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Investigation of outbreak of malaria in tribal area of Visakhapatnam, Andhra Pradesh

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The findings of an epidemiological investigation undertaken in Paderu division of Visakhapatnam district, Andhra Pradesh are reported in the present communication. The slide positivity rate (SPR) was still high (maximum SPR was 70) in spite of intensive surveillance and fever radical treatment in the affected areas. The vector, *Anopheles culicifacies*, was found resistant to DDT, but susceptible to Malathion and Deltamethrin. However, the finding of *An. culicifacies* in only 4 villages out of 12 tribal villages surveyed, and that too with highest density of 13.3, indicated that DDT was still having some impact. In a small sample, *Plasmodium falciparum* parasite was found resistant to chloroquine. The possible reasons of outbreak may be: (i) lack of surveillance and expertise in detection of malaria parasite; (ii) ineffective radical treatment as indicated by resistance in *P. falciparum*, and (iii) improper coverage of indoor residual DDT spraying in 1998. Advanced rains in the month of May 1999 also added to the hindrance in surveillance and control measures in the hilly terrain of the affected area. Suggestions for management of such outbreaks in future are discussed.

A tribal area under Paderu division of Visakhapatnam district, Andhra Pradesh (AP) started reporting fever-related deaths since March 1999. The majority of deaths occurred in May and June 1999, affecting all the 15 Primary Health Centres (PHCs) of Paderu division, comprising mainly a tribal population of 5,68,495 residing in 3370 villages. The number of blood slide collections for detection of malaria parasites also started rising from March 1999. Keeping in view high fever incidence and reported fever-related deaths in Paderu division, the State Government had drawn an epidemic action plan from 4 June 1999 till the time of survey wherein deployment of medical and paramedical staff from different parts of AP intensified surveillance and fever radical treatment and vector control measures were strengthened. In 1998, the first round of DDT spraying was undertaken from 15 April to 31 July 1999 and the second round from 5 August to 28 November 1998. In 1999, a special round of DDT spraying was undertaken in Paderu division from 1 February 1999 to 28 February 1999 except Pedabailu PHC. Intensive DDT spray operations were taken up from June 1999 and till 17 July 1999, 2022 villages (priority villages based on high fever incidence and reported death rate) with a population of 2,43,742 in 15 PHCs were covered. Fogging operations with Malathion/Pyrethrum were also done in priority villages. An epidemiological survey was therefore planned in different PHCs of Paderu division for rapid assessment of the situation, the results of which are reported here.

Visakhapatnam, the north coastal district of AP, is located between 17°15′ and 18°32′ north latitude and 18°54′ and 83°30′ east longitude. It is bounded in the north partly by Orissa and Vizianagaram district, in the south by East Godavari district, in the west by Orissa and in the east by the Bay of Bengal. The temperature ranges from 18 to 34°C throughout the year. The district receives most of the rainfall from south-west monsoon and annual rainfall ranges from 1000 to 1500 mm. The Paderu division is hilly with undulating terrain covered by Eastern Ghats and the altitude ranges from 900 to

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Table 1. Monthwise surveillance of epidemiological data in Paderu division, Visakhapatnam for 1998 and 1999

	1998					1999				
Month	BSC	PV	PF	Total	SPR	BSC	PV	PF	Total	SPR
January	13200	166	625	791	5.9	13469	136	454	590	4.3
February	13458	154	443	597	4.4	14845	132	436	568	3.8
March	14443	164	409	573	3.9	32265	279	972	1271	3.9
April	16128	198	512	710	4.4	43904	302	1160	1462	3.3
May	21478	309	778	1087	5.0	54530	201	1109	1310	2.4
June	26644	363	1571	1934	7.2	86826	538	2908	3446	4.0
Total	105351	1354	4338	5692	5.4	244839	1588	7059	8641	3.5

Source: Office of District Malaria Officer, Paderu, Visakhapatnam.
BSC, Blood slide collection; SPR, Slide positivity rate; PV, *Plasmodium vivax*; PF, *P. falciparum*.

Table 2. Monthwise, PHC-wise comparative data in Paderu division for 1998 and 1999

PHC (population)	Year	March			April			May			June			SPR (June)
		BSC	PV	PF	BSC	PV	PF	BSC	PV	PF	BSC	PV	PF	
Ananthagiri	1998	976	2	41	1413	7	64	1872	2	79	2096	6	175	8.6
(28,365)	1999	2776	15	68	4092	57	142	4881	12	123	7043	98	567	9.4
Pinakota	1998	571	0	20	480	0	13	698	1	9	912	2	45	5.1
(14,546)	1999	1204	0	36	1615	2	30	1746	2	51	2427	7	40	1.9
Ganella	1998	897	13	44	1025	22	57	1620	55	109	2213	50	244	13.2
(26,550)	1999	2392	45	113	2568	24	83	3608	27	198	4598	53	159	4.6
Madagada	1998	368	21	24	400	9	21	626	34	48	1022	40	137	17.3
(22,425)	1999	1256	16	24	1732	17	28	2052	28	44	2039	52	82	6.5
Dumbriguda	1998	1135	64	62	1752	93	150	2290	102	192	2807	96	364	16.3
(42,848)	1999	4123	77	136	5373	81	129	6962	591	36	1034	581	333	4.0
Hukumpeta	1998	840	–	13	1024	–	13	1533	–	20	1831	–	45	2.4
(51,772)	1999	2504	–	12	4987	–	36	4764	–	27	4925	44	292	6.8
Minimuluru	1998	1207	–	26	1286	–	20	1493	2	24	2304	3	80	3.6
(51,540)	1999	2989	2	107	3912	7	94	4401	1	46	7244	15	124	1.9
Pedabailu	1998	944	5	39	918	10	43	1648	14	83	1796	4	93	5.43
(49,520)	1999	1093	14	49	1369	4	48	2543	8	70	5583	19	153	0
Munchingput	1998	665	–	19	1124	1	18	1570	5	46	1001	18	18	3.5
(60,628)	1999	1607	13	71	1762	–	67	1948	–	63	5334	6	198	3.8
G. Madgula	1998	854	2	30	845	3	38	1396	4	38	1817	17	97	6.2
(51,714)	1999	1672	16	105	2617	17	122	3799	14	75	7263	70	257	4.5
Lothugedda	1998	1683	2	9	2004	4	5	2623	34	61	3415	35	167	5.9
(63,032)	1999	2560	–	12	3604	5	22	5155	4	72	1044	322	237	2.4
G. K. Veedhi	1998	852	–	17	741	1	17	874	1	15	1294	5	27	2.4
(35,583)	1999	1072	1	10	1591	9	70	2730	9	77	6889	13	124	1.9
Darakenda	1998	392	1	21	551	2	30	678	1	17	688	7	15	3.1
(17,478)	1999	1347	11	50	1329	7	51	1655	7	42	2282	7	67	3.2
R.J. Palem	1998	2291	33	24	1750	25	10	1657	41	25	1997	57	15	3.6
(30,080)	1999	3619	38	64	4880	34	115	5543	9	42	5792	6	41	0.8
Downuru	1998	770	21	20	815	21	8	900	13	12	1451	23	29	3.5
(22,410)	1999	2051	311	15	2473	38	123	2744	21	43	3698	45	234	7.5
Total population, 5,68,495														

Source: Office of District Malaria Officer, Paderu, Visakhapatnam.
PHC, Primary Health Centre; SPR, Slide positivity rate; BSC, Blood slide collection; PV, *P. vivax*; PF, *P. falciparum*.

1615 m. It constitutes mainly tribal population comprising Khond, Konda dorra, Noka dorra and Ontal tribes and is covered under Integrated Tribal Developmental Agency (ITDA). River Machigedda flows through some portions of the tribal area. The forest cover in ITDA area ranges from 39.9 to 87.5%. Paddy cultivation on

terrace farming is quite prevalent followed by ragi, jowar, bajra crops, etc.

Of the 15 PHCs under ITDA in Paderu division of Visakhapatnam district, 6 PHCs, namely Pedabailu, G. K. Veedhi, Ganella, Hukumpeta, Minimuluru and Munchingput were surveyed for parasitological and entomological aspects from 20 July to 30 July 1999. Study villages were selected based on high fever-related deaths and accessibility. Thirteen villages covering a total population of 2187 were surveyed for entomological aspects, while parasitological work was undertaken in 12 villages. Survey was also carried out in M. Koduru village (population of 4050), under Madgula, a non-tribal PHC of Visakhapatnam, to obtain comparative data on incidence of malaria in non-tribal area.

Thick and thin blood smears were prepared by collecting finger-prick blood samples on slides from persons having fever or history of fever for the last 8 weeks. The slides were stained with JSB stain and examined under microscope for detection of malaria-parasites. The stages of parasite in each malaria-positive slide were recorded. Blood smears collected in field were examined there itself and radical treatment was given as per NAMP (National Malaria Eradication Programme) guidelines[1]. Two to three ml of venous blood from *Plasmodium falciparum*-positive cases was drawn after confirming the presence of healthy asexual stage of parasites in the blood smear. The samples were transported to Malaria Research Centre (MRC), Delhi (after preserving in sorbitol–glycerin cryopreservative) in liquid nitrogen. The samples were revived and cultivated *in vitro* and the *in vitro* drug-sensitivity test was performed after synchronizing the culture to ring stage parasites following standard methods[2–5]. Entomological survey was carried out for the presence of adult malaria vector species in human dwellings and cattle sheds and their breeding habitats, as per WHO manual[6]. Insecticide susceptibility status of *Anopheles culicifacies* and *An. fluviatilis* to DDT, Malathion and Deltamethrin was determined using 4% DDT, 5% Malathion and 0.05% Deltamethrin, as per WHO guidelines[7]. Results are discussed in the light of available epidemiological data collected from the office of District Malaria Officer, Visakhapatnam based at Paderu (Tables 1 and 2). Meteorological data were collected from Meteorology Office, Paderu through DMO Office (Table 3).

The analysis of available data on the incidence of malaria in Paderu division indicates that overall slide positivity rate (SPR) for malaria parasites was 4.3, 3.8, 3.9, 3.3, 2.4 and 4.0 from January to June 1999, respectively, while for the same period in 1998, SPR was 5.9, 4.4, 3.9, 4.4, 5.0 and 7.2 (Table 1). This information does not indicate increase in malaria cases. But a close examination of increase in blood slide collection (BSC) commencing from March 1999 indicates that fever cases were increasing progressively and in April 1999 the BSC was 2.7 times more than in April 1998. In June 1999, BSC was 3.2 times more than in June 1998. PHC-wise monthly incidence of malaria cases indicates that there was increase in *P. falciparum* cases from March 1999 onwards in almost all the PHCs, but not proportionately with BSC, that is why SPR was low (Table 2). It indicates lack of expertise in detection of malaria parasites.

Table 3. Comparative data on rainfall in Paderu division, Visakhapatnam from January to June during 1998 and 1999

	1998		1999	
Months	Rainfall (mm)	Rainy days	Rainfall (mm)	Rainy days
January	13.5	3	0	0
February	31.8	4	5.23	1
March	7.7	2	12.6	2
April	54.3	6	52.8	6
May	86.1	9	146.9	18
June	184.5	10	230.3	13

Of 174 fever-related deaths, 6 were confirmed due to cerebral malaria and 42.6% of dead persons were below the age of 14 years. Rest of the fever-related deaths were only suspected due to malaria, as they were not examined for malaria parasites.

Of 173 blood slides collected from fever cases (with history of fever in past 4 weeks), SPR ranged from 22.2 to 70.0, with the maximum in G. K. Veedhi PHC and minimum in Munchingput PHC (Table 4). Results of mass blood survey in school children at Saparla village (G. K. Veedhi) revealed 54.5 SPR, while in a mass blood survey at Kiligada school complex, not a single slide (out of 38 collected) was found positive, indicating very effective case detection and treatment by local health authorities. Seventy-eight per cent of malaria-positive cases were of *P. falciparum* and slide falciparum rate (SfR) ranged from 22.2 to 100. Of 81 *P. falciparum* cases, ring stages of parasite were found in 72 (88.8%). Malaria-positive cases detected during the present parasitological survey were in the following age group: 0–5 years 13 (12.6%); 6–14 years 41 (39.8%); 15–25 years 19 (18.4%) and > 25 years 30 (29.1%). In M. Koduru village (non-tribal area, Mudgula PHC), SPR was 23.0 and all the cases detected were of *P. vivax*.

Of 12 blood samples collected from *P. falciparum* positive subjects, parasite growth was observed in only 4. All the 4 samples were found with varying degree of resistance to chloroquine by *in vitro* test. The resistant subjects belonged to Digwapedapalli (Pedabailu), Saparla (G. K. Veedhi), and Tadka (Ganella) and their sex and age were M 25, M 12, M 20 and F 20, respectively. Two subjects showed resistance up to 16 pmol, one with 32 pmol and one with 64 pmol.

Table 4. Results of parasitological survey undertaken in Paderu Division, Visakhapatnam for detection of malaria parasites

Locality (population)	BSC	Malaria positive				SPR	SfR
		PV	PF	Mix	Total		
Fever survey							
Pedabailu PHC							
Eguapedapalli (175)	22	0	7	0	7	31.8	100.0
Digwapedapalli (190)	27	2	4	0	6	22.2	14.8
Allamput (193)	20	3	6	1	10	50.0	30.0
Kottaput (135)	4	1	1	0	2	50.0	25.0
G. K. Veedhi PHC							
Duchrapallam (170)	20	5	8	1	14	70.0	40.0
Ganella PHC							
Tadka (200)	26	0	17	0	17	65.3	100.0
Hukumpeta PHC							
Bhimvaram (150)	16	2	5	0	7	43.7	31.2
Baluroda (150)	14	0	7	0	7	50.0	50.0
Minimurulu PHC							
Perdanapattu (300)	15	1	6	0	7	46.6	40.0
Munchingput PHC							
Tattapalli (80)	9	0	2	0	2	22.2	22.2
Total: 1743	173	14	63	2	79	45.66	36.41
Mass blood survey							
G. K. Veedhi PHC							
Saparla	44	5	18	1	24	54.5	40.9
Munchingput PHC							
Kiligada	38	0	0	0	0	0	0

BSC, Blood slide collection; SPR, Slide positivity rate; SfR, Slide falciparum rate; PV, *P. vivax*; PF, *P. falciparum*.

Major breeding habitats of anopheline mosquitoes were rice fields, roadside ditches near culverts, rainwater collections and small streams. Check dams were also seen as rainwater harvesting practices. *An. fluviatilis* adults emerged from larvae collected from fallow fields, rice field and ditch-water near culverts.

Of 12 villages surveyed for the presence of vectors in malaria-affected tribal villages of Paderu division (Table 5), *An. culicifacies* was found in only 4, with a maximum man hour density (MHD) of 13.3 in Allamput (Pedabailu PHC). *An. fluviatilis* was also encountered in the same 3 villages with maximum MHD of 5 in Digwapedapalli village. In M. Koduru village (non-tribal), MHD of *An. culicifacies* was 7.0. *An. culicifacies* was found resistant to DDT (40% mortality) from Allamput village (Hukumpeta PHC), while this species was fully susceptible to Malathion and Deltamethrin. *An. fluviatilis* was 100% susceptible to all these insecticides tested.

The overall results of the present study indicate that there was an epidemic of malaria in the whole Paderu division. The transmission was indigenous as evidenced by the presence of 12.6% malaria-positive subjects below 5 years of age. The presence of ring stage in 88% of *P. falciparum*-positive subjects indicated that transmission was continuing. Though in the present study, *An. culicifacies* was found resistant to DDT, very low density of this species encountered in the surveyed villages indicates that thorough coverage and intensified indoor residual spraying was effective in most of the villages. May be the coverage of indoor residual DDT spraying in 1998 was not satisfactory. However, in areas where *An. culicifacies* is resistant to DDT, Malathion or synthetic pyrethroid insecticides are recommended.

The parasite load in the community was already existing (SPR in December 1998 was 6.8). Unprecedented advanced rains in the month of May 1999 (146.9 mm; 18 rainy days) compared to 86.1 mm and 9 rainy days in the corresponding period for 1998, might have resulted in more breeding habitats for malaria vectors and hampered the surveillance and radical treatment of

Table 5. Adult malaria vectors collected in Paderu division, Visakhapatnam

Locality	Man hour density (July 1999)			History of DDT spray
	An. culicifacies	*An. fluviatilis*	*An. annularis*	
Pedabailu				
Eguapedapalli	0.0	0.0	0.0	IR 23 April 1999; IIR 23 June 1999
Digwapedapalli	1.0	5.0	0.5	IR 23 April 1999; IIR 23 June 1999
Allamput	13.3	3.3	0.6	IR 6 July 1999
Kottaput	0.0	0.0	0.0	IR 6 July 1999
G. K. Veedhi				
Saparla	0.0	0.0	0.0	IR 29 June 1999
Duchrapallam	4.0	1.0	0.0	IR 26 June 1999
Ganella				
Tadka	0.0	0.0	0.0	IR 17 June 1999
Hukumpeta				
Bhimvaram	0.0	0.0	0.0	IR 13 June 1999
Baluroda	12.0	0.0	0.0	IR 13 June 1999; IIR 7 July 1999
Minimurulu				
Pardanapattu	0.0	0.0	0.0	IR 3 June 1999, ICON started
Munchingput				
Killigada	0.0	0.0	0.0	IR 15 April 1999
Tattapalli	0.0	0.0	0.0	IR 15 April 1999
Madgula				
M. Kodaru	7.0	0.0	0.0	IR November 1998

IR, First round; IIR, Second round.

malaria-positive cases due to inaccessibility. The resistance in *P. falciparum* to chloroquine (though the sample size is inadequate) also indicates that in spite of intensive fever radical treatment, cases might have remained febrile. In Kiligada (Munchingput) case detection and treatment were highly satisfactory (out of 38 subjects, not a single one was found positive for malaria parasite).

Lack of surveillance and under-reporting of malaria cases is a common feature observed in most of the epidemic investigations[8–11]. Therefore, there is a need to strengthen surveillance and train the technical staff in laboratory diagnosis of malaria. In hilly terrain where there is no effective means of transportation and one has to walk for a long distance, surveillance and particularly radical treatment may not be satisfactory. Therefore, in such areas, the role of voluntary link workers is very crucial. Functioning of DDC and FTDs should be made viable. Insecticide impregnated bednets which have proved very cost effective and sustainable with involvement of communities in north-eastern states[12], would be worth implementing in organized tribal communities. Health education is also a prerequisite for creating awareness in communities about malaria particularly, health-seeking facilities and compliance to treatment.

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