Original Article

A comparative study of epidemiological investigations of malaria outbreaks and related deaths in two districts of Jharkhand during the same prewinter season using shoe-leather epidemiology

Dewesh Kumar[1], Shashi Bhushan Singh[1], Abhishek Kumar[1], Anupam Kishore[1], Vivek Kashyap[1]

[1]Department of PSM, RIMS, Ranchi, Jharkhand, India

Abstract

Background: Following news of deaths in two districts of Jharkhand (West Singhbum and Garhwa) in November 2016, epidemiological investigations were contemplated to investigate any current outbreak of falciparum malaria and deaths attributed to it. **Methodology:** The epidemiological investigations, verbal autopsy of suspected deaths attributed to malaria and keys interviews were conducted in the 2nd and 4th week of November 2016 in Khuntpani and Dhurki block of West Singhbum and Garhwa districts, respectively, following a strict protocol. **Results:** The affected villages were Argundi and Korba-Pahariya and their adjacent tolas in Khuntpani and Dhurki block. Undoubtedly, there was the continuous transmission of falciparum malaria in both the regions in October and November 2016. The total cases (according to case definitions) were 1002, of them, 338 and 12 patients were positive for *Plasmodium falciparum* positive (Pf +ve) and *Plasmodium vivax* positive (Pv +ve), respectively, in the affected areas of Khuntpani block. In Dhurki block, out of the total of 631 patients fulfilling the case definition, 65 patients were PF +ve and 23 Pv +ve. Comparing to the last year, there is remarkably high number of falciparum cases. Verbal autopsy of deceased individuals showed that malaria might be one of the strongly probable diagnoses, but not conclusively. **Conclusion:** According to epidemiological investigation, verbal autopsy and key interviews conducted, it may be concluded that there is a definite outbreak of falciparum malaria in the area and environment is congenial for malaria and other tropical diseases.

Keywords: Epidemiological investigation, falciparum malaria, shoe-leather epidemiology, verbal autopsy

Introduction

Malaria is mostly an endemic disease in India, but it may occur as outbreaks in regions with low seasonal transmission and if not properly managed may result in deaths. There are various factors which may cause outbreaks such as an increase in vector breeding sites, migration of infected persons into a vector-rich area having the susceptible population, arrival of new efficient vectors, inadequate vector control measures, resistance of mosquitoes to currently used insecticides and resistance of parasites to drugs.[1] These outbreaks becoming epidemic emergencies indicate the weaknesses in the epidemiological and laboratory surveillance besides poor water management practices and other socioenvironmental reasons.[2] Although the number of cases and deaths due to malaria have shown a decreasing trend during the past decade, there is an increase in Pf proportion, which currently stands at about 70% of total cases and is a major concern.[3]

Address for correspondence: Dr. Dewesh Kumar, Department of PSM, RIMS, Ranchi, Jharkhand, India.
E-mail: dr.dewesh@gmail.com

Access this article online

Quick Response Code:

Website: www.jfmpc.com

DOI: 10.4103/jfmpc.jfmpc_55_17

How to cite this article: Kumar D, Singh SB, Kumar A, Kishore A, Kashyap V. A comparative study of epidemiological investigations of malaria outbreaks and related deaths in two districts of Jharkhand during the same prewinter season using shoe-leather epidemiology. J Family Med Prim Care 2017;6:744-9.

World health Organization (WHO) endorsed the WHO global technical strategy for malaria 2016–2030 to reduce malaria incidence and mortality rates globally by 90% compared to 2015 levels. This is in synchronous with the attainment of Target 3.3 of sustainable development goals to end the epidemic of AIDS, tuberculosis, malaria, and neglected tropical diseases by 2030.[4] The ambitious goals set for 2030 is well within reach considering the excellent progress and positive trends in worst affected areas, but factors responsible for malaria outbreaks may jeopardize the recent gains.

Jharkhand, a tribal state is situated in the eastern part of India with approximately 35 million population. It has primarily a tribal predominant population constituting about 28% of total population.[5] Jharkhand is an endemic zone for malaria and the tribal population residing mainly in rural areas having vast tracts of forests. The forest covers around 29.69% of the total land which makes the problem of malaria very complex.[6] The surge of malaria may be contributed by the terrain, water bodies in the proximity of inhabitants, other environmental factors, ignorance, and poor health seeking behavior of the people.

This paper attempts to compare the findings and learning experiences of two epidemiological investigations of malaria outbreak and related deaths in two different districts of Jharkhand with the same background of few deaths occurring in the areas attributing to malaria. The reports of malaria outbreak and suspected deaths from Khuntpani block of West Singhbhum district and Dhurki block of Garhwa district appeared in the 2nd week of November 2016 and 4th week of November 2016, respectively. The media played a critical role in highlighting the news about these deaths with an upsurge of malaria in the region due to the failure of existing government mechanisms in managing people's health. Taking due note of the situation, local and district level health activities were planned and executed in the area. As a result of state-level response, an epidemiological investigation was contemplated and conducted by the investigation team comprising of experts from academia, epidemiologists and members from state health services to identify the cause of these deaths and ascertain the malaria outbreak in the area.

Methodology

Epidemiological investigations, environmental investigations, verbal autopsies, and keys interviews were planned and conducted in the affected areas of Khuntpani block of West Singhbum and Dhurki block of Garhwa district in the 2nd week and 4th week of November 2016, respectively, using Shoe-leather epidemiology.

Following steps were carried out as part of the epidemiological investigation. (1) Identify investigation team and resources, (2) Establish existence of an outbreak, (3) Verify the diagnosis, (4) Construct case definition, (5) Find cases systematically and develop line listing, (6) Perform descriptive epidemiology/develop hypotheses, (7) Evaluate hypotheses/perform additional studies as necessary, (8) Implement control measures (9) Communicate findings, and (10) Maintain surveillance.

An environmental assessment was made to look for potential and actual breeding sites of mosquitoes as water bodies were present in the vicinity of the affected areas. For verbal autopsy, members of the family members/neighbors/related persons involved in their treatment/during treatment were interrogated about course of events, positive/negative symptoms, and any other information relevant to deaths. Key interviews of community leaders, health workers and treating physicians were done to investigate the different sociomedical aspects of the disease and to understand the current situation of malaria outbreak. This has helped in obtaining the background information of the affected areas, the genesis of the outbreak, investigations carried out so far and control measures undertaken; and clinical presentation of cases. This was done to plan interventions which are feasible and acceptable for checking any further outbreaks. Desk review was also done to study the epidemiological picture of ongoing surveillance of the areas with respect to malaria. Based on the present data, descriptive analysis on the basis of time, place, and person was carried out for comparing the suspected outbreak and related deaths in both the areas.

Observations and Results

Key interviews and desk reviews

The affected village Argundi of Khuntpani block (West Singhbum district) has population of 1070 divided into Argundi (A) and Argundi (B) having 8 different tolas spread out over one kilometer. It is under Loharda subcenter catering to 3,000 population approximately. The district is malaria endemic and Khuntpani is one of the worst affected blocks of West Singhbum, but there is considerable rising trend in the fever cases compared to last year. Following this, both active and passive surveillance was strictly done in October 2016 which was followed in the 2nd week of November 2016. Following anecdotal reports and some studies carried out by international organizations recently, the block is also affected by malnutrition. In the investigation, it was also found that the environment was congenial for other infections and the situation may have become worse due to these infections. Villagers were illiterate and orthodox, who still believes in appeasing of Gods during ill-health and perform some bonga puja and show carelessness in seeking and taking treatment from registered practitioners. There was the negligible usage of mosquito nets in the homes of villagers due to their faulty behavior and attitude and also it was not provided by the government, but soon after these incidences, long-lasting insecticidal nets (LLINs)/insecticide-treated nets supplied by National Vector Borne Disease Control Programme (NVBDCP) were made available to the villagers.

The other affected village was Korba-Pahariya and its adjacent tolas having an approximate population of 2400. It comes under CHC Dhurki block of Garhwa district which is 3 km from the affected village. It was a remote village and is primarily inhabited

by primitive tribal groups and underprivileged communities. The inhabitants were uneducated and lacked awareness about the diseases and their health. There had been reports of few deaths in the last 2 months and the major reason attributing these deaths is their health-seeking behavior. Although the nearest health facility is hardly 2–3 km, the initial levels of their contacts in case of any disease are traditional healers or quacks (unregistered practitioners) due to their proximity and regular interaction. The inappropriate management of the diseases has resulted in mortalities. The frontline line health workers of the village (ASHA) was not able to deliver her services satisfactorily in regard to control of vector-borne diseases and was removed after warnings from officer-in-charge. However, this clearly indicated the insufficiencies of public health system.

Environmental assessment

Both the areas were having dense vegetations and water bodies in the form of ponds and shallow wells which were potential sources of breeding sites for mosquitoes. Although the team was able to find few active sources of breeding and the density of vectors have also decreased at the time of investigation as compared to the period of deaths according to villagers due to a considerable lowering of the temperature of the region and focal spraying of insecticides. The sources of larval breeding may have decreased due to the interventions done at the local level after the outbreak.

The laboratory investigations showed that it was a falciparum malaria outbreak with relatively less cases of vivax malaria. As per the reports of peripheral smears done at health centers, it was also concluded that almost all (98%) and 85% of the slides of the cases were positive which tested affirmative in Rapid Diagnostic Kits provided by NVBDCP of Dhurki and Khuntpani, respectively. The slide positivity rate of Khuntpani and Dhurki was found to be 30.2% and 13.6%, respectively. Based on the surveillance data of CHC Khuntpani, it was noted that out of 185 fever cases in the 2nd week of October 2016, 40 and 4 cases were found to be *Plasmodium falciparum* positive (Pf +ve) and *Plasmodium vivax* positive (Pv +ve), respectively. Whereas in 2015, the total number of fever cases reported were 8,083 and 914 found to be positive for malaria. On analyzing the data of CHC Dhurki, it was found that out of total fever cases (2655) during January–December 2015, Pf +ve and Pv +ve were 11 and 99, respectively. Whereas in October 2016 alone (including active surveillance), there were total 1515 fever cases, and Pf +ve and Pv +ve were 18 and 27, respectively. After analysis, it was found that during this prewinter season the cases of falciparum have increased significantly in comparison to last month and previous years [Table 1]. From the line list of the Pf +ve patients, it can be said that there is no predilection of age or sex in both the areas and was statistically insignificant.

All the cases were managed by providing appropriate and adequate treatment according to NVBDCP. All the preventive measures were explained to the inmates of the affected villages through Behaviour Change Communication and they were asked to protect themselves from mosquito bites. The LLINs provided by NVBDCP were promoted and distributed amongst the masses on political advocacy. Indoor residual spraying of the insecticides was done for controlling the menace of the mosquitoes. Environmental manipulation was also suggested to local people for destruction of breeding sites and the mosquito larvicidal oil was used as a larvicidal agent in water bodies. Even some indigenous methods of vector control were also recommended for easy acceptance and local adoption. Special focus was given to continue the surveillance with same vigor to keep malaria at bay, and frontline workers were motivated to check complacency creeping in them. On the spot, training was also provided to clear all the doubts among health workers regarding malaria and its management.

On verbal autopsy of eight dead patients suspected due to malaria in Khuntpani, it was found that two of the cases had symptoms of malaria and it may be one of the differential diagnoses based on suspicion only and without any confirmatory laboratory investigations [Table 2]. However, in Dhurki, out of the 11 dead patients, three had confirmed malaria based on the laboratory investigations available with the patients and some were able to tell Pf +ve but no reports found [Table 3]. There was one case in which sudden death was noted in which malaria was completely ruled out in the absence of symptoms. There was a travel history in two suspected of cases which may also have played a role in its transmission.

Discussion and Conclusion

Malarial outbreaks are multi-factorial and complex and are driven by natural as well as man-made determinants.[7] The deaths due to malaria are even more perplexing in the presence of treatment available at nearest government health facility. In both the outbreaks in prewinter season of Jharkhand, the author was the part of the multidisciplinary investigation team and had a very close vigilance on all the activities of the epidemiological investigation. Both the outbreaks may be attributed to factors such as ideal breeding sites, inadequate vector control and low implementation of personal protection in addition to weak case detection during surveillance.[8] The deaths occurred in two areas

Table 1: Laboratory findings of current epidemiological investigation

Village	Date	Fever and associated symptoms	Tests done (RDK)	Pf positive	Pv positive	Mixed
KHUNTPANI, (west Singhbum)	November 08, 2016-November 12, 2016	1002	1002	338	12	06
DHURKI (Garhwa)	November 16, 2016-December 02, 2016	631	631	65	23	00

RDK: Rapid diagnostic kits, Pf: *Plasmodium falciparum*, Pv: *Plasmodium vivax*

Table 2: Verbal autopsy of suspected deaths in Khuntpani, West Singhbum

Serial number	Age (years)	Sex	Laboratory investigations	Date of death	Clinical findings	Probable diagnosis
1	4.5 years	Male	None	November 3, 2016	Diaarhea, vomiting, malnutrition	Acute gastoenteritis
2	9 month	Female	None	November 5, 2016	Diarrhea, vomiting malnutrition	Acute gastoenteritis
3	2 years	Female	None	November 8, 2016	Diarrhea, prostration	Diarrhea
4	26 years	Female	None	November 9, 2016	Faced three deaths of their children in the past 5 days	Starvation and traumatic stress for 5 days
5	20 years	Male	None	November 7, 2016	Cough, vomiting	TB/LRI
6	55 years	Male	None	November 8, 2016	Age, diarrhea, vomiting	Acute gastroenteritis
7	3 years	Male	None	November 7, 2016	Fever for last 3 days before death	Febrile convulsion/cerebral malaria
8	4 years	Male	None	November 9, 2016	Fever and headache	Meningoencephalitis/cerebral malaria

LRI: Lower Respiratory Infection, TB: Tuberculosis

Table 3: Verbal autopsy of the suspected deaths due to malaria of Dhurki block, Garhwa

Serial number	Age (years)	Sex	Date of death	Lab investigation	Clinical findings	Probable diagnosis
1	12*	Female	November 29, 2016	Pf positive	Fever, bodyache	Malaria
2	10*	Female	November 25, 2016	Anemia, Pf positive (papers not found)	Fever	Malaria
3	14	Female	November 17, 2016	Pf and Pv positive, Hb-6.8 g/dl	H/G fever, h/o of blood transfusion	Malaria
4	6	Female	November 17, 2016	Pf positive (papers not present)	Fever, headache	Malaria
5	10	Female	November 15, 2016	Papers not found	Fever	Malaria
6	7	Female	November 14, 2016	Papers not found	H/G fever, prostration	Malaria
7	50	Male	November 12, 2016	No investigation	Sudden death	Myocardial infarction
8	60	Male	November 10, 2016	No investigation	Fever, age related symptoms, toxic look	Septicemia/malaria
9	22	Female	November 8, 2016	Papers not found	Fever, confusion	Malaria
10	9	Male	October 3, 2016	Pf positive	Fever, prostration	Malaria
11	8	Female	September 17, 2016	Pf positive (papers not found)	Fever	Malaria

*Travel history to Bhojpur district (Bihar) during incubation period. H/G: High grade, Pf: *Plasmodium falciparum*, Pv: *Plasmodium vivax*

were the result of poor and faulty health seeking behavior of the masses due to their ignorance and low confidence in government health facilities. The causes of deaths in both the areas were quite different, and malaria alone cannot be the culprit in all cases conclusively. However, in most of the cases, irrespective of the underlying disease, the treatment seeking was delayed, and appropriate medical care was missing. In cases of malaria, early and appropriate treatment reduces the progression of illness and henceforth morbidity and mortality rate and also onward transmission.[9,10] Treatment seeking behavior is influenced by numerous factors, but the important ones are caregiver's education, perception about the disease and socioeconomic status and cultural practices of the community.[11]

Disease prevention is the key in reducing morbidity and mortality rates, but its practice in households and communities depends on the risk perception of the disease and knowledge about malaria. Adequate knowledge about malaria is paramount for the correct application of preventive measures and decreasing the disease exposure.[12,13] However, misconceptions regarding malaria persist in the communities and households that may jeopardize the gains of control interventions adopted in malaria control programs. This should be tackled by improving caregiver's health education through communication activities aimed at generating behavioral changes.[14,15]

As a part of an epidemiological investigation of deaths suspected due to malaria, verbal autopsy tool was adopted to investigate the causes of deaths in both the studied regions. Since in our study all the deaths occurred at home so, there was no reliable method to ascertain the cause of deaths except verbal autopsy. The causes of deaths in both the studied areas were varied although both had confirmed outbreaks of falciparum malaria during the season as observed by the laboratory findings of the fever cases. Despite having low sensitivity and specificity, verbal autopsy methods have been accepted as the alternative approach in settings with inadequate vital registries to determine malaria-specific cause of death for community-based studies in many endemic countries.[16,17] In Khuntpani block, four cases appear to be of acute gastro-enteritis as a major symptom of malaria, i.e., fever was not present according to the family members on verbal autopsy, but the suspicion of algid malaria cannot be ruled out as mortality rate was high in the area and deaths were sudden with the presence of other symptoms suggesting complicated malaria. Furthermore, initial episodes of fever may go unnoticed sometimes by the family members in the midst of other predominant symptoms. Even clinicians opined that algid malaria was quite common in the health-care settings of Jharkhand although the documentation is poor. Algid malaria is one of the complications of tropical malaria chiefly involving gastro-intestinal system.[18] It is characterized by bloody diarrheic stools and persistent vomiting leading to hemodynamic changes in the form of shock with pronounced metabolic changes and hypothermia.[19] However, the presence of some other infections cannot be ignored as the environment

is congenial for various infectious agents and transmission of other communicable diseases. Some anecdotal notes also suggest that malnutrition is also rampant and may have contributed in worsening of symptoms and ultimately death.

The epidemiological investigation of malaria outbreak is incomplete without entomological investigation hence the team has advised state health to involve experts of National Institute of Malaria Research, India in regards to entomological surveillance. Knowledge of local vector species and their susceptibility to insecticides, as well as vector and human behaviours are essential for effective malaria control. Periodic collection of such data is helpful in making strategies for vector control and further track the impact on malaria transmission.[20] One of the key tools for the control and elimination of malaria is the antimalarial drugs and recent success in global malaria burden is likely due to efficient use of artemisinin-based combination therapies. However, the emergence of artemisinin-resistant parasites in South-East Asia have raised concerns and have lead to changes in drug policies and regimen to counter the spread of drug resistance.[21]

There are recent advances in malaria control such as RTS, S (ASO1) vaccine, and use of technologies other than the conventional measures may accelerate the elimination of malaria from the endemic zones.[22] The utility of geographical information system combined with spatial statistical tools in instantly analyzing the generated epidemiological data at the local level is enormous. This can be done by detecting spatial patterns of disease distribution and delineation of hot spots to assess the situation for better planning and management of malaria.[23]

These outbreaks are eye-openers for program implementers and policymakers that despite robust interventions under NVBDCP, the malaria cases are on the rise in India.[24] Hence, there is a need of local operational research, robust entomological surveillance, and monitoring to assess the extent and relative contribution of residual transmission to malaria burden across different settings.[25]

Acknowledgment

We acknowledge the support of State Programme Officer, NVBDCP (Jharkhand) for giving us the opportunity to perform epidemiological investigation of malaria outbreaks.

Financial support and sponsorship

This study was financially supported by Government of Jharkhand.

Conflicts of interest

There are no conflicts of interest.

References

1. Kumar A, Valecha N, Jain T, Dash AP. Burden of malaria in India: Retrospective and prospective view. Am J Trop Med Hyg 2007;77:69-78.
2. Khera AK, Jain DC, Datta KK. Profile of epidemic emergencies in India during 1991-95. J Commun Dis 1996;28:129-38.
3. National Vector Borne Disease Control Programme. Malaria Situation; 2017. Available from: http://www.nvbdcp.gov.in/Doc/malaria-situation-Dec16.pdf. [Last accessed on 2017 Feb 10].
4. World Health Organization. World Malaria Report 2016. Geneva, Switzerland. Available from: http://www.apps.who.int/iris/bitstream/10665/252038/1/9789241511711-eng.pdf?ua=1. [Last accessed on 2017 Jan 31].
5. Government of Jharkhand. Jharkhand at a Glance; 2016. Available from: http://www.jharkhand.gov.in/about. [Last accessed on 2016 Dec 12].
6. Government of Jharkhand. About Forest Department; 2016. Available from: http://www.jharkhand.gov.in/about-forest-department. [Last accessed on 2016 Dec 12].
7. World Health Organization: Field Guide for Malaria Epidemic Assessment and Reporting. Geneva, Switzerland; 2004. Available from: http://www.apps.who.int/iris/bitstream/10665/68764/1/WHO_HTM_MAL_2004.1097.pdf. [Last accessed on 2016 Dec 12].
8. Sharma PK, Ramanchandran R, Hutin YJ, Sharma R, Gupte MD. A malaria outbreak in Naxalbari, Darjeeling district, West Bengal, India, 2005: Weaknesses in disease control, important risk factors. Malar J 2009;8:288.
9. Romay-Barja M, Cano J, Ncogo P, Nseng G, Santana-Morales MA, Valladares B, *et al.* Determinants of delay in malaria care-seeking behaviour for children 15 years and under in Bata district, equatorial guinea. Malar J 2016;15:187.
10. Sonkong K, Chaiklieng S, Neave P, Suggaravetsiri P. Factors affecting delay in seeking treatment among malaria patients along Thailand-Myanmar border in Tak province, Thailand. Malar J 2015;14:3.
11. Mwenesi HA. Social science research in malaria prevention, management and control in the last two decades: An overview. Acta Trop 2005;95:292-7.
12. Yimer F, Animut A, Erko B, Mamo H. Past five-year trend, current prevalence and household knowledge, attitude and practice of malaria in Abeshge, South-central Ethiopia. Malar J 2015;14:230.
13. Erhun WO, Agbani EO, Adesanya SO. Malaria prevention: Knowledge, attitude and practice in a Southwestern Nigerian community. Afr J Biomed Res 2006;8:25-9.
14. Canavati SE, de Beyl CZ, Ly P, Shafique M, Boukheng T, Rang C, *et al.* Evaluation of intensified behaviour change communication strategies in an artemisinin resistance setting. Malar J 2016;15:249.
15. Regmi K, Kunwar A, Ortega L. A systematic review of knowledge, attitudes and beliefs about malaria among the South Asian population. Infect Ecol Epidemiol 2016;6:30822.
16. Deressa W, Fantahun M, Ali A. Malaria-related mortality based on verbal autopsy in an area of low endemicity in a predominantly rural population in Ethiopia. Malar J 2007;6:128.
17. Todd JE, De Francisco A, O'Dempsey TJ, Greenwood BM. The limitations of verbal autopsy in a malaria-endemic region. Ann Trop Paediatr 1994;14:31-6.
18. White NJ. Malaria. In: Garden C, editor. Manson's Textbook of Tropical Diseases. 20th ed. London: WB Saunders; 1996. p. 1087-164.
19. Popov AF. Algid malaria. Med Parazitol (Mosk) 2005;(1):10-2..

20. Govella NJ, Chaki PP, Killeen GF. Entomological surveillance of behavioural resilience and resistance in residual malaria vector populations. Malar J 2013;12:124.
21. Cui L, Mharakurwa S, Ndiaye D, Rathod PK, Rosenthal PJ. Antimalarial drug resistance: Literature review and activities and findings of the ICEMR network. Am J Trop Med Hyg 2015;93:57-68.
22. Gosling R, von Seidlein L. The future of the RTS, S/AS01 malaria vaccine: An alternative development plan. PLoS Med 2016;13:e1001994.
23. Saxena R, Nagpal BN, Das MK, Srivastava A, Gupta SK, Kumar A, *et al.* A spatial statistical approach to analyze malaria situation at micro level for priority control in Ranchi district, Jharkhand. Indian J Med Res 2012;136:776-82.
24. National Vector Borne Disease Control Programme. Operational Manual for Malaria Elimination in India. MOHFW, GOI; 2016. Available from: http://www.nvbdcp.gov.in/Doc/Operational-Manual-Malaria-2016-Version-1.pdf. [Last accessed on 2017 Feb 02].
25. World Health Organization. Control of Residual Malaria Parasite: Guidance Note. Geneva: WHO; 2014. Available from: http://www.who.int/malaria/publications/atoz/technical-note-control-of-residual-malaria-parasite-transmission-sep14.pdf. [Last accessed on 2016 Feb 16].