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Short Research Communications

Transversal analysis of malaria outbreak in non-endemic region of rural Haryana, north India

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In India, malaria was the foremost public health problem in last two centuries and it continues to being so. Malaria is mostly present as an endemic disease, but in low transmission areas it may occur as an outbreak[1]. Malaria outbreaks are the complex public health challenges attributed to both natural and man-made causes. Several reports are available on small malaria outbreaks with continued localized transmission[2]. Factors responsible for malaria outbreaks include, population migration (in or out of an endemic area), increase in breeding sites and vector population, presence of new efficient vector(s), drug resistance in parasite or insecticide resistance in vectors and break down in the control measures[2]. Malaria outbreaks are common in regions where malaria transmission is not prevalent[3]. Haryana region in north India is a low prevalence zone for malaria with annual parasite incidence (API) <2[4]. Malaria control programme is one of the oldest health activity carried out in India. Active and passive malaria surveillance is the most important public health activity for a health worker (male) at primary health care level. Malaria outbreak particularly in non-endemic region is a challenge for these health workers and entire health system at the primary care level. Malaria surveillance activity in one of the villages in rural Ballabgarh block in Faridabad district of Haryana state, India reported sudden rise in malaria cases. The present study was a transversal analysis of the malaria outbreak in this non-endemic region.

Study area named Chhainsa in Faridabad district was one of the 11 villages served by PHC, Chhainsa which was a part of Comprehensive Rural Health Services Project, Ballabgarh of All India Institute of Medical Sciences, New Delhi[5] (Fig. 1). Total population of the study area was 10,394 in the year 2012. Preventive, promotive and curative services under various National Health Programmes were being provided to the study area through health workers and doctors posted at the PHC. The study area was situated on the bank of the major River Yamuna in northern part of India. As a part of active malaria surveillance, health worker visits each house in the village to identify and notify fever cases in the community and make peripheral blood smears of all fever cases. In passive malaria surveillance, peripheral blood smear of all fever cases reported in the OPD were made

Fig. 1: Map of Faridabad (Haryana) showing village with malaria outbreak (study village–Chhainsa). (*Source: http://www.haryana.nic*).

in laboratory at PHC. Routine malaria surveillance and microscopic examination of blood smears revealed malaria positive cases in the study area. Malariometric indicators, viz. slide positivity rate (SPR) and annual blood examination rate (ABER) for the preceding year (2011) in the study area were found to be 0.5 and 7%, respectively.

This study was conducted from April to October 2012. In the present study, all smear positive malaria cases reported in the study area were included. In addition to malaria surveillance, mass fever survey (MFS) was also carried out in the study area for active case detection. MFS was a one day survey in which all households in the study area visited by health worker and peripheral blood smear of all fever cases was made. Confirmation of malaria diagnosis was done by microscopic examination of peripheral blood smear using field staining method at the PHC by trained laboratory technician. All malaria positive slides were cross-checked at district headquarter as a part of routine quality control mechanism. A semi-structured questionnaire was prepared to seek information from malaria cases about clinical history, travel history, treatment history and surrounding environmental conditions. Mapping of all cases in the study was done by using spot map. Questionnaire was administered by investigators who were also working as medical officers at PHC. Entomological observations were made by biologist from district headquarter.

Data were entered into Microsoft Excel and analysed using SPSS (version 13.0 for windows). This study was conducted as a routine health system activity under malaria outbreak investigation, hence, ethical clearance from the institute ethical committee was not sought. However, informed verbal consent from each study participant was taken and appropriate treatment as per guidelines was provided to all study participants.

During the study period, a total of 2713 fever cases were reported from the study area. Out of these, 2384 were reported through routine malaria surveillance and 329 through MFS. On laboratory confirmation, 109 cases were found to be positive for *Plasmodium vivax* in malaria surveillance and two of *P. vivax* cases were detected through MFS. None of the cases were positive for *P. falciparum.* All the 111 malaria cases were included in the study. During the study period SPR and ABER in the study area were 4.6 and 22.9% (excluding slides made during MFS), respectively. The mean age of the cases was 24.4 yr (SD: 14.9). Most of the cases were males (56.8%) and younger age group (Age <30 yr) (74.7%). Most of them were students (35.1%) followed by housewives (23.4%), farmers (17.1%) and daily wage labourers (9.9%) (Table 1).

Table 1. Socio-demographic characteristics of the malaria cases observed during outbreak (n = 111)

Variable	Frequency	Percentage
Age (yr)		
<30	88	74.7
31–50	22	19.8
>51	6	5.4
Sex		
Males	63	56.8
Females	48	43.2
Occupation		
Student	39	35.1
Housewife	26	23.4
Farmer	19	17.1
Daily wage labourer	11	9.9
Others*	16	14.1

*Others include, in service, shopkeeper and unemployed.

The first case of the outbreak was reported on April 28, 2012 and the last case was reported on September 24, 2012. The number of cases of slide positive malaria gradually increased and reached a peak in Week 34 in the month of August after that numbers began to fall gradually (Fig. 2). Mapping of cases on the spot map revealed that most (80%) of the cases were clustered along the western bank of the River Yamuna, that borders the study area.

Almost every patient with malaria reported fever (99.1%). Nearly two third (67.6%) had periodicity of fever and 95.5% had chills. Other symptoms reported by the patients were headache (73.9%), backache (49.5%), vomiting (23.4%) and abdominal pain (4.5%). The mean duration of fever was 4.8 (SD: 3.5) days. No death due to malaria was recorded during the study period.

Majority of blood slides were made at the PHC laboratory in passive surveillance (88.7%) and the remaining were made in patients' houses during active surveillance by health workers. About 97% of the patients consumed

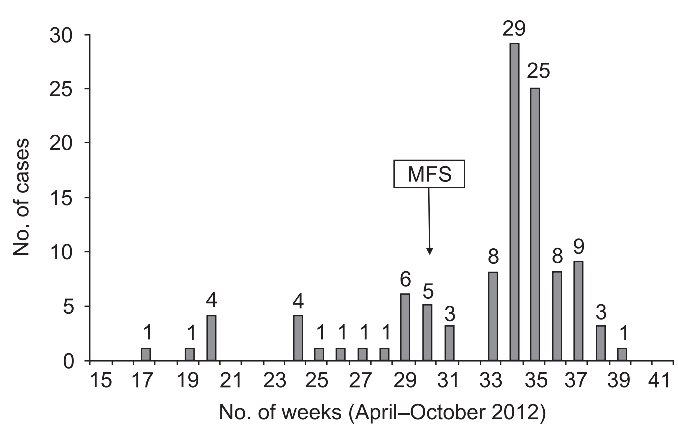

Fig. 2: Distribution of malaria cases on the basis of onset of fever according to number of weeks in year 2012; MFS – Mass fever survey day.

chlorquine tablets whereas 3 (2.7%) patients did not consume the drug. The common reasons given for not consuming prescribed chlorquine were abdominal pain and palpitation. Among those who took chloroquine tablets only 92.6% consumed it for the total prescribed duration of three days. About 94% of the patients consumed prescribed primaquine tablets while 3 (2.7%) patients did not take primaquine and 4 (3.6%) had contraindications (pregnancy and infancy) for primaquine. Among patients who had consumed primaquine tablets only 35.7% had consumed them for the total course duration of 14 days, 61.2% were still on treatment and 2.7% discontinued. The common reasons given for not taking prescribed primaquine were diarrhoea and abdominal pain. All patients responded to prescribed medications.

About 11% of the patients reported a history of travel outside the study village in the last three months before onset of fever and among them about 83% stayed overnight at destination site. About 10% of the patients reported that at least one family member had suffered from malaria or fever in the current season.

Around 68% of the patients reported presence of a potential mosquito larvae breeding site outside the house premises. These sites were mostly blocked drainage canals nearby (85.3%) followed by, water vessel for cattle (5.3%) and potholes on the road filled with water (14.7%). *Anopheles* larvae were identified in 13% of these sites by the biologist from district headquarter. About 43% of the patients reported that efforts were being made to remove these sites. Village *Panchayat* was involved in such efforts in 66% of the cases, followed by self-efforts (19%) and the health department (16%).

Around 30% of the patients' houses had a potential mosquito larvae breeding site within the premises. The nature of these sites was unchanged water in coolers (19.4%), vessel for cattle (6.5%) and in uncovered vessels (77.4%). The biologist verified that about 10% of these sites had *Anopheles* larvae. Around 42% of the patients reported that efforts were being made to remove these sites and the health department was involved in such efforts in 62% of the cases and self-efforts in the remaining. Around 80% of the patients reported that they had taken some sort of protective measures to prevent mosquito bites. The most popular method was using fans (81.8%) followed by coils (62.5%), bednets (27.3%), long clothes (16%) and mats (3.4%).

The mean delay between onset of fever and making blood slides for microscopy was 2.7 (SD: 5.3) days. The mean delay between onset of fever and chloroquine intake was 2.7 (SD: 5.4) days. The mean delay between onset of fever and primaquine intake was 9.8 (SD: 12) days. Among the patients who had completed the full prescribed course of primaquine, a follow-up slide examination was done only in 23% of cases. Blood slides were made for other members of the family in about 60% of cases and for neighbours in about 59% of cases. None of the follow-up slides was reported malaria positive.

SPR observed during the study year (2012) for the study area was more than three times of the value of preceeding year. This confirmed the outbreak of malaria in the study area. The index case of outbreak was reported in the month of April and peak of the outbreak was observed in the transmission season of malaria (August–September). Epidemic curve observed in this study was similar to outbreaks reported in other parts of the country[6]. Relationship of malaria transmission with climatic variables such as rainfall, humidity, and change in temperature were explained by many studies from India[6–8] and from other countries[9–13]. During June–September, Haryana state received 277.8 mm of rainfall against its long period average of 460.2 mm (1941–90) with overall lack of 40% leading to another meteorological drought year which is fifth in row in the last decade[14]. Faridabad district in which the study area is situated observed 36% less than the average annual rainfall in year 2012[13]. In the rainy season, people use Yamuna river bank for paddy cultivation. These paddy fields probably provided the potential breeding sites for *Anopheles* mosquito due to huge amount of stagnant water. Inadequate rainfall and increased humidity at the time of transmission season might be responsible for persistence of breeding sites in this area. This might also be the reason for clustering of majority of cases near Yamuna river bank and ultimately outbreak of malaria in the study area.

Though, Haryana falls in low *P. falciparum* prevalence zone, there was not a single case of *P. falciparum* reported in the outbreak. This was unlike malaria outbreaks reported in other non-endemic regions of India[15–16]. Clinical manifestations of majority of cases were of typical malaria. No death due to malaria was recorded this might be attributed to the low incidence of severe type of malaria in this region. Low compliance to radical treatment was observed in the study. Assuming that this was a usual practice this malaria outbreak might be the relapse of previously untreated malaria infection in the study area. Potential breeding sites were identified in the house premises as well as in the area surrounding houses of the malaria cases. Though, poor self-effort of cleaning these breeding sites was observed, local village authorities were actively involved in the cleaning process. This might be attributed to lack of knowledge regarding malaria transmission and lack of individual responsibility of prevention of mosquito breeding in the community.

Similar findings were also reported in malaria outbreak investigation in the same district of Haryana by Singh *et al*[16]. Active malaria surveillance in the study area was poor in preceding year as evident by poor ABER. During the study period, case detection by active surveillance was minimal. Poor surveillance activity was documented as a reason for outbreaks of malaria in non-endemic region[8]. Delay in starting radical treatment was observed for majority of the cases, this was attributed to irregular supply of primaquine form district authorities. Being non-endemic malaria region vector control activities like indoor residual spray, regular space spraying and awareness generation in the community was minimal in the study area. Malaria outbreak preparedness of both local and district authorities in the study area was minimal as evident by delay observed in diagnosis and treatment of malaria cases.

In response to this malaria outbreak, active steps were taken to contain the outbreak both by local and district health authorities. MFS was conducted for active case detection. Vector control activities like space spraying, pouring larvicidal oil in the stagnant water, clearing of choked sewages, and overall improvement of sanitation in the study area was carried out through PHC, Chhainsa with the help of district health officials and the village *Panchayat*. Accredited social health activist (ASHA), *Anganwadi* workers along with health workers were involved in awareness generation drive in the study area. No case of malaria was reported in the study area since 24 September 2012.

This transversal analysis supported the fact that malaria outbreak in a non-endemic region attributed to factors like disruption of surveillance, lack of preparedness due to consistently low API and favourable climatic conditions for vector breeding. Though travel history was reported in few cases, possibility of imported malaria case could not be ruled out. Incomplete radical treatment, lack of awareness about malaria transmission and poor preventive measures in the community were the factors responsible for sustaining malaria outbreak. Though *P. falciparum* malaria was reportedly associated with severity, recent studies provided evidence of severity in vivax malaria[17]. However, severe complication in vivax malaria is less frequent as compared to falciparum and mixed infections[18]. Perhaps, low proportion falciparum malaria and uncomplicated vivax malaria in the region might be a reason for zero mortality in this outbreak.

Hypothesis testing about causes of outbreak is an important step of modern outbreak investigation[19]. Major limitation of this study was lack of hypothesis testing aspect to validate causes of outbreak. As this study was a part of routine health system service delivery based documentation, it had its financial limitations. Study with similar methodology of outbreak investigation was reported from Odisha[15].

There is a need for augmenting malaria surveillance activities for preventing such outbreaks in future. Regular sanitation and monitoring of health workers and medical officers at PHCs is essential to prevent outbreaks of malaria in non-endemic regions. This should be supported with awareness generation drive about transmission and prevention of malaria. In the community with help of local health authorities, opinion leaders and various stakeholders in the community. Zoller *et al*[1] gave recommendations for management of malaria in non-endemic region, these are also relevant for developing country like India. Public health approach in planning and implementation of preventive and control measures is cornerstone of malaria control. It includes community participation (participation of local health authorities, opinion leaders and various stakeholders from the community in planning), inter-sectoral coordination (involvement of water and sanitation department, public health engineering), appropriate technology (basic laboratory support at primary care level) and equitable distribution (intervention escalating all strata in the community).

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