Prospects of Malaria Control in Northeastern India with Particular Reference to Assam

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Abstract

Malaria is endemic in the entire northeastern region comprising of 7 states. *P. falciparum* is the most predominant species. *P. falciparum* has become resistant to chloroquine (CQ) and sulphadoxine pyremethamine (SP) drugs. The principal vectors viz. *An. baimaii* (formerly species D of *An. dirus* complex), *An. minimus* and *An. fluviatilis* are highly efficient in malaria transmission with exophilic and exophagic behavior, and maintain stable malaria in the region. Problems in malaria control and way forward in achieving sustainable malaria control are described.

Introduction

The present situation of malaria in India is best described as malaria endemic country with >95% of her population at risk of malaria. Reported cases of malaria vary from 1.8 to 2.0 million (1.2 million in 2006) and 1, 000 deaths per year. WHO SEARO estimates 15 million cases and 19,500 deaths, whereas WHO HQs estimates 70 million malaria cases (Sharma, 2005). The proportion of *P. vivax* and *P. falciparum* is almost equal but it varies greatly from place to place and seasonally. *P. falciparum* is a killer parasite and it has become resistant to chloroquine with reports of resistance to other antimalarial drugs. *P. vivax* is sensitive to chloroquine but in the last decade resistance to chloroquine has been reported from a few places in the country (Dua et. al. 1996). The total number of cases and the percentage of *P. falciparum* are rising as a result of fall in *P. vivax*. Furthermore clinical profile of *P. falciparum* patients is becoming more severe with increasing trend of renal and respiratory complications and multi-organ failure (B.S. Das, Personal Communication, formerly at the Ispat Hosptial Rourkela). The major vector of malaria *An. culicifacies* responsible for generating 65% malaria cases has developed resistance to DDT and Malathion (Sharma, 1996). Synthetic pyrethroids are being sprayed to control the emerging epidemics. Multiple insecticide resistant mosquito strains have emerged so that malaria control is attainable partially, if at all. Malaria returns year after year requiring spraying, but due to limited resources spraying is carried out in 10% endemic population. National Anti Malaria Programme (NAMP) has been renamed as the National Vector Borne Disease Control Programme (NVBDCP) making it accountable for the control of all vector borne diseases. Malaria epidemics have become commonplace and more devastating. Emergency measures are adopted to suppress the epidemics. This produces transient relief, but the over all picture remains unchanged. New diseases are emerging and spreading e.g. Dengue and Dengue Hemorrhagic Fever (DHF) and Chikungunya virus fever (CHIKV). NVBDCP is spending its limited resources in fighting the re-emerging arboviral diseases (Lahariya and Pradhan, 2006; Bhargava and Chatterjee, 2007; NVBDCP Website). Malaria control in the tribal settlements is to be seen in the above background of rapidly deteriorating situation of vector borne diseases and resource crunch.

Tribal Malaria

India has 635 tribes and constitutes 7.8 % of the country's population. The tribal population is 87.7 million. Bulk of this population is scattered in 8 states. Almost all population of northeastern states belong to tribal group which has a separate funding mechanism i.e. malaria control in NE states is a centrally sponsored activity since December 1994. Therefore central government contribution has no restriction of 50% matching grant from the states. That makes malaria control more sustainable in as far as the resources are concerned. Tribal malaria control generally refers to the Enhanced Malaria Control Project (EMCP) launched with World Bank (WB) financing to cover 1,045 Primary Health Centre (PHCs) in 100 predominantly tribal and malaria endemic districts in 8 states namely, Andhra Pradesh, Bihar, Chhatisgarh, Gujarat, Jharkhand, Madhya Pradesh, Maharashtra and Orissa. Enhanced Malaria Control Project (EMCP) was launched with World Bank funds in September 1997 with the objective to strengthen malaria control by additional inputs through a mix of interventions. While malaria control in the EMCP areas of 8 states is being presented by other investigators (Sharma, 1999). I wish to briefly describe the tribal malaria situation in the northeastern states, in particular the state of Assam.

Situation Analysis

The population of northeastern (NE) states is 39 million i.e. 3.96% of the country's population. Of the total burden of malaria in India, NE states contribute 10% malaria and 11% *P. falciparum* cases and 20% malaria deaths. Malaria control depends on effective vector control. In the NE region malaria vectors are viz., *Anopheles minimus* (perennial species), *An. baimaii* (monsoon species), and *An. fluviatilis* (winter species). All these mosquitoes are highly efficient in the transmission of malaria (Dev, 1996; Dev et. al. 2001). Malaria vectors are susceptible to DDT, HCH, Malathion and Synthetic Pyrethroids but because of the exophilic and or exophagic vector behavior they avoid resting on the sprayed walls, and thus avoid the killing action of insecticides. The situation is further complicated by high proportion of *P. falciparum* >60%), a killer parasite that has become multi-drug resistant (Dua et. al. 2003; Dev et al, 2003). Table 1 gives the areas and population involved in cross-border malaria. *P. falciparum* is the dominant parasite all along the international borders which is widely disseminated by the population movement on both sides of the international borders.

Fig. 1 gives the location of districts in Assam. Fig. 2 gives the An. minimus man hour densities in Sonapur PHC villages. High densities are encountered from March-April till the end of August and these are related to rainfall. Fig 3. gives the malaria incidence (Pv and Pf) over a three year period. Malaria peaks during the rainy season. It is notable to mention that environmental determinants favor malaria transmission almost throughout the year except a brief period of interruption due to cold weather (Dev et. al. 2006a). Table 2 gives the epidemiological situation of malaria in Assam. NVBDCP reports declining trend of malaria each year and in 2006 1.2 million cases were reported (lowest since resurgence in 1976). It is notable to mention that malaria situation in Assam is grim as is evident by the fact that in 2006, malaria cases have doubled, and 300 malaria deaths were reported from 23 districts. An estimated one million population of 66 PHCs and 1,720 villages were severely affected in the outbreaks. Malaria is also affecting the economic zones of the state e.g. tea gardens and industrial belts of the state.

Table 1: Malaria profile of inter-border populations of Assam*

Inter-state/ International Border	No. of bordering districts & (PHC's)	Population of bordering PHC's	No. of blood-smears examined (% of population checked)	No. and (%) of blood-smears		% of malaria cases positive for *P. falciparum*	No. of deaths
				+ve for malaria parasite (SPR)	+ve for *P. falciparum* (SFR)		
Indo-Bhutan	6 (12)	2265137	195215 (8.6)	14634 (7.5)	5008 (2.6)	34	10
Indo-Bangladesh	3 (10)	1943795	84982 (4.4)	1316 (1.5)	1215 (1.4)	92	2
Arunachal Pradesh	7 (19)	4138566	246669 (5.9)	19536 (7.9)	4661 (1.9)	24	26
West Bengal	2 (5)	1043973	43801 (4.2)	1366 (3.1)	967 (2.2)	71	5
Manipur	2 (5)	612617	21776 (3.5)	1075 (4.9)	1058 (4.8)	98	0
Mizoram	3 (5)	1145594	44176 (3.8)	1766 (4.0)	1746 (3.9)	99	2
Meghalaya	7 (19)	3028263	148434 (4.9)	8765 (5.9)	7181 (4.8)	82	7
Nagaland	5 (13)	2161451	148116 (6.8)	6659 (4.5)	5747 (3.9)	86	22
Tripura	1(1)	293445	21897 (7.4)	126 (0.57)	101 (0.5)	80	0

*Data based on the year 2001 (Source, State Health Directorate)

Table 2: Malaria incidence in Assam

Year	Population in millions	Malaria cases (Pf %)	ABER (% of population checked)	API (No. of cases/ 1000 population)	Malaria Deaths
2000	26.9	84915 (61%)	8.23	3.15	43
2001	27.3	95142 (62%)	8.90	3.48	122
2002	27.7	89601 (62%)	8.32	3.21	72
2003	27.8	76570 (63%)	7.66	2.74	53
2004	28.7	58134 (71%)	6.45	2.02	52
2005	29.0	67885 (67%)	7.06	2.34	113
2006	29.3	121339 (67%)	8.35	4.14	300

Source: State VBDCP

Fig. 1: District map of Assam

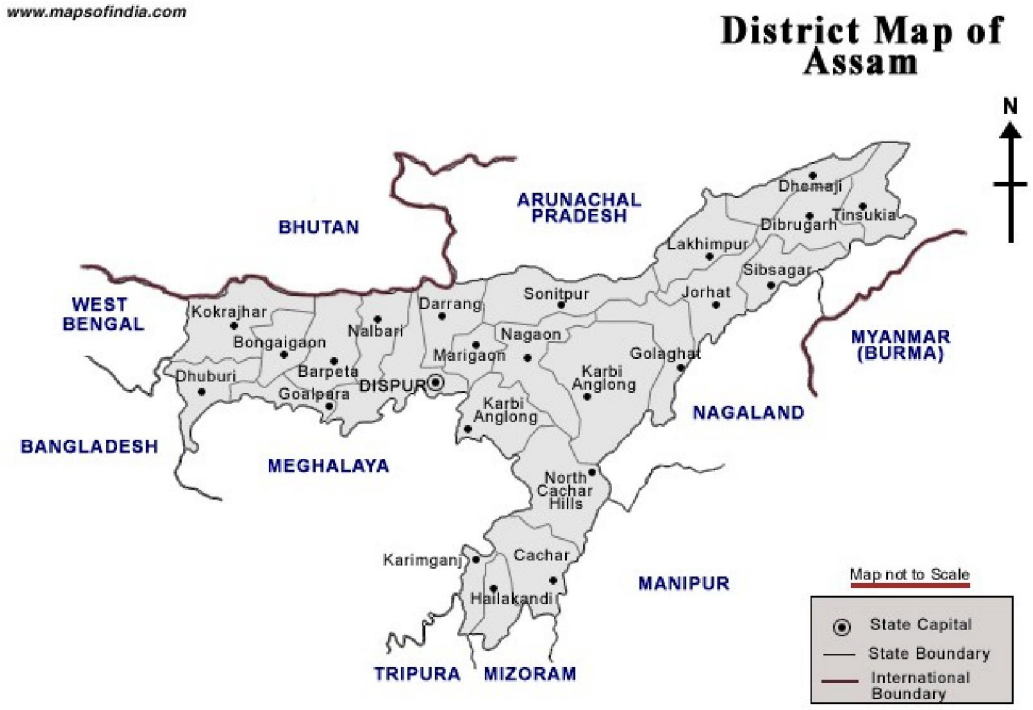

Fig. 2: Trend of *Anopheles minimus* densities (measured as man hour density) in Sonapur PHC, Kamrup district, Assam



Fig 3: Trend of malaria in relation to environmental conditions in Sonapur PHC, Kamrup district, Assam.



Note the perennial malaria transmission with peaks during the rainy season

High densities are encountered from March-April till the end of August and these are related to rainfall.

In Assam malaria cases were detected in all months of the year and peaks during May–June, which coincides with rainy months. These were also the months with highest incidence of infection with *P. falciparum.* Malaria cases were detected in all age groups of both sexes, and there was clustering of cases in villages near the vector-breeding habitat (perennial seepage streams), and foothill villages. However, malaria cases were consistently low in villages within 5-km of the nearest health care facility, which were in town areas (Dev et. al. 2004). Another study (Dev et. al. 2006) revealed that the main transmission season of malaria in Sonapur PHC, Kamrup district in Assam was the wet season from April to September and malaria cases were low during the dry season from October to March. Indian Tea Association has reported >66%. *P. falciparum* was the prevalent infection in almost all tea gardens on the north bank of Brahmaputra river often causing epidemics. *Anopheles minimus* was positive with sporozoites almost throughout the year. The EIRs per person/night were 0.46–0.71 in *P. falciparum*-predominant areas and 0.12 in the district where *P. vivax* predominated (Dev et. al. 2004).

Malaria control in Assam required innovative approaches. Therefore for the first time insecticide treated mosquito nets (ITMN) were introduced in endemic villages (Jana-Kara et. al. 1995). Based on this experience in Assam and to promote the national policy of the insecticide treated bed nets as the main strategy of malaria control, transfer of technology workshops were organized in all the NE states as shown in Table 3.

Table 3: Technology transfer of the insecticide treated bed nets in the North-eastern states

State	Nets Distributed	Deltamethrin 2.5% flow (kg)	Date of Training	Venue	No. of Trainees
Meghalaya	11,000	110	21-07-95	Shillong	44
Assam	24,000	240	24-07-95	Sonapur	25
Nagaland	10,000	100	04-08-95	Sonapur	02
Arunachal Pradesh	17,500	175	08-08-95	Itanagar	16
Mizoram	15,500	155	13-10-95	Sonapur	02
Tripura	11, 000	110	13-12-95	Agartala	16
Manipur	11,000	110	24-01-96	Imphal	42

Table 4: Impact assessment of insecticide treated bed nets on malaria transmission in the northeastern states

State	Population	Time Period*	BSC/E	No. of +ve Cases	SPR	PI ('000)
Assam	31467	Jan '95 –Dec '95	12713	2215	17.41	70.39
	32732	Jan '96 –Dec '96	2715	178	6.55	5.34
Meghalaya	8946	Jan '95 –Dec '95	4424	609	13.76	60.00
	10270	Jan '96 –Dec '96	4494	274	6.09	26.67
Arunachal	9404	Jan '95 –Dec '95	6431	828	12.87	88.05
	9710	Jan '96 –Dec '96	5567	86	1.54	8.86

* Jan 1995 –Dec 1995 is the base line year data. Mosquito Nets Treated with Deltamethrine (2.5% flow) were introduced in January 1996.

Source: Data collected by the respective State Health Dte through primary health care system (for the remaining northeastern states, the distribution of nets was irregular and patchy, thus data could not be evaluated). The re-treatment of nets was not conducted as scheduled, thus data of the subsequent

years could not be considered.

Simultaneously ITMN were distributed in the endemic villages by the trained staff, who also monitored the impact of ITMN. Table 4 gives the results of ITMN on the malaria incidence. There was remarkable improvement in malaria situation compared to the malaria situation in the neighboring villages held as control.

Table 5 gives the people's response to the ITMN programme. A very high percentage of people reported the benefits from sleeping under the ITMN, and ITMN users preferred nets over the spraying. Over a period of time additional demand of ITMN was generated, although poverty prevented people from opting for the ITMN, if not provided free by the government.

Table 5: Response surveys among ITMN users

Sl. No.	Question	% Positive Response			
		1989 (n=490)	1991 (n=439)	1992 (n=154)	1999 (n=117)
1.	Using Regularly	99	96	93	99
2.	Reporting discomfort (headache, itching)	08	06	14	01
3.	Reporting benefits	100	96	87	100
4.	Would like to continue using	99	96	91	97
5.	Would like to buy own nets	43	96	67	-

Problems in Malaria Control

Malaria control in the NE faces many challenges. Inter alia these challenges are:

1. Tropical rain-forest rich in wild life including reserve forests and sanctuaries, interspersed with valleys, hills and settlements making the region highly receptive for maintaining perennial malaria transmission;
2. Schedule tribes and scheduled castes comprise of 12.8% and 7.4% respectively and suffer from neglect and high levels of poverty, and about 30-40% population of Assam lives below the poverty line which is a big driver for maintaining perennial transmission (Sharma, 2003);
3. Vast areas inundated with floods annually;
4. Inaccessible settlements that remain cut off during the rainy season which happens to be the peak transmission season;
5. Unrest in some areas hampering work ;
6. Weak to non-existent health infrastructure;
7. *P. falciparum* predominant in most areas of the state resulting in high morbidity and mortality and unaffordable treatment cost;

8. High proportion of carriers;
9. Presence of mono and multi-drug resistance;
10. Stable malaria except small pockets with unstable malaria;
11. International borders encouraging cross-border malaria;
12. Presence of highly efficient vectors viz., *An. minimus*, *An. baimaii* (formerly species D of *An. dirus* complex) and *An. fluviatilis*;
13. Poor and scattered houses mostly made of mud and bamboos;
14. Tribal rely on traditional methods of treatment and healers;
15. Population migration and nomadic behavior;
16. Deforestation and man made changes in the ecology etc;
17. Gross under-reporting of cases gives a false sense of good performance. Burden of malaria is high and available data does not reflect true malaria incidence;
18. Malaria control based on DDT spraying to control exophilic and exophagic vector populations, whereas most transmission is extra-domiciliary;
19. Environment of the NE states is highly receptive for malaria transmission;
20. There is almost round the year transmission with peaks following rains. Vast areas are inaccessible, remain cut off during the rainy season;
21. There are vacancies at all levels and shortage of essential medicines.

There are many more administrative and socio-economic problems hampering successful malaria control in the NE states. All the above factors work in unison to maintain perennial malaria transmission.

Way Forward

1. Health Infrastructure: De-centralize malaria control to district level, eliminating all controls from the Centre. The responsibility should be shifted to Zila Parishad. Initially some problems may arise but gradually experienced and trained cadre would rise to the occasion, and successfully tackle the specific problems at the micro-level. Training and re-training should be an in-built component of the district health infrastructure. Training courses should be prepared for each category of staff keeping in mind the local requirement of malaria planning and control. A regular system of laboratory checks and counter checks should be maintained so that staff is in place, and supplies are available at the lowest level of health system. The region should have norms of the primary health care system considering the terrain and ecology of the region to ensure adequate coverage. Furthermore planning and implementation of malaria control should be based on more realistic assessment of the disease burden in the NE. Accelerated economic and infrastructure development is urgently needed to improve this situation.

2. Stratification: Each district should take up malariogenic stratification based on DALYs, malaria risk maps should be prepared and updated periodically, hot spots of malaria should be highlighted for preventive action, prioritize economically important areas (e.g. tea gardens, industrial areas, defence establishments, R & D organizations

etc.) for interventions. Based on the above information a calendar of activities should be prepared and all supplies arranged before time. Community participation must be ensured and they should be made aware of their rights, privileges and responsibilities. There should be complete transparency in the planning and implementation of the malaria control activities and communities should be taken into confidence, and made partner from the very beginning.

3. Vector Control: Malaria control in NE is based on the indoor residual spraying of DDT. In the last 30 years, since the resurgence started malaria picture in Assam has remained more or less static, although DDT was being sprayed. DDT spraying should stop forthwith (Sharma, 2003a). Malaria control should rely on the use of insecticide treated mosquito nets; preferable long lasting insecticide bed nets (LLINs). Wherever it is feasible bioenvironmental methods of vector control must be introduced for long-term sustainable malaria control. Drainage should be organized to channelise streams and stagnant water bodies to control mosquito breeding. Care should be taken to maintain the ecological integrity of the region. Removal of streams/water bodies from the vicinity of human settlements up to 1 -1.5 km (the flight range) should be practiced. This strategy will protect from the bites of vector species viz., *An. minimus* and *An. fluviatilis*. Wherever feasible, bioenvironmental methods of vector control should be applied to control the mosquitoes. All efforts should be made to maximize preventive vector control coverage. It may be noted that malaria control in NE requires sustained and multi-pronged attack on the disease.

4. Parasite Control: In areas where laboratory services are deficient or not available, dipstick method of diagnosis should be introduced. WHO guidelines for the treatment of malaria should be followed. Quinine is currently used in the treatment of severe malaria cases. Quinine should be replaced with the artemisinin as the later provides early recovery and saves more lives (Woodrow et. al. 2005). Monitoring of drug resistance should be a continuing process for updating drug policy. Equipping hospitals and training of para-medicals and medical staff should be given priority for correct and efficient treatment of patients. There is high prevalence of multi-drug resistant malaria in the NE states. The existing malaria drugs such as chloroquine, sulphadoxine-pyremethamine, mefloquine etc. are inefficient and pose the danger of accelerated resistance. WHO now recommends that the treatment of *P. vivax* may continue with chloroquine but for the treatment of *P. falciparum* fixed dose artemisinin based combination therapy (ACT) should be adopted as the national drug policy (Sharma, 2006). This policy is being adopted widely throughout the world and there is no scientific basis or rationale to continue with the outdated drug policy.

5. Epidemic Malaria: Malaria epidemics visit the state of Assam with increasing frequency leading to high morbidity and mortality. Early warning system should be developed for early preventive action. Each district should have well trained staff that can be drafted to fight the epidemics. Epidemic malaria control may require spraying with an efficient insecticide like the synthetic pyrethroids supported by the intensive surveillance to detect all parasite positive cases. In some areas mass drug administration or mass radical treatment may be required. Standard techniques and norms should be followed in the control of malaria epidemics. Patient care in the hospital must be strengthened. Medical and para-medical staff should be trained in the management of severe malaria. Malaria audit must be carried out to pin down the causes of deaths due to

malaria, and areas of weakness must be strengthened. A recent finding is that in malaria cases iron supplementation to treat anemia may enhance severity of the disease.

6. Border Malaria: Malaria control along the international borders should receive special attention. WHO should be requested to organize border meetings on regular basis so as to implement an agreed strategy on both sides of the international border. Checkpoints should be set up to test migrant population for the presence of malaria parasites. Carriers can spread malaria, particularly new strains that are more lethal. Blood test should be made an essential requirement for labor hired by the contractors, engineering departments, and labor-intensive development agencies.

7. Malaria Awareness: Information, Education and Communication (IEC) should become a continuing activity to help strengthen early case detection and prompt treatment (EDPT), use and care of bed nets (LLINs/treated nets), eliciting people's participation in vector control, and encouraging inter and intra sectoral coordination.

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