3

Epidemiology and Clinical Studies

3.1 Application of GIS to map the distribution of malaria vectors and to develop disease surveillance system in Jodhpur Cantonment area

A surveillance study using Geographical information system and remote sensing was initiated in Jodhpur Cantonment area for mapping the distribution of malaria vectors. Using Survey of India toposheet 1 : 50,000 base map has been prepared. Using hand-held GPS, the area was surveyed and important landmarks which include major roads, drains, water bodies, major mosquito breeding sites, etc. were geo-referenced. Contour layers have also been digitised (Fig. 3.1). The whole cantonment area can be divided into six different sectors. The indoor and outdoor densities of adult mosquitoes were recorded from various GPS registered localities using manual aspirators (per man hour density) and CDC light traps. The larval density of mosquitoes from different water bodies was recorded by using ladle. Different species of mosquitoes collected from each sector were identified for species composition.

Fig. 3.1: Study area, Jodhpur over toposheet 1 : 50,000

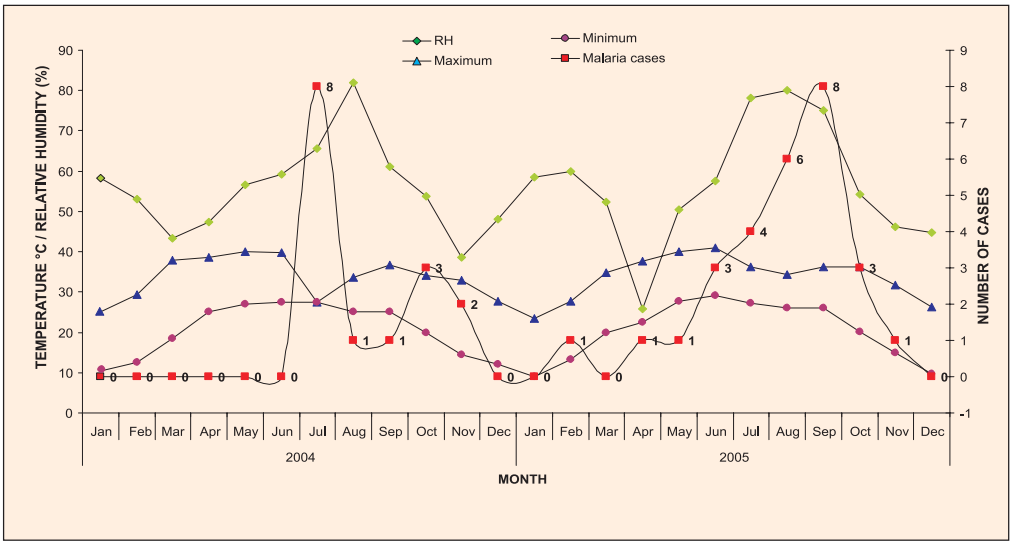

Fig. 3.2: Correlation of malaria cases *vs* meteorological data in Cantonment area, Jodhpur

The meteorological data (January 2004 to December 2005), number of malaria cases among troops and family members reported in Army Hospital (July 2004 to March 2005) and details of hygiene, chemicals used for mosquito control programme were procured and analysed.

The meteorological data showed that during the month of July and August 2004 the maximum temperature ranged between 34 and 37.64°C and minimum temperature ranged between 25.21 and 27.16°C. The relative humidity (RH) ranged between 62 and 89.14% similarly, during 2005 also the maximum temperature ranged between 32.64 and 36.70°C, minimum from 25.63 to 27.89°C and RH between 70.29 and 90.57% (Fig. 3.2).

The number of malaria cases reported in Jodhpur Army Cantonment area was found maximum (8) during July 2004 and September 2005. The malaria cases started increasing from June 2005. However, after September 2005 the malaria cases were found to decline till November 2005. The environment conditions with RH above 55% and temperature 17 to 28°C were favourable for the occurrence of malaria cases. From the available data it showed that the occurrence of maximum malaria cases coincided very well with the suitable environmental conditions prevailing in July and August (Fig. 3.2). It was observed that malaria cases were reported more in Army Hospital among troops and family members who came from states other than Jodhpur as compared to indigenous (Fig. 3.3). Out of all states, malaria cases among troops and family members from Rajasthan were highest followed by Madhya Pradesh and Uttar Pradesh.

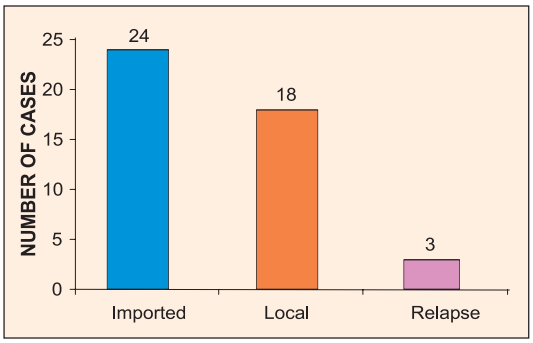

Fig. 3.3: Malaria cases among troops and family members from Jodhpur (Local)

3.2 Application of RS and GIS to map the malaria receptivity of Indira Sagar and Omkeshwar Dam project areas

The mapping of the receptivity of Indira Sagar and Omkeshwar Dam project areas is in progress. Village wise map of District Dhar had been digitised using GIS software ARC/View 3.2 and attribute data were collected from state health authorities, NVDA and Survey of India had been attached. Thematic maps of altitude, soil, rainfall, forest cover, temperature, etc. have also been prepared (Figs. 3.4–3.6). Trend analysis of epidemiological data from 2002–2004 had been done (Fig. 3.7). Submerged villages under Indira Sagar Dam have been mapped. The data on various entomological and parasitological parameters are being collected through periodic surveys and are regularly entered in GIS-based framework to view the impact of the construction of dams in space and time.

3.3 Health impact assessment of Indira Sagar Dam and resettlement & rehabilitation of colonies in SSP Reservoir Impoundment areas in Narmada Valley in Madhya Pradesh

A total of six surveys (3 pre-monsoon, 1 post-monsoon and 2 monsoon) were carried out in seven districts—Khandwa, Badwani, Khargone, Devash, Dhar, Harda and Jhabua of Indira Sagar, Omkeshwar and Sardar Sarovar Project areas to assess health impact.

Mosquitogenic conditions created due to construction of dams, seepage of the reservoir, pits and pools of downstreams, new canals, pools created due to earthwork, curing tanks, etc. have been identified (Figs. 3.8–3.11). Surrounding to these, a total of 29 villages, 14 rehabilitation and resettlement centres and 3 command area villages were surveyed for

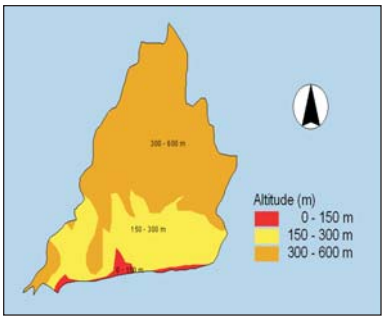

Fig. 3.4: Altitude ranges in District Dhar

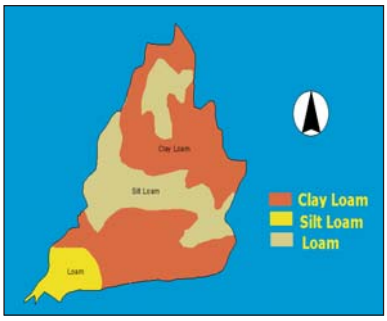

Fig. 3.5: Soil types in District Dhar

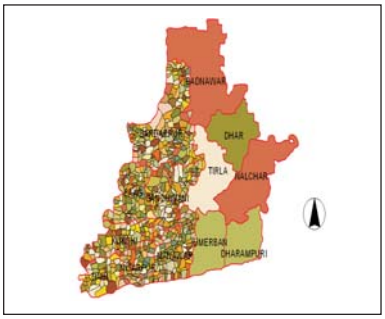

Fig. 3.6: Location of affected villages of District Dhar

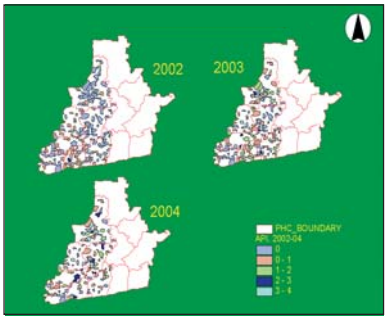

Fig. 3.7: API from 2002–04

Fig. 3.8: Seepage from reservoir supporting the breeding of *An. culicifacies*

Fig. 3.9: Riverbed pools in downstream supporting the heavy breeding of *An. culicifacies*

Fig. 3.10: Canal (under construction) supporting the breeding of *An. culicifacies*

Fig. 3.11: Canal supporting the breeding of *An. culicifacies*

entomological and epidemiological data for the vector borne diseases—malaria, dengue, JE and filariasis.

During cross-sectional surveys carried out in villages, R&R and labour colonies in post-monsoon, pre-monsoon and monsoon, 609, 1032 and 1929 slides were collected respectively. Out of these, 13 were found positive during post-monsoon, 53 in pre-monsoon and 1 during monsoon. It is noteworthy to mention that before the construction of dam, no malaria case was recorded from these surveyed villages.

Cross-sectional surveys were also carried out for dengue, JE and filariasis in villages, R&R and labour colonies in post-monsoon, pre-monsoon and monsoon periods. During the survey, 609 (post-monsoon), 980 (pre-monsoon) and 1929 (monsoon) blood samples on filter paper were collected and none was found positive. Besides this, 33 blood samples during March–April 2005 and 58 samples during July–August 2005 were also collected for dengue and JE but none was found positive.

Man hour density/room density of malaria vectors, *An. culicifacies* and *An. stephensi*, filaria vector—*Culex quinquefasciatus,* JE vector—*Culex vishnui* and dengue vector—*Aedes aegypti* were estimated in all the three seasons. Impact of dam construction was observed in nine villages as the vector density was reported high in all the three seasons. To establish the transmission, other entomological parameters—biting habit, parity rate, gonotropic cycle,

sporozoite rate, human blood index and presence of sibling species were also carried out. Breeding sites created due to dam construction were surveyed for larval breeding and species-specific breeding sites were identified for all the disease vectors. The insecticide susceptibility test for *An. culicifacies* was also carried out in all the three seasons and *An. culicifacies* was found resistant to DDT and susceptible to synthetic pyrethroids. Data from various agencies were also collected and it was found that there was no case of dengue, filaria, JE and kala-azar.

3.4 Studies on the epidemiology of urban malaria in mega, medium and small cities of India

3.4.1 Ajmer district, Rajasthan

The study was carried out in Ajmer City in post-monsoon (November 2005) and pre-monsoon (January 2006). Entomological and cross-sectional fever surveys were carried out. Entomological survey revealed that in almost all the colonies *Aedes aegypti* larvae/adult were present which is the vector of dengue. Since last 15–20 years there is no report of *Aedes* mosquito from Ajmer. The main urban malaria vector—*An. stephensi* was found and the density varied from 3 to 20 per man-hour whereas *An. culicifacies* density varied from 1 to 9 per man-hour only in few colonies. The *Culex* mosquitoes density was found much higher which varied from 130 to 356 per man-hour. In cross-sectional surveys out of 385 blood slides collected, 3 *P. vivax* cases were recorded.

the Office of Joint Director, Health, Ajmer in January 2006, for networking and to brief about the work to be carried out in Ajmer under the project. State health officers, entomologists, NGOs, general practitioners and pathologists etc. participated in the workshop (Fig. 3.12).

3.4.2 Delhi urban

A study in Delhi City has been initiated from November 2005 and reports are being maintained on weekly basis. The entomological and cross-sectional fever survey in 20 colonies situated in four Zones of Delhi like south, west, east and north—Badli, Burari, Mukandpur, Rohini, Transport Nagar, Ayur Vigyan Nagar, Bakarwala, Basant Kunj, Mahipalpur, Nazafgarh, Okhla, Kalyanpuri, Kondli, Mayur Vihar III, Patpar Ganj, Trilokpuri, Gokulpuri, Karawal Nagar, Sonia Vihar and Yamuna Vihar were carried out. In most of the colonies, *Culex* larvae/adults were found creating the mosquito nuisance. The main malaria vectors—*An. stephensi* and *An. culicifacies* were also found but density was low and ranged from 0 to 3 per man-hour in few colonies.

In a cross-sectional fever survey, 15 *P. vivax* cases were recorded from 651 blood slides— one each from Burari, Gokulpuri, Rohini, Mahipalpur, Mukandpur, 2 from Okhla and 3 each from Nazafgarh and Trilokpuri.

Five workshops were jointly organised with the help of Health Director of MCD in different zones of Delhi under USAID, Urban Project for networking and

Fig. 3.12: Workshop on urban malaria at Ajmer, Rajasthan

Fig. 3.13: Workshop on urban malaria at Delhi

to brief about the work to be carried out in Delhi under the project. MCD health officers, entomologists, NGOs, GPs, pathologists, etc. participated in the workshop (Fig. 3.13).

3.5 Situation analysis of malaria in Car Nicobar after Tsunami attack using ground surveys and remote sensing with immediate remedial measures

Field surveys were undertaken in all the 15 villages and relief camps of Car Nicobar and 5 selected sites in Port Blair for breeding habitats, salinity level, man hour density of mosquitoes, fever survey for the detection and prompt treatment of malaria cases. Twenty-four subjects were also recruited for monitoring the therapeutic efficacy of chloroquine in the treatment of *P. falciparum* malaria. Of 24 subjects followed for therapeutic efficacy of chloroquine in the treatment of *P. falciparum* malaria, only 4 did not respond. Spray of *Bacillus thuringiensis* was undertaken in major water-bodies to contain excessive breeding of malaria vector. Fish hatcheries were established at 8 ponds.

Satellite images of IRS P6 with LISS III and IV sensors, before and after Tsunami attack were analysed to find out the ecological changes. It was found that mosquitogenic conditions have tremendously increased due to ingression of water at several points. Larval density of anophelines ranged from 1–23 per dip and man hour densities from 4–51. Biting rhythm of *An. sundaicus* was observed from 1800 to 0500 hrs. ITN was not found suitable for complete protection from mosquito bites. Analysis of pre- and post-tsunami satellite images revealed ingression of sea water at two points leading to formation of new water bodies. The human settlements were totally demolished on the periphery of the island.

3.6 Relationship between sea surface temperature (SST) and malaria

In recent years, various reports showing relationship of ENSO and malaria have been published. In some situations it has been found of predictive value while in others the results are quite reverse. We have attempted to find out the association of satellite derived values of sea surface temperature (which determine dry or wet conditions) and monthly malaria incidence reported in Bikaner (Rajasthan), Banaskantha (Gujarat) and Tumkur (Karnataka). Retrospective analysis of monthly malaria incidence of Bikaner, Banaskantha and Tumkur districts for around 15 years with SST values was done to find out the relationship for prediction of malaria.

In Tumkur district, rainfall from March to December remains more than 100 mm while the SST values remained more than 1.0 in 7 months. In October, rainfall was recorded as 268 mm but SST values even in preceding 6 months were more than 1.0. Therefore, ENSO events were not found of predictive value for rainfall or malaria in Tumkur district. In Bikaner, the rainy season remains from July–October with maximum rainfall (117.5 mm) in August. The SST values in preceding 6 months were recorded which ranged from 1.7 to 2.2 indicating strong El Nino conditions. In 1994 (outbreak year) weak El Nino conditions prevailed in preceding 6 months before the onset of rains in June. Correlation coefficient (r) between SST values and rainfall was –0.52, –0.58 and –0.29 with month-to-month, 2 months and 4 months time lag respectively. In Banaskantha, rainy months are from June to September with maximum rainfall of 46.8 mm in the month of August. The SST values in preceding 6 months remained around 0.6 or less than 1 indicating that weak El Nino phenomenon is related to rainfall pattern in Banaskantha (Gujarat). The same is true for the years 1988 and 90. SST values were found associated with weak El Nino or La Nina conditions. It may be concluded that SST values may be of predictive significance in Rajasthan and Gujarat with 2 months lag, but not in Tumkur.

3.7 Environmental assessment under the proposed World Bank assisted vector borne disease control project

Indoor residual spray by DDT, malathion and pyrethroids are used for vector control in malaria and

kala-azar in rural areas, while larviciding by temephos and fenthion is done in urban areas. In some areas where settlements are scattered and it is not feasible to undertake IRS due to difficult terrain, insecticide treated mosquito nets are used. It is a well known fact that chemical insecticides are toxic to human beings. If not used as per recommendations, they cause adverse health impact to the persons involved, community and leads to contamination of environment.

In order to ensure that the insecticides and insecticide treated material (ITM) used in the project do not cause threat to health of persons involved, community and environment, NVBDCP assigned the project to undertake environmental assessment of the use of insecticides and ITM for development of Environmental Management Plan (EMP). Therefore, visits were made to the states like Orissa and Karnataka (representating low capacity and high capacity state respectively) to understand the gaps in implementation of guidelines and scope for improvement so that EMP may be developed for environmentally sound project. Health officials right from Joint Directors (who is State Programme Officer for vector borne disease control), state entomologists, store keepers, district malaria officers, medical officers of primary health centres, senior malaria inspectors, supervisors, health workers and anganwadi workers were contacted for understanding the intricacies of the programme and the problems faced in the implementation of guidelines. Stakeholders at community level like spray workers, village chiefs, teachers, shopkeepers and villagers in general were also contacted.

It was found that a system of sound spray operations, implementation and monitoring programme exists in all states up to sub-centre and village level. The programme is affected in some areas due to vacant posts of health workers, which are key supervisory posts at community level, and lack of awareness and training to some categories of stakeholders. Some spray workers were not adhering to use of protective gears particularly while spraying DDT and malathion. Insecticide storage conditions were found far from satisfactory in most of the areas. An EMP for centre and state/district level has been prepared for implementation with emphasis on strengthening the existing guidelines and development of IEC programme for all categories of officials. Implementation of integrated vector management with microstratification of areas has been emphasised for effective vector control and less reliance on insecticides. Constitution of village level committees for social participation and monitoring at central, state and district level has been suggested for effective auditing of the insecticide use operations. Use of long-lasting nets, improvement in stores conditions, adhering to protective gears, strengthening of guidelines for disposal of empty containers and plan of IEC for different categories of personnel has been suggested.

3.8 Assessment of therapeutic efficacy of antimalarial drugs against uncomplicated *P. falciparum* malaria

Antimalarial drug resistance is a major obstacle in the fight against malaria. Establishment or strengthening of systematic surveillance system with periodic updating is essential for containment. The treatment policies can be updated only if the information on the extent of the problem is known from various parts of the country. Since India is a vast country with several eco-epidemiological subtypes of malaria, it is necessary to evaluate efficacy of first and second line antimalarial drugs at several sites so as to help adopt alternative strategies for treatment as per need.

India is also contemplating a partial change in its drug policy including a consideration for use of combination therapy for drug resistant areas. Therefore, while the studies on the occurrence of resistance to first line drugs should be continued, there is a need to evaluate efficacy of these proposed new regimens. Thus, in view of urgent need to update and rationalise treatment policies, which can be done only after updating the information on drug efficacy and safety with existing drugs used in the country, the present studies were initiated with following objectives: (i) assessment of therapeutic efficacy of chloroquine (CQ), sulphadoxine-pyri-

methamine (SP) and combination therapy in the treatment of uncomplicated *P. falciparum* malaria in endemic districts in Orissa, Jharkhand and Indo-Bhutan border district in Assam; and (ii) To validate the *in vivo* drug resistance data using molecular markers and therapeutic concentration of drugs. The studies were conduced according to WHO protocol for therapeutic efficacy.

3.8.1 Assam

Paneery Central Hospital in District Udalguri was selected as a study site. Orientation meeting was held at Guwahati on 19 October 2005 which was attended by 16 officials from Downtown Hospital, Guwahati; Directorate of Health Services, Guwahati; Tezpur Central University, Assam and Officers from NIMR, Sonapur and Delhi.

Enrolment of patients in Darrang district

At Paneery Central Hospital in District Udalguri, 53 patients were enrolled and treated with Artesunate + Sulphadoxine-pyrimethamine combination. Out of 51 completed cases, only 3 reported with recrudescence on Day 28 and the rest 48 showed adequate clinical and parasitological response (Table 3.1 and Fig. 3.14).

Table 3.1. Baseline characteristics of patients in Darrang district

Drug: Artesunate + Sulphadoxine-Pyrimethamine
Dose: AS: 4 mg/kg x 3 days SP: 25 mg/kg single dose

No. of cases enrolled	:	53
Male/Female	:	27/26
Age (Range)	:	3–60 yr
Parasitaemia/µl on D0 (Range)	:	1,040–2,29,600

3.8.2 Orissa

The work was initiated in the middle of August 2005 in Keonjhar town, where sulphadoxine-pyrimethamine is the first line of treatment and a nearby PHC Banspal with chloroquine as the first line treatment for malaria. Before starting the study, a workshop on monitoring of drug resistance in uncomplicated *P. falciparum* cases was organised for medical officers of all the PHCs in Keonjhar district on 20 August 2005. The workshop was attended by 52 medical officers from district hospital, sub-divisional hospitals, municipality health officer and

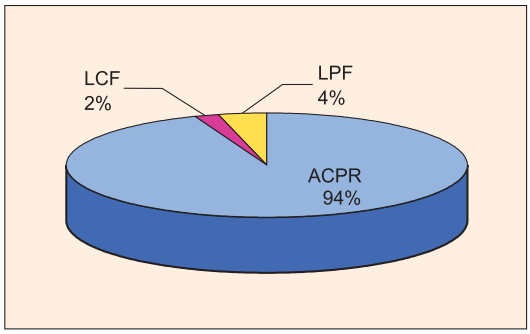

Fig. 3.14: Classification of therapeutic response in Darrang district

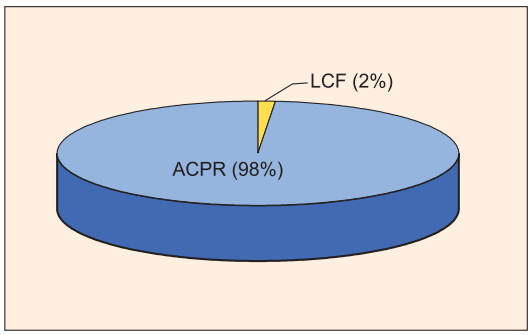

Fig. 3.15: Classification of therapeutic response in Keonjhar town, Orissa

Table 3.2. Baseline characteristics of patients in Keonjhar town, Orissa

Drug: Artesunate + Sulphadoxine-Pyrimethamine
Dose: AS: 4 mg/kg x 3 days SP: 25 mg/kg single dose

No. of cases enrolled	:	71
Male/Female	:	41/30
Age (Range)	:	1–70 yr
Parasitaemia/µl on D0 (Range)	:	1,000–82,000

medical officers from 13 PHCs in Keonjhar district. The faculty was from NIMR, Ispat General Hospital, Rourkela and State Health Directorate.

In Keonjhar town, therapeutic efficacy of Artesunate + SP combination therapy was evaluated in 71 *P. falciparum* patients fulfilling the inclusion criteria (Table 3.2 and Fig. 3.15). Follow-up for 28 days as per standard WHO protocol has shown adequate response to the combination therapy in majority of cases. Only one case reported back on Day 25.

3.8.3 Jharkhand

A meeting was held with State Programme Officer in Itki, Jharkhand on 23 March 2006 for identification of study sites. After deliberation and considering the epidemiological situation in different districts, Tathaitanagar PHC in District Simdega and Angada PHC in District Ranchi were selected. Site visits were done and discussions were held at respective PHC/Districts with Medical Officers and DMO. The study will be initiated in the last week of June 2006. In Banspal PHC, 72 patients were enrolled and tested with standard dose of chloroquine. Out of these, treatment failure was observed in 30% cases (Tables 3.3 and 3.4).

Table 3.3. Baseline characteristics of patients in Banspal PHC, District Keonjhar, Orissa

Drug: Artesunate + Sulphadoxine-Pyrimethamine
Dose: AS: 4 mg/kg x 3 days SP: 25 mg/kg single dose

No. of cases enrolled	:	72
Male/Female	:	47/25
Age (Range)	:	9 months–60 yr
Parasitaemia/µl on D0 (Range)	:	1,000–94,000

Meeting for site selection for the trial at Jharkhand

Table 3.4. Classification of therapeutic response in Banspal PHC, District Keonjhar, Orissa

Classification	No. of patients
ACPR	44
ETF	5
LCF	11
LPF	4
Loss to follow-up & withdrawal	8

3.9 Assessment of malaria treatment practices in public and private health sectors

The National Vector Borne Disease Control Programme has a strategy of early detection and prompt treatment of malaria cases through the primary health care system. A large proportion of suspected cases of malaria are being treated outside the public health system. The private sector is highly variable and unregulated. Antimalarial drugs are available over the counters and they are used injudiciously and sometimes in inappropriate doses. Exact information on the malaria treatment practices in private sector and compliance with prescribed drug policy at different levels across the public health facilities/sector is lacking. It is proposed to ascertain the treatment practices

through a combined review and observational study at various levels of health system in the urban and rural areas. The objectives of the study are: (i) to evaluate allopathic treatment practices for malaria in public and private health sectors; (ii) to assess and compare the awareness for National Drug Policy in public (teaching & non-teaching sectors) versus private sectors; and (iii) to assess the proportion of clinicians using rational treatment for the disease. Questionnaire for the study has been designed. Meetings with social scientist and statistician were held for finalising the questionnaire. Monitoring committee meeting was held.

In Orissa, pilot study has been conducted in Rourkela district and 33 questionnaires were completed covering practitioners from tertiary care hospital, district hospital, PHC, private hospital and general practitioners. In addition, 10 DDC/FTD workers were also covered. In Gujarat, which is moderately endemic for malaria, a pilot study was completed including 33 doctors from public and private sectors. In Delhi, 34 doctors were interviewed from public and private health sectors. It was found after interim analysis that awareness about drug policy is only 50%. Knowledge in public sector was slightly better as compared to private sector. Knowledge about drug resistance was found to be very poor among most of the doctors. For further assessment, the main study has been initiated in all the three sites with a plan to include 250 practitioners from public and private sectors each.

Orientation workshop held at Rourkela, Orissa

A workshop was conducted at NIMR, Delhi for Indian Medical Association (IMA) representatives from Orissa, Gujarat and Delhi. Just before initiation of the main study, The rationale, objective, methodology and preliminary results were presented and discussed. It was decided that IMA will coordinate in each state with Officer Incharge of IDVC field unit and help in the assessment of treatment practice from private sectors.

Monitoring committee meeting in progress

3.10 A Phase II, double-blind, parallel-group, randomised, dose-ranging study assessing the antimalarial activity and safety of RBx 11160 administered for 7 days in patients with acute uncomplicated *P. falciparum* malaria

RBx11160, a new peroxide, is a synthetic trioxolane that is easy to synthesise, inexpensive, achiral and orally rapidly acting with high antimalarial activity. It is a potential new antimalarial agent with demonstrable activity in pre-clinical models and a substantial safety margin between an effective dose for malaria and the toxic dose. Safety pharmacology studies carried out indicate that RBx11160 is safe and does not produce any clinically significant effect on behavioural parameters and cardiovascular systems. It is critical to gather data on clinical safety and efficacy of RBx11160 when used as monotherapy in adult patients suffering from acute uncomplicated *P. falciparum* malaria. The present study has been designed to assess the clinical safety and efficacy of three dose levels of RBx11160 (50, 100 and 200 mg), administered as a single dose for 7 consecutive days, in patients with uncomplicated *P. falciparum* malaria.

Workshop for Indian Medical Association representatives

SAC and Ethics committee of NIMR have approved the proposal. Administrative approval for sponsored research has been obtained from the DG, ICMR. The dossier has been submitted for DCGI approval.

3.11 Development of field trial site for malaria vaccines at Rourkela field unit, Orissa (A collaborative project of NIMR and ICGEB)

This is a collaborative project with International Centre for Genetic Engineering and Biotechnology (ICGEB), New Delhi and is being funded by the Department of Biotechnology (DBT), Govt. of India under Jai Vigyan Mission. The studies are being carried out to understand the epidemiology of malaria in Sundargarh district, Orissa, that will facilitate the field trials for *P. falciparum* malaria vaccines through collection of clinical, entomological and molecular epidemiological/immunological indicators from the study site. The longitudinal epidemiological studies were continued in two sets of villages in the forest and plain areas characterised by hyper- and mesoendemic malaria situations, respectively. There are 35 study villages (forest-23, plain-12) with a total population of 15,525. The longitudinal parasitological surveys were conducted in all the villages of phase-I study area. Weekly surveillance with the help of village volunteers was organised to measure malaria incidence. The annual parasite index (API) (number of cases/1000 population) in the forest and plain areas was 188.3 and 12.4 respectively. Malaria is persistent throughout the year in both the areas but peak transmission was observed during post-monsoon months—September, October and November. The proportion of *P. falciparum, P. vivax* and *P. malariae* species in the forest area was 85, 14 and 1 respectively whereas it was 75, 25 and nil respectively in the plain area.

In the forest area, the highest malaria incidence rate of *P. falciparum* (only first episode per individual per year) was 43.2% and was recorded in the 1–5 year age group and it was inversely proportional to increasing age, whereas in the plain area, the incidence rate was below 2% and all the age groups were equally affected. The highest attack rate due to *P. falciparum*—number of episodes per person per year in the forest area was recorded in the 1–5 year age group (0.62 episodes per child per year). The average attack rate in total population was found to be 0.16 and 0.01 in the forest and plain areas respectively.

Malaria prevalence in the study population during different transmission seasons was measured through cross-sectional point prevalence surveys in all the 35 study villages during March, June and November characterised by moderate, low and high transmission seasons respectively. In all, 40% of the houses were selected through computerised random numbers and all occupants of these houses were examined for malaria parasite irrespective of clinical symptoms. The average annual parasite rate in the forest and plain areas was 6.5 and 1.5 respectively. The highest parasite rate (30%) in the forest area during these surveys was found in the 1–5 year age group with a gradual decline as the age progressed, whereas in the plain area parasite rate was low and all the age groups were equally affected. Out of total parasite positive cases found in the forest area during cross-sectional surveys, about 38% of the cases were asymptomatic and 9% were found gametocyte carriers. During the year, 29 patients from study area were admitted to the hospitals for various ailments including severe malaria but no death was recorded due to cerebral malaria. The spleen rate in children and adults in the forest area was 80 and 18.4 respectively, whereas in the plain area it was 17.9 and 0.83

respectively. The average enlarged spleen (AES) in children in the forest and plain areas was 1.6 and 1 respectively. Study population was also screened for haemoglobin to estimate anaemia status of different age groups. Therapeutic response to chloroquine in the study population was assessed using WHO protocol. In Gurundia PHC area, chloroquine failure was recorded in 32% of the cases whereas, in Birkera PHC study area, the chloroquine failure was only 5.6%.

Longitudinal entomological surveys were conducted in two indicator villages each from forest and plain areas. A total of 15 anopheline species from the forest area and 10 species from the plain area were recorded. *An. culicifacies* was the most predominant species and accounted for 38.8 and 24.9% of the total anophelines in forest and plain areas respectively. *An. fluviatilis* was restricted to only forest area and its prevalence rate was 6.3%. The human blood index (HBI) of *An. culicifacies* and *An. fluviatilis* was 0.005 and 0.90 respectively thereby showing that the latter species was responsible for maximum transmission whereas, the former plays only supplementary role during spring and monsoon seasons. The average entomological inocculation rate (EIR) in the forest area during low, intermediate and high transmission seasons was 0.0, 0.085 and 0.35 infective bites per person per night whereas in the plain area the EIR during different transmission seasons was 0, 0.014 and 0.005 infective bites per person per night respectively.

Studies on the prevalence of genetic factors such as G-6-PD and sickle-cell in the study population were continued. Blood samples for studies on the parasite diversity and immune response during different transmission seasons were collected and transported to the HQ.

On the basis of existing epidemiological data as well as immune status of the study population, the children in the age group of 1-5 yr are eligible for vaccine trial in the forest area. The sample size on the basis of infection rate in this target group has been calculated. The required number of target children for vaccine trial will be sufficiently met out of the existing study population. As a pre-requisite to vaccine trial, the methods of data collection and measurements have been standardised.

Repeated cross-sectional surveys were conducted at four sites each from forest and plain areas. Individuals were categorised on the basis of fever and/or presence or absence of *Pf* infection. This way 160 and 92 subjects of different age groups were screened from forest and plain areas, respectively. Finger-prick blood samples were tested by Indirect ELISA to measure immunoglobulin isotypes, IgG and IgM levels against PfMSP-1_{19}, EBA175 and TRAP antigens. For test set up, the ELISA cut-off point was set at three S.D. above the mean $O.D._{490}$ values obtained with the sera from 6 individuals without a history of malaria infection. It was observed that overall IgG antibody profiles with three antigens were higher in individuals of forest area than those of plain area. The age-dependent increase of specific antibody level was noticed in individuals of two areas in both seasons. The mean ELISA O.D. was significantly lower in children < 5 years than adults ($p < 0.001$). Proportion of high responders was higher in adults than in children ($p < 0.01$). In afebrile (healthy) and febrile/non-malarial subjects, IgG levels against all the 3 antigens were higher than febrile/*Pf*+ patients. However, antigen-specific IgM was higher in this group compared to afebrile/healthy and non-malarial fever cases. The individuals belonging to the plain area showed lower levels of antibodies than forest inhabitants, but the trend looked similar. From earlier batches, 127 and 68 blood samples collected from forest and plain areas during mass survey were tested for their IgG subtypes. Age-wise increase in IgG level has been observed in individuals of both forest and plain areas. The IgG1 and IgG2 were the predominant subclass responses to all the three antigens. The results demonstrated that acquisition of antibodies during the time of high transmission phase was more, compared to low transmission phase.

3.12 Identification of malaria risk factors in Jaisalmer district for preparation of strategic action plan

Preliminary survey was carried out to collect

epidemiological and entomological data. Study sites were selected based on preliminary entomological/ parasitological survey and data were collected for each village/subcentre selected from core PHC areas of the district. Census survey of all the indicator villages was carried out and information on housing patterns, terrain features, water bodies was collected. Entomological investigations revealed prevalence of the two major vector species of malaria, *An. stephensi* and *An. culicifacies*. Density of *An. culicifacies* was maximum in canal area and *An. stephensi* was prevalent in high density in almost all the PHCs surveyed.

Data collected will be used to identify risk features and appropriate strategic plan will be prepared for disease management and vector control.

3.13 Malaria clinics

3.13.1 At 22 Sham Nath Marg, Delhi

A total of 312 patients attended the Malaria Clinic at 22 Sham Nath Marg or were referred from hospitals for blood examination and treatment of malaria from January to December 2005. Out of 50 patients found positive for malaria, 33 were diagnosed as *P.vivax* and 17 as *P. falciparum*.

3.13.2 At 2 Nanak Enclave, Delhi

A total of 3,342 patients availed blood examination facility at Malaria Clinic of National Institute of Malaria Research, 2 Nanak Enclave during April 2005 to March 2006. Of which 548 patients were found positive for malaria infection. Among all the malaria positive patients, 541 (98.7%) were positive for *P. vivax* while 6 were positive for *P. falciparum* and only one was found positive for both *P. vivax* and *P. falciparum*. Specific symptomatic treatment was given to all these patients. Blood samples from volunteer patients based on their verbal consent, were collected for in-house research activities. Month-wise distribution of cases is given in Table 3.5.

Table 3.5. Malaria cases reported at Malaria clinic, 2 Nanak Enclave, Delhi

Month	BSE	Total	*Pv*	*Pf*	Mix	SPR
Apr	201	12	12	0	0	5.97
May	228	26	26	0	0	11.40
Jun	174	49	48	1	0	28.16
Jul	320	62	60	2	0	19.38
Aug	546	119	118	0	1	21.79
Sep	623	225	224	1	0	36.12
Oct	420	29	27	2	0	6.90
Nov	193	7	7	0	0	3.63
Dec	118	6	6	0	0	5.08
Jan	109	3	3	0	0	2.75
Feb	159	3	3	0	0	1.89
Mar	251	7	7	0	0	2.79
Total	3,342	548	541	6	1	16.40