	3,155	9.14	4.31	3.94
Sindh	Shikarpur	442,549	17,054	1,731	10.15	3.85	3.91
Baluch	Ziarat	17,631	3,456	64	1.85	19.60	3.63
NWFP	Bannu	936,859	37,274	3,221	8.64	3.98	3.44
Baluch	Turbat	220,718	3,907	714	18.27	1.77	3.23
NWFP	Khyber Ag.	372,399	8,229	1,109	13.48	2.21	2.98

Table A (cont.)

Province	District	Population	Taken	Pos.	SPR	ABER	API
Sindh	Hyderabad	746,615	41,853	2,036	4.86	5.61	2.73
NWFP	Mardan	909,924	38,345	2,407	6.28	4.21	2.65
NWFP	Kurram Ag.	191,324	9,844	461	4.68	5.15	2.41
NWFP	Dir	513,740	13,705	1,227	8.95	2.67	2.39
Sindh	Sukkur	827,363	36,153	1,921	5.31	4.37	2.32
Sindh	Tharparkar	1,414,792	56,051	2,874	5.13	3.96	2.03
NWFP	Charsadda	624,899	9,806	1,134	11.56	1.57	1.81
Baluch	Jafferabad	227,686	7,150	411	5.75	3.14	1.81
Baluch	Kharan	126,172	5,261	225	4.28	4.17	1.78
NWFP	Kohat	625,434	41,981	1,105	2.63	6.71	1.77
Sindh	Sanghar	602,083	35,156	1,024	2.91	5.84	1.70
NWFP	D.I.Khan	744,101	37,612	1,232	3.28	5.05	1.66
Sindh	Badin	516,718	24,855	775	3.12	4.81	1.50
Baluch	Gwader	106,636	775	159	20.52	0.73	1.49
Sindh	Nawabshah	1,189,799	39,451	1,655	4.20	3.32	1.39
Baluch	Sibi	117,639	7,039	160	2.27	5.98	1.36
Punjab	Muzaffargarh	1,791,713	40,367	2,353	5.83	2.25	1.31
NWFP	Swabi	806,713	19,380	973	5.02	2.40	1.21
Punjab	D.G.Khan	952,202	32,988	1,074	3.26	3.46	1.13

**Table A (cont.)**

<b>Province</b>	<b>District</b>	<b>Population</b>	<b>Taken</b>	<b>Pos.</b>	<b>SPR</b>	<b>ABER</b>	<b>API</b>
Sindh	Jacobabad	793,246	23,506	880	3.74	2.96	1.11
Sindh	Karachi	316,081	38,766	347	0.90	12.26	1.10
Baluch	Khuzdar	344,593	9,648	376	3.90	2.80	1.09
Baluch	Panjgur	125,891	4,394	135	3.07	3.49	1.07
Sindh	Thatta	1,007,319	38,565	993	2.57	3.83	0.99
Baluch	Loralai	247,583	10,521	241	2.29	4.25	0.97
Baluch	Zhob	194,572	3,023	185	6.12	1.55	0.95
Punjab	Rajanpur	643,771	33,361	569	1.71	5.18	0.88
NWFP	Peshawar	1,628,015	32,624	1,386	4.25	2.00	0.85
Baluch	Pishin	334,812	6,708	285	4.25	2.00	0.85
NWFP	Chitral	91,733	4,999	72	1.44	5.45	0.78
Punjab	Bahawalpur	1,384,480	69,092	976	1.41	4.99	0.70
Baluch	Tambooo	136,525	2,445	92	3.76	1.79	0.67
Punjab	Sialkot	2,620,540	86,866	1,712	1.97	3.31	0.65
Punjab	Layyah	787,490	25,916	407	1.57	3.29	0.52
Baluch	Bela	184,179	2,720	93	3.42	1.48	0.50
Punjab	Gujranwala	1,926,581	80,667	920	1.14	4.19	0.48
Punjab	Sheikhupura	1,984,729	41,080	946	2.30	2.07	0.48
Baluch	Kalat	305,212	6,619	137	2.07	2.17	0.45

Table A (cont.)

Province	District	Population	Taken	Pos.	SPR	ABER	API
Punjab	Jhang	1,779,560	78,517	664	0.85	4.41	0.37
Punjab	Okara	1,348,104	91,529	492	0.54	6.79	0.36
Punjab	Sargodha	1,712,539	55,781	625	1.12	3.26	0.36
Punjab	Khanewal	1,375,857	58,526	492	0.84	4.25	0.36
Baluch	Kachhi	344,940	5,750	108	1.88	1.67	0.31
Punjab	R.Y.Khan	1,805,493	82,203	564	0.69	4.55	0.31
Punjab	Attock	913,460	52,189	283	0.54	5.71	0.31
Punjab	Rawalpindi	1,265,806	69,930	391	0.56	5.52	0.31
Punjab	Khushab	612,280	23,555	166	0.70	3.85	0.27
NWFP	Orakzai Ag.	147,099	4,665	36	0.77	3.17	0.24
Punjab	Multan	2,117,797	93,681	499	0.53	4.42	0.24
Baluch	Chaghai	146,246	5,241	34	0.65	3.58	0.23
Punjab	Gujrat	2,924,361	75,781	584	0.77	2.59	0.20
Punjab	Jhelum	596,222	28,045	118	0.42	4.70	0.20
Punjab	Bahawalnagar	1,397,956	71,923	262	0.36	5.14	0.19
Punjab	Faisalabad	2,725,728	85,186	505	0.59	3.13	0.19
NWFP	Abbotabad	1,168,512	40,462	208	0.51	3.46	0.18
Punjab	Bhakkar	673,985	28,324	116	0.41	4.20	0.17
Punjab	Sahiwal	2,207,529	88,794	334	0.38	4.02	0.15

Table A (cont.)

Province	District	Population	Taken	Pos.	SPR	ABER	API
Punjab	T.T.Singh	1,131,371	32,637	166	0.51	2.88	0.15
NWFP	Mansehra	549,761	23,379	74	0.32	4.25	0.13
Punjab	Kasur	1,479,694	52,607	192	0.36	3.56	0.13
Punjab	Mianwali	631,951	33,580	73	0.22	5.31	0.12
Punjab	Chakwal	862,710	20,433	92	0.45	2.37	0.11
Punjab	Lahore	695,114	19,501	62	0.32	2.81	0.09
Baluch	Qila Saif.	67,804	730	6	0.82	1.08	0.09
Punjab	Vehari	1,582,967	58,691	96	0.16	3.71	0.06
Baluch	Dera Bugti.	81,474	0	0	ERR	0.00	0.00
Baluch	Kohlu	31,283	0	0	ERR	0.00	0.00

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