

Original article

An epidemiological investigation of outbreak of Project Malaria in PHC area of Rajkot district, Gujarat, India, 2014

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Abstract:

Introduction/ Background: Gujarat is an endemic state for malaria with Annual Parasitic Incidence (API) between 1 and 2. During this calendar year, total 3291 cases of malaria were reported till October month in Rajkot district. The highest contribution was from the Primary Health Center (PHC) of Bharatnagar area (1863 cases). The present study investigates the epidemiological distribution of the malaria cases and determinants which contributed towards the outbreak of malaria in Bharatnagar PHC with special focus on industrial belt.

Method: The study was carried out based on the secondary data generated as a part of National Vector Borne Disease Control Program (NVBDCP) through active surveillance and routine health care at PHC & CHC as passive surveillance. Also meetings with the local health staff, local stakeholders and migrant workers etc, as well as field visits to observe the ecological situation were carried out.

Observations: The incidence of malaria cases has increased double fold every year in Bharatnagar PHC since year 2011. Out of total cases, almost half of the cases (up to July) were reported from industrial project sites. Two peaks were observed respectively in months of May and August 2014 (121 and 169 cases respectively), with intermediate fall in the number of cases in June, July and again in September, October. Climate, water and irrigation as well as ecological factors affecting this outbreak were studied.

Discussion: Rapid development of industrial belt with influx of new migrants from tribal areas of Madhya Pradesh and east Gujarat might have contributed to sudden increase in malaria incidence in month of May. This was followed by prompt measures taken by PHC like IRS and EDPT. However, with initiation of rainy season at the end of July, again sharp peak was observed in the month of August. This was followed by gradual fall after second round of IRS and continued EDPT.

Conclusion and Recommendations: Looking to the epidemiological factors, high transmission would remain till the construction would be going on. Strengthening of active surveillance by deputing/ filling the vacant post of MPWs, motivation and proper training should be carried out. Mass screening of incoming migrants with Rapid Diagnostic Kit (RDT) for malaria followed by prompt treatment. Quality assured regular IRS (Indoor Residual Spray) should be continued over the monthly time period.

Introduction

Malaria continues to pose major public health problem in developing countries, which is a complex and fatal disease caused by four species of *Plasmodium* parasites and transmitted by different species of Anopheles mosquitoes. In India, about 22 percent population lives in malaria high transmission areas and about 67 percent in low transmission areas. ⁽¹⁾India is characterized predominantly by unstable malaria transmission, the seasonal

transmission being related to rains. Due to the low and unstable transmission dynamic, most of the population has little or no immunity towards malaria. ⁽²⁾ While malaria is mostly an endemic disease, it may also occur as outbreaks. Factors that may cause outbreaks include an increase in vector breeding sites, migration of infected people into a vector-rich area populated with susceptible individuals, arrival of new efficient vectors, breakdown of vector control measures, resistance of the parasites to treatment and resistance of the vectors to insecticides. ⁽³⁾ For the purpose of stratification and identification of malaria priority areas, major epidemiological types of malaria are 1) Tribal malaria, 2) Rural malaria, 3) Urban malaria, and 4) Project malaria. Project areas are those areas where construction and developmental activities are taken up and temporary tropical aggregation of laborers takes place. The labor force in these projects may come from varied epidemiological backgrounds - some from malaria endemic areas with some degree of acquired immunity, and others from non-endemic areas and completely immunologically naïve. ⁽⁴⁾ This results in disturbance in eco-system, prolific increase in vector breeding places and increased man-mosquito contact favoring high malaria transmission. These pockets contribute a large number of malaria cases which are highly disproportionate to the relatively small population groups inhabiting the area. ⁽⁵⁾ 90 percent of malaria cases in 2011 in India were reported from 12 states. 90 percent of deaths in 2011 were reported by 9 states in which Gujarat was the highest contributor (16.9 %). ⁽⁶⁾ Gujarat is an endemic state for malaria with Annual Parasitic Incidence (API) between 1 and 2. Annual malaria cases reported for the year 2011, 2012, 2013 for Rajkot district (excluding Rajkot city) were 5693, 3394, 2369 respectively. ⁽⁷⁾ During this calendar year, total 3291 cases of malaria were reported till October month in Rajkot district. The highest

contribution was from the Primary Health Center (PHC) of Bharatnagar area (1863 cases). A significant increase in the incidence of malaria cases (1863 cases up to October 2014) was observed in comparison to previous year (446 malaria cases in the year 2013) in PHC Bharatnagar area. The present study investigates the epidemiological distribution of the malaria cases and determinants which contributed towards the outbreak of malaria in Bharatnagar PHC with special focus on industrial belt. Additionally the study was also taken up to suggest measures for further control and prevention based on the available evidences.

Method:

Study Area:-

Bharatnagar PHC is located at geo coordinates 22°54'17"N, 70°49'31"E in Morbi Taluka of Rajkot district, Gujarat state. It is distanced at 68 Km towards north from the district Headquarters along Morbi - Samakhiali National Highway 8A. It lies at an altitude of about 49 meters above sea level. ⁽⁸⁾ Total population of PHC area is 37223, spread across 29 villages. But there is additional population of 6081 migrant workers working in Vaadi's (fields) for agriculture work (seasonal) and 11950 workers in industries. Major occupation in the PHC area is the cultivation and ceramic industries.

Data collection:

The study was carried out based on the secondary data generated as a part of National Vector Borne Disease Control Program (NVBDCP) through active surveillance and routine health care at PHC & CHC as passive surveillance.

For active case detection, multipurpose health workers (MPWs) searched for cases of fever in their field areas. For passive case detection, laboratory technicians in health care facilities collect blood smears of the patients presenting with fever. Malaria

surveillance reports were reviewed. A case of malaria was defined as an acute febrile illness with a peripheral blood smear positive for malaria or a positive rapid antigen test in a resident of Bharatnagar PHC area. Laboratory registers were reviewed to abstract slide examination results. Health care facility records and registers were reviewed to find the demographic details regarding PHC area and details regarding the staff position at PHC. Also meetings with the local health staff, local stakeholders and migrant workers etc, as well as field visits to observe the ecological situation were carried out.

Observations:

The outbreak was noticed by the PHC medical officer with rise in the malarial cases in the passive surveillance during the month of April in the various PHC areas including industrial belt. Following that he has strengthen active surveillance to find out the malaria cases.

Descriptive epidemiology / Malaria prevalence and spatial trend

Table 1 shows the incidence of malaria cases of Bharatnagar and surrounding PHCs of last 4 years. The incidence of malaria cases has increased double fold every year in Bharatnagar PHC since year 2011. In 2014, 1863 cases have been reported till October (Attack rate: 33.8 per 1000); 616 from industrial project sites whereas remaining cases from Vaadi’s (agriculture fields) and villages. However not a single death due to malaria was reported during this period.

Table 1: Malaria cases, year wise incidence in Bharatnagar PHC and other nearby PHC’s

Year	Primary Health Center			
	Bharatnagar	Vavaniya	Khareda	Sarvad
2011	100	24	171	44
2012	284	27	66	33
2013	446	11	46	87
2014 (up to Oct.end)	1863	3	25	19

A retrospective analysis of the data indicated that the epidemic threshold (i.e., number of reported cases exceeding by two standard deviations of average number of reported cases in 2011-2013) had been almost reached in June 2014 (559 cases in PHC area for a threshold of 622) and had crossed in July 2014 (692 cases). Total seven spots were identified in the PHC areas reporting the rise in the malaria cases. Out of total cases, almost half of the cases (up to July) were reported from industrial project sites. Hence an attempt was made to investigate the various epidemiological factors responsible for outbreak across the industrial areas.

Table 2: Malaria cases and deaths, by age and sex, January - October 2014

Characteristics		Total number of cases* (%)	Total deaths
Age group (years)	0 - 5	121 (19.6)	0
	6 - 15	100 (16.2)	0
	16 - 59	389 (63.2)	0
	≥ 60	06 (1.0)	0
Sex	Male	424 (68.8)	0
	Female	192 (31.2)	0
Total		616 (100.0)	0

Table 2 shows the age and sex wise distribution of 616 malaria cases in industrial project sites. Majority (63.2%) cases belonged to age group of 16 - 60 years, whereas 19.6% cases were reported in under 5 age group. About two third cases (68.8%) were reported in males and remaining one third in females.

Distribution as per native residence of the cases

Out of 330 cases in month of August to October 2014, details of native residence were available in 246 cases. 74 percent (182 out of 246) of the cases were native residents of tribal areas of west Madhya Pradesh and east Gujarat. Moreover 67.2% of *P. falciparum* cases (90 out of 134) reported during these 3 months were from same areas as mentioned above. (Table 3)

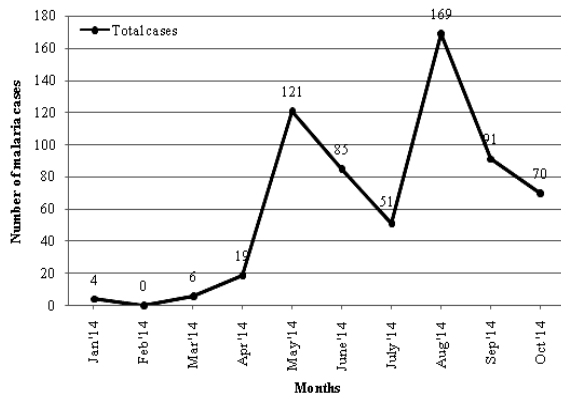
Table 3: Malaria cases distribution, by native residents, August - October 2014

Native residents	August - October 2014	
	Total malaria cases (N=330) (%)	Pf cases (N=134) (%)
Madhya Pradesh (Dhar, Alirajpur, Jhabua)	114 (34.5)	60 (44.8)
Gujarat (Dahod, Chhota Udepur, Godhra)	68 (20.6)	30 (22.4)
Others (Uttar Pradesh, Rajasthan, Bihar)*	63 (19.1)	25 (18.6)
Not known	85 (25.8)	19 (14.2)
Total	330 (100.0)	134 (100.0)

Epidemic curve and its association with various parameters

Two peaks were observed respectively in months of May and August 2014 (121 and 169 cases respectively), with intermediate fall in the number of cases in June, July and again in September, October (Figure 1).

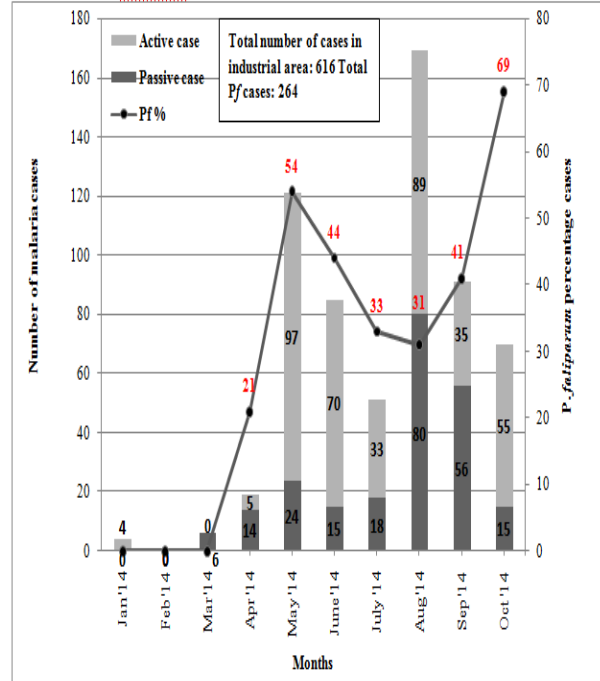
Figure 1: Malaria cases, month wise with interventional control measures, January to October 2014



.....→	Active surveillance started from May, 15 rounds of surveillance till date
---→	First round of IRS at the end of May, newly developing industries covered
- . . . →	First rainfall; potential development of water pockets in and around industries leading to breeding places of mosquitoes
— . . →	Second round of IRS at the end of August, all 150 industries covered
→	Fogging of industrial area in the mid-September
↔	Continuous influx and efflux of migrant laborers round the year - dynamic migration/ circular migration

More than 50 percent cases were reported by active surveillance in industrial areas. Overall, 264 (42.9%) had *P. falciparum* infection (Figure 2).

Figure 2: Malaria cases in project sites by month of onset, active case detection, and proportion of *P. falciparum* cases, January - October 2014



Climate, water and irrigation

The climate of Bharatnagar is semi-arid, with hot and dry summers from mid-March to mid-June and the wet humid monsoon season from mid-June to October. During summer time, the temperature ranges between 24 °C and 42 °C. In the months of monsoon, the average humidity rises up to 75%.

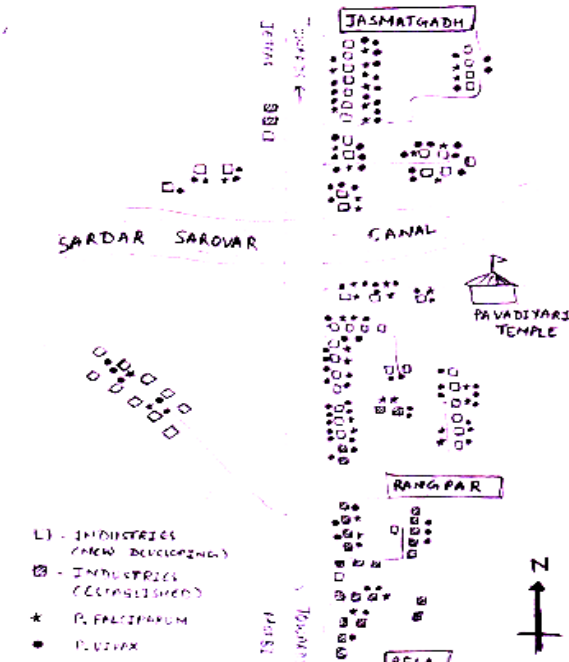
The Sardar Sarovar canal runs along the PHC area traversing village areas and industrial project sites. The construction of canal was completed in the year 2011 and from 2012 onward water was released in this canal. The water supply through this canal is available round the year.

Ecological factors

The area of PHC is characterized by rapid development of ceramic industries since last 2 years following the regular supply of the water through newly created canal. About 150 industries have been established in this area along the belt of Jasmatgadh - Bela belt. This belt has clear cut two division of area, one from Rangpar to Bela, which is having already functioning factories and second from Jasmatgadh to Rangpar, having 100

factories in different stages of construction since last 12 months. This second part of the belt reports dynamic migration of around 1100 to 1200 having continuous influx of new migrant laborers and efflux of existing migrants (Figure 3).

Figure 3: Spot map to highlight industrial zone and cluster of malaria cases



water leaching from the canal by using siphon for industries had created numerous water bodies around few industries. This was creating favorable situations for mosquito breeding around the industries throughout the year besides water logging during rainy season.

Preventive and control activities carried out by PHC

The action taken by PHC following increase in malaria cases were; early diagnosis and prompt treatment (EDPT) by strengthening of active surveillance in the month of May followed by vector control through IRS activity (with alpha cypermethrin) in newly developing industries during first week of June. Long Lasting Insecticide Nets (LLINs) were also distributed to the positive cases. Vector control through second round of IRS in all 150 industries during the last week of August and impregnation of the mosquito

nets available with the migrant workers or donated by the owner of the industries.

Discussion:

Epidemiological factors that might have contributed for the increase in cases leading to first peak of epidemic in month of May were;

1) Vulnerability/ Human factor - As many as 100 new industries were under simultaneous construction which had brought in huge influx of migrant laborers. Majority of the migrants were from Madhya Pradesh (mainly from Jhabua, Dhar and Alirajpur districts) and east Gujarat (mainly Dahod, Godhra and Chhota Udepar districts). Jhabua and Alirajpur are known *Adivasi* districts and up to 85.6% population is tribal. ⁽⁹⁾ These three districts were identified as endemic for malaria and have been included in Enhanced Malaria Control Project (EMCP) of NVBDCP with support from World Bank. ⁽¹⁰⁾ Population of Dahod district is mostly tribal (Bhils). ⁽¹¹⁾

2) Receptivity/ Entomological factor - Potential breeding places were present around the industrial zone due to passage of Sardar Sarovar canal. Such places were also observed around new construction sites due to pockets of water accumulation.

A second peak in epidemic curve with as many as 169 cases was observed in the month of August. It might have been occurred due to;

1) Climatic factors - First rainfall in this area happened at the end of July 2014 which had caused the development of conditions favorable for breeding of mosquitoes.

2) Vulnerability/ Human factor - Continued dynamic migration might have acted as a contributory factor for the increase in incidence of cases.

The control and preventive measures (EDPT, IRS, LLINs) implemented by PHC as described in observation section

was responsible for the gradual fall in the incidence of cases in months of June, July and again in September, October 2014.

Challenges observed for control of epidemic:

- Health service related - In Bharatnagar PHC, Laboratory Technician is on deputation for 3 days in a week and out of sanctioned posts of 7 Multi Purpose Health Workers and 7 female Health Workers, 5 and 2 positions have been respectively vacant till date.
- Ecology related - Due to passage of canal and continuous development of new industries, breeding sites remain present potentially favouring the transmission of malaria throughout the year.
- Population movement -Dynamic migration round the year has challenged the health system to effectively control the outbreak.
- Tribal population is illiterate and having complete different dialect and languages affecting in imparting effective health education.

Conclusion & Recommendations:

This was a project malaria epidemic with a constant influx of migrant workers from the endemic districts with perennial presence of water pools favoring constant breeding places, low level of health awareness and protective behavior and poor compliance to treatment coupled with crunch of human resource. Looking to the epidemiological factors, high transmission would remain till the construction would be going on. Thereafter perennial transmission due to favorable environmental condition and availability of vulnerable host in the industries would be continued. To control present epidemic and prevent future outbreaks following recommendations were made.

- Strengthening of active surveillance by deputing/ filling the vacant post of MPWs, motivation and proper training.

- Mass screening of incoming migrants with Rapid Diagnostic Kit (RDT) for malaria followed by prompt treatment.
- Drug Distribution Centres (DDCs) and Fever Treatment Depots (FTDs) can be an established in project areas for providing easy access to anti-malarial drugs to the migrant workers. Motivated migrant workers with some education from the group may be involved in screening, FTDs and health education on malaria.
- Quality assured regular IRS (Indoor Residual Spray) should be continued over the monthly time period.
- Awareness about importance and benefits of completing the treatment and behavior change communication for using insecticide mosquito net must be imparted.
- Looking to high monthly turnover of the migrant workers with short stay requirement of mosquito net will be huge, hence strategy to distribute mosquito net to local employers/contactor should be adopted instead distributing to the workers.
- Attempts were carried out to reduce the water leakages from and of larval breeding places by collaboration of various departments, like revenue, irrigation etc
- Attempts were made to involve local stakeholders with little success. Efforts should be continued with various advocacy approaches. Local NGOs should be sought for health education, EDPT and providing personal protective measures like insecticide nets.

- Efforts for sensitization of and cooperation from local political leaders and senior administrative officers from related departments in source reduction must be continued.

Limitation:

The study is based on the secondary data generated as a part of NVBDCP.

References:

1. World Health Report. , WHO; 2013.
2. Bhalwar Rajvir. Textbook of Public Health and Community Medicine. 1st ed.: Department of Community Medicine, AFMC, Pune in collaboration with WHO, India Office, New Delhi; 2009.
3. Khera AK, Jain DC, Datta KK. Profile of epidemic emergencies in India during 1991-1995. J Commun Dis. 1996.
4. Operational Manual for implementation of Malaria Programme, 2009. Ministry of Health and Family Welfare, Directorate of National Vector Borne Disease Control Programme, Directorate General of Health Services.
5. Park K. Park's Textbook of Preventive and Social Medicine. 22nd ed.; 2013.
6. Annual Report of NVDCP, 2013. National Vector Borne Disease Control Project. [Online]. [cited 2014 October. Available from: nvbdcp.gov.in/Doc/Annual-report-NVBDCP-2012.pdf.
7. Office of District Malaria Office, Rajkot District Panchayat. 2014..
8. OneFiveNine: Explore India. [Online]. [cited 2014 November. Available from: <http://www.onefivenine.com/india/villages/Rajkot/Morvi/Bharatnagar>.
9. "Jhabua", District Administration. [Online]. [cited 2014 October. Available from: <http://jhabua.nic.in/factfile.htm>.
10. NVBDCP, Directorate of Health Services, Madhya Pradesh. [Online]. [cited 2014 October. Available from: <http://www.health.mp.gov.in/malaria.htm>.
11. Wikipedia. [Online]. [cited 2014 October. Available from: http://en.wikipedia.org/wiki/Dahod_district.