

Original Research Article

A retrospective study of malaria outbreak in children of a defence establishment in Gujarat State of India

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	International Archives of Integrated Medicine, Vol. 2, Issue 7, July, 2015. Copy right © 2015, IAIM, All Rights Reserved. Available online at http://iaimjournal.com/ ISSN: 2394-0026 (P) ISSN: 2394-0034 (O)
	Received on: 13-06-2015 Accepted on: 22-06-2015 Source of support: Nil Conflict of interest: None declared.

Abstract

Introduction: Malaria is a major health threat in India. Many states including Gujarat reported local and focal outbreaks of malaria from 1997 to 2006. A defence establishment located in western part of India suffered from an epidemic of BT malaria in 2005, which was confirmed by epidemiological investigation.

Material and methods: An outbreak of malaria occurred in a closed defence campus was investigated by an epidemiologist and was confirmed as an epidemic. Measures advised for its control and further prevention were strictly implemented to control it. The study is based on the reported information and data collected at the time of investigation.

Results: In a population of 4832 in a closed campus, 363 cases were reported with high slide positivity rate of 27.07 percent and overall API of 75.12 per thousand populations. The incidence was relatively higher among the children below 16 years with a very high API of 156.43 in 6-11 years' age group. High spleen rate and infant parasite rate confirmed the local transmission of malaria. An excessive breeding of vector was noticed as several places.

Discussion: The campus suffered from BT malaria epidemic with very high API among younger population of school going children mainly due to local transmission caused by *An. stephensi*. Vectors were found breeding heavily in pools, ditches, overhead tanks and static tanks. The epidemic resulted due to insincere efforts in implementing anti-malaria activities.

Conclusion: The epidemic affected all age groups with a very high incidence in pre-school and school going children especially 6-11 years' age group. Lack of anti-malaria activities, uncontrolled

breeding of anopheles in the campus, delay in diagnosis and treatment, poor reporting, record maintenance and follow up of the cases were the causes of the epidemic. It was effectively controlled by implementing measures of control suggested by the epidemiologist.

Key words

Malaria epidemic, Malaria in children, Investigation of malaria outbreak, API, Malaria control measures.

Introduction

Malaria is a major public health threat in India with a very large number of cases occurring in many of its states. About 27 percent of India's population lives in malaria high transmission area with more than 1 case per thousand population [1]. Realising the situation of very large number of cases (75 million cases and 0.8 million deaths) annually in post independent period, National Malaria Control Programme was launched by the government in the year 1953. The programme was implemented with major strategy of indoor residual spraying with DDT and was proved to be a great success in controlling malaria. Encouraged with the results the programme was changed to National Malaria Eradication Programme in the year 1958. In its initial years the eradication programme was so effective that the number was brought down to just 0.1 million cases with no death in 1965. But there had been resurgence of the malaria with 6.4 million cases in the year 1976. This happened due to operational, administrative and technical shortcomings in the programme [2, 3, 4]. Presently the activities undertaken to control malaria are based on the strategy followed by the Modified Plan of Operation (launched in 1977) now named as National Vector Borne Diseases Control Programme (NVBDCP). A defence establishment in the Kutch area of Gujarat state witnessed an alarming rise in the number of cases of malaria among the defence employees in a closed campus in the year 2005 as a result of post-earthquake (26 Jan 2001) effects. The higher formation of the area was informed by local authorities about the incident. A team headed by a senior defence epidemiologist accompanied by local administrative and medical authorities was deputed to look into the matter,

submit a report and advise the measures for prevention and control of malaria in the region. The team investigated the rise in number of the cases and declared it as an epidemic of malaria and advised measures for its control and prevention. Investigation revealed a significantly high incidence of malaria initially among the defence employees which later affected the family members with a very high number of cases among the preschool and school going children. The team confirmed it as an epidemic of Benign Tertian (BT) malaria caused due to local transmission of *Plasmodium vivax* by *Anopheles stephensi*. The measures for prevention and control advised by the team were strictly implemented by the authorities and the epidemic was controlled successfully. The suggested measures were implemented in other defence establishments of the region also to prevent occurrence of any similar outbreak.

Material and methods

District Bhuj located in Kutch area of the Gujarat state is the westernmost part of India with a high endemicity of malaria. The area witnessed an earthquake on the Republic Day i.e. 26 January 2001, with vast devastating effects, leaving over 18,600 persons dead, more than 150,000 of them homeless and an economic loss of about Rs. 22,000 crores [5]. Urban locality of Bhuj is an endemic malaria region where cases keep occurring throughout the year with peak spurts in the months between September to December due to rise in humidity and fall in temperature favouring multiplication of the vector. Earthquake and its after effects created rise in number of water bodies and water collection in artificial pools which were created to store water

for construction and renovation work at most of the places. These were left as such even after the work was over without demolishing, hence became potential breeding places for anopheles mosquitoes. These water collections were found as the main cause of rise in the number of cases during post-earthquake period which continued afterwards also till 2006. In recent past, malaria epidemics have been reported from 1994-2006 with large number of cases and many deaths from the states of Rajasthan, Gujrat, Goa, West Bengal, Karnataka, Haryana and Manipur [2]. There had been a sudden rise in the number of malaria cases in the year 2005 inside the campus with a report of more than 30 cases among defence employees in a short span of three months from May to July. Occurrence of these cases was considered as an outbreak by the authorities at higher formation to take decision to control this abnormal rise of malaria cases. A team comprising of a senior epidemiologist as head of the team and other members from related departments was deputed to investigate, submit the report and later on monitor the implementation of the suggested measures to control the disease. A preliminary report was submitted in a week by the team followed by the final report at the end of four weeks. Preliminary report confirmed the rise in number of cases as an epidemic of malaria due to local transmission. Since the epidemic continued during the period of investigation, measures suggested in preliminary report were implemented under guidance of the team for its effective control. The

epidemic was successfully controlled by strictly implementing the advised anti-malarial activities.

Confirmation of the epidemic of malaria

Medical records of defence employees available at the local section hospital were analysed to assess the problem of rise in the number of malaria cases. Data was also collected from nearest defence referral centre (Military Hospital) and District Malaria Centre. A comparison of the cases occurred in the study area, other defence establishments and rural and urban localities of the civil area was as per **Table - 1**. It is evident that API of different areas in past three years was in the range between 2.18 to 12.45 percent which makes the area as a high malaria endemic region. In the study area occurrence of 31 cases among employees in a span of three months from May to July, with an API of 61.39 per thousand per year was considered as an outbreak. By the end of year their number increased to 70 as it is evident as per **Table - 2** and **Figure - 1**. Out of total 70 cases, 67 were of BT type of malaria and a small contribution of 3 cases was of MT malaria. Since the record was maintained only in respect of service employees the data of their families could not be made available for the past years. However, the recent information in respect to the families including children was recovered from lab investigation, OPD and IPD records. This data was analysed to work out the epidemiology of malaria and evaluate the extent of the disease in the family members.

Table - 1: Comparison of malaria cases among employees in the area under study and outside the campus.

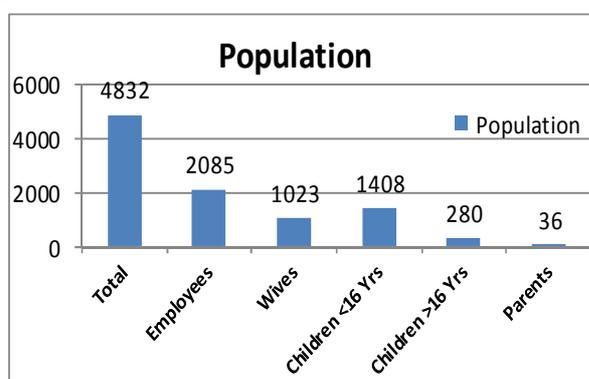
Locality	Approximate population	Malaria cases and API in the region					
		2003		2004		2005	
		Cases	API	Cases	API	Cases	API
Area under study	2,085	12	5.75	10	4.79	70	33.57
Other defence areas in the region*	28,500	150	5.26	141	4.94	167	5.85
Civil area (urban)	1,35,000	339	2.51	437	3.23	294	2.18
Civil area (rural)	2,25,000	2802	12.45	2342	10.41	1147	5.1

*There are several small defence units located in the area reporting to local Military Hospital for their medical needs.

Table - 2: Year wise malaria cases among employees.

Year	BT	MT	Total	API
2000	11	1	12	5.75
2001	65	15	80	38.36
2002	13	3	16	7.67
2003	11	1	12	5.75
2004	9	1	10	4.79
2005	67	3	70	33.57
2006	15	2	17	8.15

Figure - 1: Category wise distribution of the population.



Results

Following were the results of the epidemiological investigation of the outbreak.

Demographic profile of the study population

Out of the total 4832 population of the residential complex there were 2085 defence employees and 2747 family members. Out of the family members 1023 were wives of the employees, 36 parents and 1688 were the children of the employees. 1408 of the children were below 16 years and rest 280 were of the age above 16 years. (Figure - 1) Share of below 16 years children in total population was 1408 out of 4832 making it to 29.14 percent while rest 3424 of them were above the age of 16 years contributing to 70.86 percent.

Types of malaria

Out of two prevalent types of malaria in the region, Benign Tertian (BT) malaria caused by *Pl. vivax* was predominant as compared to Malignant Tertian (MT) caused by *Pl. falciparum*. Only service employees suffered from MT malaria. Out of 70 employees only 3 persons were found to have MT malaria rest 67 of them showed presence of BT malaria making a ratio of 1:22.3 in favour of BT malaria. All persons in other categories were detected to have only BT malaria in their slides.

Overall incidence of malaria

In the total population of 4832, there were 363 persons who suffered from malaria as confirmed by blood slide making an overall API of 75.12 per thousand (Table - 3). Out of the population of more than 16 years of age (formed by adults and late adolescents), 190 were found positive for malaria on blood examination with an API of 55.4 per thousand as compared to the children below 16 years with a very high API of 122.86 per thousand. Defence employees suffered least with an API of 33.57 followed by wives and parents with API of 82.11 and 83.33 per thousand respectively.

Malaria in children

In the child population of below 16 years who suffered from malaria with API of 122.86, maximum API of 156.43 per thousand was observed in children of the age group of 6-10 years followed by 137.20 in age group of 1-5 years and 108.11 in the infants. Age group 11-16 years had an API of 78.02 which was least in the children. Sex wise a significant difference was noticed in the age groups of infants and the age group of 6-10 years (Table - 4). In infants males suffered three times more while in 6-10 years age group females suffered more than the males with their numbers being 41 and 38 respectively.

Quarter-wise distribution of malaria cases

The number of cases increased gradually from 24 cases in first quarter to 73 and 152 cases in 2nd and 3rd quarter respectively (Table - 3). Thereafter there was decline in the number of

cases to 114 in 4th quarter. Peak API of 127.48 was observed in 3rd quarter of the year. Month wise maximum number of cases 66 occurred in the month of September.

Measurements of malaria

Annual blood examination rate (ABER)

In all 1175 slides of the fever cases were prepared and examined for malaria parasite in total population of 4832 giving an ABER of 36.93 percent. Out of the total 1408 children below 16 years of age 546 slides were prepared and examined at the rate of 39.05 percent [6, 7, 8].

Annual parasite incidence (API): Defined as number of blood smear positive cases per thousand population per year [6], API was calculated as 75.12 per thousand population (363 cases in the population of 4832) in present epidemic. Although 434 slides were found positive during the year, these belonged to only 363 cases who were asked to undergo blood examination test every time on reporting as fever cases. Out of these cases 311 were detected positive once, 44 were shown positive twice, 5 had their slides positive three times, while 3 cases were detected to have their four slides positive. 8 cases were other than defence persons

living outside the campus, hence were not reflected in counting of the cases. Out of all cases, one case had mixed infection of MT and BT, two had MT and rest 360 were BT cases. Overall API calculated for total population was 75.12 per thousand populations. API in different categories was 33.57 for service employees, 82.11 for lady wives and 122.86 for the children. Out of the children below 16 years, distribution of disease was maximum in 6-10 years age group with API 156.43, followed by 137.20 in age group of 1-5 years, 108.11 in infants and 78.02 in the age group of 11-15 years. (**Figure – 2**)

Spleen rate considered as a reliable index of measurement of malaria of the pre eradication era was calculated in the age group of 2-5 years [7]. Out of 287 children who reported as case of fever or for follow up, all were examined for the enlargement of spleen. 3 children were found to have enlarged spleen by 2-5 cm. The spleen rate is worked out to be 1.04 percent.

Infant parasite rate: It is the percentage of blood slides of infants reported as positive out of all slides examined [7, 8]. Out of all 37 infants, 9 developed fever and their blood smear slides were made. 4 of them were found positive with an infant parasite rate of 10.81 percent.

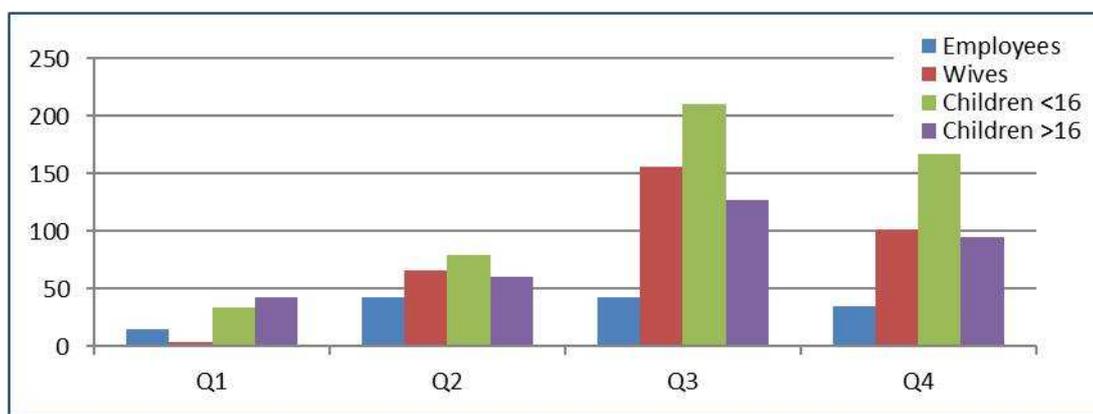
Table – 3: Quarter-wise distribution of malaria cases in different categories.

Category of the persons	Malaria cases (and API) in different quarters of the year				Total cases
	Q1	Q2	Q3	Q4	
Employees	8 (15.34)	22 (42.21)	22 (42.21)	18 (34.53)	70 (33.57)
Family members	--	51	130	96	293
Wives	1 (3.91)	17 (66.47)	40 (156.40)	26 (101.66)	84 (82.11)
Parents	--	--	02 (222.22)	01 (111.11)	03 (83.33)
Children < 16 yrs	12 (34.09)	28 (79.54)	74 (210.22)	59 (167.61)	173 (122.86)
Children > 16 yrs	3 (43.01)	6 (86.02)	14 (200.72)	10 (143.37)	33 (118.05)
Total	24 (19.86)	73 (60.43)	152 (127.48)	114 (94.37)	363 (75.12)

Table - 4: Category and age-wise cases and API of malaria.

Category	Age wise malaria cases and API in different categories								Total	API
	0-12 months	1-5 years	6-10 years	11-15 years	16-20 years	21-30 years	31-40 years	Above 40 yrs		
Employees		--	--		4	26	25	15	70	33.57
Wives		--	--	--	--	40	42	02	84	82.11
Children below 16 Yrs	04	52	79	38					173	122.86
a. Sons	03	28	38	21					90	123.12
b. Daughters	01	24	41	17					83	122.59
Children above 16 Yrs					32	01			33	117.86
a. Sons					17				17	118.05
b. Daughters					15	0			16	117.64
Parents cases of malaria		--	--	--		--	--	03	03	83.33
All cases	04	52	79	38	36	67	67	20	363	75.12
Total population	37	379	505	487	400	1087	1341	596	4832	N/A
API	108.11	137.20	156.43	78.02	90.00	61.63	49.96	33.55	N/A	N/A

Figure – 2: Bar diagram showing Annual Parasite Incidence in different categories.



Review of anti-malaria activities of the campus

On reviewing the anti-malarial activities on ground and from existing records maintained at section hospital, following reasons were identified as the responsible factors of the epidemic.

Survey of the breeding places

On conducting survey of the area to look for breeding of the mosquitoes several pockets of fresh water collection were found inside and in surrounding areas of the campus showing presence of larvae. Two of the static tanks in vicinity of residential area were found to have very heavy breeding of anopheles. Static tanks are open underground concrete tanks to keep

reserve water for use mostly at the time of fire fighting [4]. On making an aerial survey of the area it was found that about 20 percent of the overhead tanks were lying open due to missing covers. On examination of 50 such OHTs, seven of them were found to have breeding. These tanks were having stagnant water due to its non-use as the residents were out of the station for more than a week. A joint survey on the request of the station authorities was conducted separately by the District Malaria Officer in the area with his team who concluded with the remarks of local breeding of *Anopheles stephensi* in the area. This is considered to be primary urban vector in large parts of the country [2].

Anti-larval activities

As per defence directive, all houses and buildings are required to be sprayed twice in a year with malathion or Baygon. To carry out spraying and anti-larval work, the local authorities were required to appoint and provide 17 workers to the medical establishment named as Anti-malaria lascars (AMLs) [6]. In place of 17 of them, only five were employed to carry out this work. As a result regular spraying activities were not conducted as per directive. In addition, at several occasions there was non availability of transport to carry out these activities in distant parts of the station. Shortage of commonly used hygiene chemicals for spraying such as Malathion, Baygon (propoxur), Baytex (phenthion) and Abate (temphos) also played key role in increase in the number of mosquitoes.

Personal protective measures

In warm and humid climate of the area, residents are not in practice of using the mosquito nets despite repeated instructions and health education given by the authorities. However, for service personnel it is compulsory to use deltamethrine impregnated nets regularly.

Discussion

Epidemic of Benign Tertian Malaria

From the results as per Tables 1, 2, 3 and 4 it is evident that the rise in number of cases was far

more than the normal expectancy in the year 2005 and thus occurrence of large number of cases was declared as an epidemic of Benign Tertian (*vivax*) malaria transmitted by *An. stephensi*. The quarter wise distribution of the cases (**Table - 3**) showed that the rise in the number of cases began in the first quarter of the year which increased in second and reached its peak in 3rd quarter of the year and showing a decline thereafter.

Rise in the number of cases in surrounding localities

Local area is a high endemic zone where the trend in past four years had been on the declining side. This is similar to the national trend as reported API has been gradually declining in India from 3.29 in 1095 to 1.10 in 2011 [9]. The reporting system in civil localities is not reliable as most of the serious cases report to the private practitioners for treatment and are not registered with the reporting medical authorities [9]. This leads to under reporting of the cases. On the other hand in defence establishments all the service personnel are compulsorily required to take treatment from the defence medical establishments, therefore there is hundred percent reporting of the cases. Although there had been, rise in number of cases among employees in other defence establishments who were treated at the same defence hospital, the number was comparatively very high in the area of study. The API at these establishments was 5.85 and 33.57 per thousand populations respectively (**Table - 3**).

Measurements of malaria epidemic

The community as a whole living in the closed campus was affected by the epidemic of malaria including both sexes and all the age groups. Overall API of 75.12 per thousand is considered to be very high as compared to the national average of 1.68 per thousand during the period of epidemic [2]. Children, lady wives and young adults suffered more than adult males. Lady wives outclassed their male counterparts with API 82.11 mainly due to strict use of deltamethrine impregnated nets by the

bachelor/forced bachelor employees in the single accommodation.

Malaria in children

Number of infants and the older children of the age group above 16 years were comparatively less in the campus. This was because most of the personnel prefer their wives to go to the home town for delivery and after care of the new born. Older children above 16 years were less as they go out to live in hostel for their higher studies. Children below 16 years of age suffered from malaria at a higher API of 122.86 per thousand populations as compared to API of 90.0 in the children of above 16 years' age. Out of different age groups, the category of 6-10 years had highest API of 156.43 as is evident from Table-3. This may be attributed to their outdoor activity of playing in the parks in the evening hours as this age group was found most active in the grounds and parks. Other groups were affected according to their exposure in the parks. Even infants did not escape the infection reflecting on the indoor transmission. A higher number of cases among girls was seen in the age group of 6-10 as compared to boys which might have been by chance as the difference was not found significant. In infants the sex wise difference was found significantly higher in females but the number of suffering infants was too small to comment on its occurrence.

Transmission of malaria

Most of the population living in the closed campus belongs to distant places of the country who keep visiting their native places at least once in a year. Barring a few imported cases, most of the cases contracted infection locally at the station. In the beginning months of epidemic, the cases might have contracted infection from outside but the large number of cases in subsequent months is indicative of heavy infection load in the campus due to local transmission. Large number of breeding places of anopheles, lacking anti-malarial activities and half-hearted efforts in early detection and prompt treatment were the main causes of local transmission of the disease. Presence of MP in

infants (API of 108.11) is a definite indication of local transmission and high number of cases among children (API 122.86) and house wives (82.11) indicates a vigorous local transmission in the campus. Although the cases occurred throughout the year, the highest incidence was observed in the months of 3rd quarter i.e July, August and September which is in accordance with the seasonal variation mentioned in the literature [2, 3, 6].

Conclusion

Kutch area of Gujrat in post earthquake period was observed as a high endemic zone of malaria with an average range of API between 2-10 per thousand population per year with a higher incidence in rural areas. A closed defence campus of the region had an epidemic of BT malaria with a very high API of 75.12 per thousand populations in the year 2005. The API worked out for different categories was 33.57 for service employees, 82.11 for women and 122.03 for the children. Out of the children, age group 6-10 years was affected most due to their outdoor activities of playing in the parks in the evening hours. A typical seasonal trend of maximum cases of malaria was observed in post rainy season. Main reasons of outbreak was the local transmission of the disease in the residential area of the campus due to uncontrolled breeding of mosquitoes in fresh water collection pools, static tanks and stagnant overhead tanks. This was added by insincere efforts of implementing of the strategy of early detection and prompt of treatment, failure of implementing anti-malarial activities and ignoring of personal protective measures. On implementing the control measures strictly with proper vigilance and multidiscipline approach, the epidemic was brought under control in a period of about 4 months.

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