MALARIA OUTBREAK IN A TRIBAL AREA OF GUJARAT STATE, INDIA

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Abstract. Malaria incidence in Gujarat state had been on a general decline since 1989. However in some tribal villages in forested areas of Valsad district, southern Gujarat, there was an outbreak of malaria in September 1995. Five children died in Ashlona village. During investigation conducted in October 1995 in affected villages, the malaria parasite rate was 26% (217/833) with >91% infections due to *P. falciparum*. A high proportion of *P. falciparum* infections had ring stages suggesting active transmission. Against a minimum norm of 10% annual blood examination rate, there was a major breakdown of active surveillance for malaria. In the absence of health agencies in or near affected villages, the malaria parasite load continued to build up leading to an outbreak towards the end of monsoon season. Indoor residual spraying with deltamethrin caused significant reduction in densities of malaria vector *An. culicifacies*. Measures to prevent malaria outbreaks in inaccessible areas have been discussed.

INTRODUCTION

In Gujarat state the most malarious region comprises the districts of Valsad, Dangs, Surat, Bharuch, Vadodara, Kheda and Panchmahal whose eastern territories lie in the Satpura-Sahyadri hill ranges while on the western parts lie the Arabian sea. In recent years the highest number of malaria cases reported in Gujarat were 598,653 in 1989 when there was a general rise in malaria incidence all over the state. Thereafter there has been a gradual decline in the cases. In Valsad district in south Gujarat too there was a decline in malaria cases during 1990 to 1994, but there was no marked decline in *P. falciparum* cases. In September 1995, a rapid increase in malaria cases and a few deaths were reported in Sutharpada Primary Health Center (PHC). Following these reports an investigation on malaria was undertaken in Sutharpada and Anklach PHCs in October 1995 and the findings of the investigation are reported in this paper.

MATERIAL AND METHODS

Valsad is the southernmost district of Gujarat state. On its west lies the Arabian Sea, on the north is Surat district, on the east Maharashtra state and on south the union territories of Daman, Dadra and Nagar Haveli. The south-eastern region is hilly-forested at 150-300 m altitude in the Sahyadri hill range. There are 14 rivers in Valsad, 9 of that are perennial. The main monsoon season ranges from June to October. During 1990-95 the mean annual rainfall was 1,891 mm and mean annual rainy days were 55. The mean monthly temperature ranged from a minimum of 19.8ºC in January to a maximum of 33.3ºC in May.

Following the malaria outbreak, parasitological and entomological investigations were carried out in malaria affected villages of Sutharpada and Anklach PHCs in October 1995. These PHCs consisted of 25,000 and 45,000 population, respectively, >95% of which were aboriginal tribes. The villages included in study were Ashlona, Pipalset, Fali and Panchvera in PHC Sutharpada and Nirpan, Chaunda and Kamalzari in PHC Anklach. The villages were situated in densely forested foothills and had hill-streams and rice fields. Panchvera and Chaunda villages were situated near rivers Par and Auranga, respectively. There was a paucity of arable land and irrigation facility.

The data available on malaria incidence based on routine surveillance were obtained from the PHCs and analysed. A mass blood survey was carried out in all the affected villages. Thick and thin blood smears were taken on glass slides, stained with JSB-stain and examined. Persons with active fever (>37.4ºC) or a recent history of fever were given chloroquine (600 mg base; adult dose). On microscopic confirmation, *P. falciparum* cases were given two more doses of chloroquine over next 2 days (total 25 mg chloroquine base/kg body weight)

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and 45 mg primaquine base. *P. vivax* cases were given primaquine at the rate of 15 mg daily for five consecutive days (all adult doses). Morning resting mosquitos were caught from 4 dwelling rooms and 4 cattle shades in each village. Larval sampling from the breeding habitats in the villages was also done.

RESULTS

Analysis of temporal changes in malaria incidence from 1976 to 1995 in relation with rainfall showed no significant association between them ($r = 0.007$; $p = 0.75$). When malaria resurged in India with a peak in 1976, in Valsad district the annual parasite index (API *ie* cases/1,000 population/year) was about 10 cases/1,000 and the proportions of *P. falciparum* and *P. vivax* cases were 11.3% and 88.7%, respectively. Thereafter till 1985 there was a general declining trend in overall incidence although the *P. falciparum* proportion started rising from 1982. In 1988 malaria API reached to 30 cases/1,000 when one third of all cases were due to *P. falciparum*. The slide positivity rate also showed a similar trend. From 1989 till 1994 malaria declined but the proportion of *P. falciparum* increased gradually from 22.6 to 32.8%. In 1995 there was an increase in malaria incidence but then 51.3% cases were due to *P. falciparum*.

Malaria incidence in Sutharpada and Anklach PHCs during 1991-1995 has been given in Table 1. In Sutharpada annual blood examination rate (ABER) in 1991 was 9.1% which ranged between 11.8-15.6% during 1992-94. Malaria incidence decreased till 1993 and remained stable in 1994. There was a major increase in 1995 mainly towards the end of the monsoon although the total rainfall was less than in 1994 (Fig 1). It is noteworthy that during 1992-94 either no or a few *P. falciparum* cases were reported in the whole PHC, whereas in 1995, 76.9% of total cases were due to *P. falciparum*. In contrast in Anklach PHC malaria increased till 1993 but decreased in 1994 and again increased in 1995. The ABER was >10% during 1991-1994.

Five children (3 females and 2 males) in 3-9 years age group died in September/October, 1995 in Ashlona village in Sutharpada PHC. According to the investigations carried out by state malaria department, 4 children had fever and other symptoms related to malaria. Only one of them attended a private clinic and was given an anti-pyretic drug. None of them reported to any government health facility and their blood smears could not be taken.

Table 1
Malaria incidence in Sutharpada, Anklach and other PHCs in district Valsad based on routine surveillance under primary health care.

PHC	Year	Pop[a]	BSE[b]	ABER[c]	Cases	Pf [d]	SPR[e]	SfR[f]	%Pf	API[g]
Sutharpada	1991	19,019	1,730	9.1	191	18	11.0	1.0	9.4	10.0
	1992	19,447	3,026	15.6	188	1	6.2	0.03	0.5	9.7
	1993	24,012	3,289	13.7	115	0	3.5	0.0	0.0	4.8
	1994	24,612	2,904	11.8	106	3	3.6	0.1	2.8	4.3
	1995	25,227	9,363	37.1	1,413	1,088	15.1	11.6	76.9	56.0
Anklach	1991	41,709	5735	13.8	114	30	2.0	0.5	26.3	2.7
	1992	42,647	7,895	18.5	192	60	2.4	0.8	31.2	4.5
	1993	43,520	9,514	21.9	357	225	3.8	2.4	63.0	8.2
	1994	44,608	7,554	16.9	75	32	0.9	0.4	42.6	1.6
	1995	45,723	14,441	31.5	917	721	6.3	4.9	78.6	20.0
Other PHCs	1991	1,815,314	270,669	14.9	14,806	4,163	5.2	1.5	29.5	7.8
	1992	1,856,152	320,606	17.3	10,992	3,447	3.4	1.1	31.4	5.9
	1993	1,957,812	334,338	17.0	12,585	3,518	3.7	1.1	27.9	6.4
	1994	2,006,754	308,598	15.4	7,994	1,725	2.5	0.6	21.6	3.9
	1995	2,056,921	367,411	17.9	13,372	6,256	3.6	1.7	46.8	6.5

Source: District Malaria Office, Valsad; [a]Population; [b]Blood smears examined; [c] Annual blood examination rate; [d]*P. falciparum;* [e]Slide positivity rate; [f]Slide falciparum rate; [g]Annual parasite index (Cases/ 1,000 population/year)

Table 2
Malaria incidence in the study villages of Sutharpada and Anklach PHCs based on routine malaria surveillance under primary health care.

Villages	Year	Pop	BSE	Cases	Pf	SPR	%Pf	ABER	API
Sutharpada PHC									
Ashlona	1992	2,385	127	8	0	6.3	0	5.3	3.3
	1993	3,338	173	9	0	5.2	0	5.2	2.6
	1994	3,422	142	9	0	6.3	0	4.1	2.6
	1995	3,597	1,333	341	289	25.6	84.7	37.0	94.8
Pipalset	1992	871	378	18	1	4.8	5.5	43.4	20.6
	1993	1,077	346	12	0	3.5	0	38.1	11.4
	1994	1,104	247	13	0	5.3	0	22.4	11.8
	1995	1,132	529	42	25	7.9	59.5	46.7	37.1
Fali	1992	538	191	11	0	5.7	0	35.5	20.4
	1993	895	106	5	0	4.7	0	11.8	5.6
	1994	917	63	0	0	0.0	0	6.8	0.0
	1995	940	307	39	28	12.7	71.8	32.6	41.5
Panchvera	1992	357	62	2	0	3.2	0	17.4	5.6
	1993	326	68	2	0	2.9	0	20.8	6.1
	1994	334	91	9	0	9.8	0	27.2	26.9
	1995	342	211	32	28	15.2	87.5	61.6	93.5
Anklach PHC									
Nirpan	1993	687	163	8	1	4.7	12.5	24.4	11.6
	1994	687	353	0	0	0	0	51.4	0
	1995	698	248	36	31	14.5	86.1	35.5	51.5
Chaunda	1993	2,117	341	12	12	3.5	100	16.1	5.7
	1994	2,117	303	4	0	1.3	0	14.3	1.9
	1995	2,217	488	106	94	21.7	88.6	22.0	47.8
Kamalzari	1993	551	354	3	0	0.8	0	64.2	5.4
	1994	551	222	1	1	0.4	100	40.2	1.8
	1995	569	140	7	3	5.0	42.8	24.6	12.3

Source: District Malaria Office, Valsad

Table 3
Malaria prevalence in Sutharpada and Anklach PHCs based on mass blood surveys

PHC	Village	Pop	BSE	Cases	*Pf*	*Pv*	Mix	PR	%*Pf*
Sutharpada	Ashlona	3,175	140	25	22	2	1	17.8	92.0
	Pipalset	1,026	103	23	22	1	0	22.3	95.6
	Fali	851	69	17	12	2	3	24.6	88.2
	Panchvera	357	102	47	42	0	5	46.1	100.0
Anklachh	Nirpan	662	341	71	58	11	2	20.8	84.5
	Chaunda	2,040	42	30	28	2	0	71.4	93.3
	Kmalzari	351	36	4	4	0	0	11.1	100.0
	Grand total	8,642	833	217	188	18	11	26.1	91.7

BSE: Blood smears examined; PR: Parasite rate (%)

Table 4
Age wise malaria parasite rates based on mass blood surveys.

Age (yrs)	BSE	Malaria cases	*P. falciparum cases*				Parasite rate (%)
			Rings	Rings+Game-tocytes	Gamet-ocytes	Total	
<1	23	3	0	0	1	1	13.0
2-4	113	34	5	20	3	28	30.1
5-9	153	41	8	25	5	38	26.8
10-14	80	28	11	16	0	27	35.0
≥15	464	111	27	43	35	105	23.9
Total	833	217	51	104	44	199	26.1

Table 5
Man hour density of mosquitos in villages of Sutharpada and Anklach PHCs in October 1995.

Species	Sprayed villages in Sutharpada PHC[a]				Unsprayed villages in Ankalach PHC		
	Ashlona (100)	Pipalset (94%)	Fali (95%)	Panchvera (90%)	Nirpan	Chaunda	Kamalzari
An. aconitus	0	0	0	0	0	0	0.5
An. culicifacies	0	2.5	3.0	35.5	40.0	11.0	5.0
An. fluviatilis	0	0	0	1.5	0	1.0	2.5
An. theobaldi	0	0	0	1.0	0	0	0
An. subpictus	0.5	1.0	0	0.5	1.0	0	1.0
An. vagus	0	0	0	0.5	0	0	0
All anophelines	0.5	3.5	3.0	39.0	41.0	12.0	9.0
Culex spp	0	0	0	0	0	2.0	2.5
All mosquitoes	0.5	3.5	3.0	39.0	41.0	14.0	11.5

[a]DDT, BHC and in the end deltamethrin (20 mg/m^2).
Figures in parentheses are house coverage under spraying.

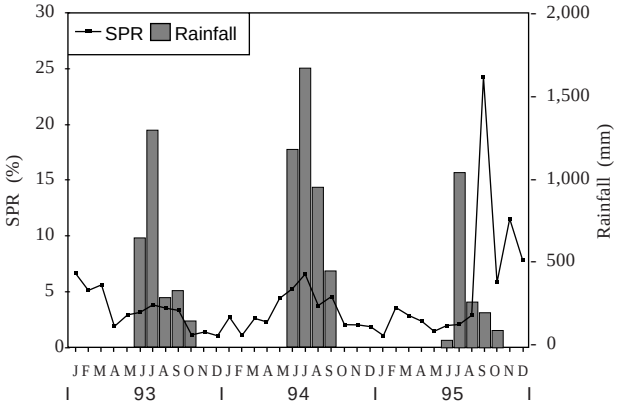

Fig 1–Malaria incidence in PHC Sutharpada.

From 1992 to 1994 ABER in village Ashlona declined from 5.3 to 4.1% and the API from 3.3 to 2.6/1,000 (Table 2). No *P. falciparum* case was reported in these years. In Pipalset and Fali the trend was similar. In Panchvera both ABER and malaria cases increased from 1992 to 1995 but during the first 3 years no *P. falciparum* case was detected while in the fourth year these accounted for 87.5% of all cases. In Anklach data of three malaria affected villages was available from 1993 to 1995. In Nirpan village, although ABER in 1994 was 51.4%, not even a single case of malaria was reported. In 1995 the API rose to 51.5% and 86.1% cases reported were *P. falciparum*. In Chauda village ABER increased from 16.1 to 22% whereas API declined in 1994 but rose considerably in 1995 and

88.6% cases were of *P. falciparum*. A similar trend was seen in Kamalzari village.

The results of the mass blood survey carried out in seven villages are given in Table 3. The mean parasite rate was 26% (217/833) which ranged from 11.1 to 71.4% in different villages. Out of 217 infections, 188 (86.6%) were of *P. falciparum*, 18 (8.3%) were of *P. vivax* and 11 (5.1%) mixed ones. Out of 199 *P. falciparum* cases, 25.6% cases had rings, 52.3% had rings and gametocytes and the remainders had only gametocytes. Among persons with fever 48.3% (98/203) and among afebrile persons 18.9% (119/630) had malaria parasitemia. The parasite rates among males and females were 25.98% (99/381) and 26.1% (118/452), respectively and these were not different significantly (χ^2= 1.54, df =1, p=0.96). Data on prevalence of malaria by age have been given in Table 4. The parasite rate among various age groups was 13% (3/23) in infants, 30.1% in 1-4 years age, 26.8% in 5-9 years, 35% in 10-14 years and 23.9% in >15 years of age, but the differences were non-significant (χ^2=7.43, df=4, p=0.11). The *P. falciparum* mean gametocyte rate was 17.8% (148/833) which was 4.3% in infants and ranged from 16.8% to 20.3% in other age groups.

Two rounds of DDT were sprayed every year from 1991 to 1995 in Sutharpada PHC as per the schedule. In addition, in the second week of September 1995 BHC was sprayed in Ashlona village to curtail malaria transmission. Since *P. falciparum* cases did not show a decline in the whole area, deltamethrin-WP was sprayed in all villages of Sutharpada PHC during 1-10 October . However, none of the study villages in Anklach was sprayed in 1995.

Mosquito densities were recorded in four sprayed villages of Sutharpada and 3 unsprayed villages of Anklach. Man-hour densities (MHD) are shown in Table 5. Six anopheline species including malaria vectors *An. culicifacies* and *An. fluviatilis* were found. In general, mosquito densities were higher in unsprayed villages than in deltamethrin sprayed villages. *An. culicifacies* was predominant in both areas. It was absent in Ashlona village but was recorded in all others although its densities were lower in deltamethrin sprayed villages.

Hill streams, wells and rivers were major breeding sources. Wells were found negative for 3rd-4th stage larvae due to constant disturbance. Hill streams were potential mosquito breeding sources in all villages. Besides these other habitats of *An. culicifacies* were riverbed pools and rock-pools in streams. *An. fluviatilis* was found breeding in rice fields and hill streams with slow running water.

DISCUSSION

Most of the arid and semi-arid areas in western India fall in an unstable malaria zone in the country. Malaria generally has a cyclic trend of low and high incidences and is often influenced by climatic changes such as rainfall (Mathur *et al*, 1992; Bouma and van der Kaay, 1994) and canal irrigation coupled with poor surveillance and insecticide resistance in vectors (Sharma and Gautam, 1990).

Under the primary health care system malaria case detection and treatment services are supposed to be undertaken through fortnightly house to house visits by the multipurpose health workers (MPHWs) and passive case detection/treatment agencies such as fever treatment depots (FTDs) and drug distribution centers (DDCs). In Sutharpada and Anklach since the blood slide collection rate was much below the minimum norm of 10% per annum, it is evident that there was a major breakdown of active surveillance for malaria preceding the outbreak. There were no DDCs and FTDs working in the affected villages thereby people in these remote areas had poor access to even passive health agencies. The presence of malaria infections in infants and high proportion of *P. falciparum* with ring stages indicate active transmission of malaria at the time of outbreak. Malaria affected all ages and both genders equally. A high *P. falciparum* gametocyte rate further reflects a gradual build up of parasite load in the community owing apparently to inadequate treatment. Before the outbreak there was a 15-day time lag between slide collection and examination. Soon after the outbreak there was a large backlog of unexamined slides (n=3,381) in Anklach PHC which could not be cleared untill November 1995.

Except for monsoon, in other months the area remained generally dry. The malaria affected villages were either on the bank of hill-streams or rivers, which stabilized post-monsoon and provided high vector breeding grounds. In the entire south Gujarat area the malaria vector *An. culicifacies* is known to have developed triple resistance to DDT, malathion and BHC. Since the villages were being sprayed routinely with DDT or BHC, little dent on malaria transmission was expected. Thus when *P. falciparum* gametocyte load reached to

flash point, high vector potential led to intense transmission and the outbreak.

Following spraying with deltamethrin (house coverage ranged from 90-100%), vector densities were much lower than in unsprayed villages. Deltamethrin is known as a potent insecticide against *An. culicifacies* (Ansari *et al*, 1986). In south Gujarat a field study in January 1995 reported that this species was fully susceptible to deltamethrin (Commissionerate of Health, Government of Gujarat, unpublished report 1995-96). Its presence in morning catches indoors in deltamethrin sprayed villages during our investigation suggest that the spray quality and coverage of all indoor surfaces might not have been satisfactory. However we did not check delayed mortality in morning resting mosquitos.

To prevent outbreaks of malaria there is a need to improve malaria surveillance and opening of passive case detection agencies (DDCs and FTDs) involving the community or NGOs. Refresher training to laboratory technicians, improving laboratory services, making sufficient provision of anti-malarial drugs, supervision of MPHWs and other field staff and evaluation of drug and insecticide resistance status should be considered as a priority. When pyrethroids are sprayed the coverage and quality of spraying should be high. In forested areas with *An. culicifacies* or *An. fluviatilis* as vectors, insecticide treated bednets have been found to be very effective (Yadav *et al*, 1998; Sharma and Yadav, 1995) and these should be promoted in similar situations.

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