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A Case-Based Epidemiological Investigation And Health System Response Analysis Of A Focal Malaria Outbreak In A Low Endemic Area Of Tripura

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Abstract:
Background: *Few parts of State of Tripura are in high endemic zone of malaria but West Tripura district's annual parasite index is less than 1 usually since last five years but recently single case has been reported in Tulabagan village of West District of Tripura. Hence, the study aims at to assess the reason for re-establishment of foci malariaand the community knowledge on Malaria in a low endemic zone and to assess the state of existing preventive practices or control measures.*
Materials and Methods: *A cross-sectional descriptive study was conducted in the month June 2023 using an interview schedule among the members of 100 households of Tulabagan catering the area around 1.5 km radius from first case.Environmental assessment and Entomological study were done. Health system analysis was done using a checklist. Data were analyzed using SPSS v. 25 software and expressed using descriptive statistics.*
Results: *Mean age of participant was 44.4 ±12.41 years. The knowledge among the community was adequate (81%) on malaria even though the place is a low endemic zone.Entomological study showsAnopheles subpictus. Assessment of environment and health system response shows favorable for malaria re-establishment.*
Conclusion: *The case based epidemiological investigation with climate study shows favorable condition for malarial transmission. However, source of plasmodium falciparum could not be detected.The study revealed that the level of knowledge on malaria among the community of low endemic area was adequate but control and practices were inadequate indicating the needs of comprehensive sensitization among the community people.*
Keywords*: Malaria, low endemic area, outbreak, investigation, knowledge, control, health system response.*

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I. Introduction

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.[1] Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected female *Anopheles* mosquitoes and their species. It is preventable and curable. There are 5 parasite species that cause malaria in humans, and 2 of these species – *Plasmodium falciparum* and *Plasmodium vivax* – pose the greatest threat. In 2020, nearly half of the world's population was at risk of malaria. Most cases and deaths occur in sub-Saharan Africa. However, the WHO regions of South-East Asia, Eastern Mediterranean, Western Pacific, and the Americas also report significant numbers of cases and deaths.[1] There were an estimated 247 million cases of malaria in 2021, and the estimated

number of malaria deaths stood at 619000. The WHO African Region carries a disproportionately high share of the global malaria burden. In 2020, the region was home to 95% and 96% of malaria cases and deaths, respectively. Children under 5 years of age are the most vulnerable group affected by malaria; in 2021, they accounted for nearly 80% of all malaria deaths in the WHO African Region.[1]

Although few district of State of Tripura like Dhalai, Gomti, Khowai and Unakoti were being hotspot of varieties of malaria for last five years, the west District of Tripura, which is highly populated had reported a few cases of malaria (as epidemiological report from State Malaria, NVBDCP cell). Annual parasite index has been <1 in the west district.[2]As per State health report,Dhalai, South Tripura, Khowai, Gomati and North District were reporting remarkably higher number malaria cases but West Tripura District still reporting almost zero cases.[2] Under National Malaria Elimination Programme (NMEP) and NVBDCP, all Government of India are committed to eliminate malaria by 2027 (SDG 2030).[3] As per the strategy to eliminate, early diagnosis and prompt treatment, DDT indoor residual spray, LLIN use, behaviour change communication, strong surveillance, adequate drug and other logistic, application of larviparous fishes and integration with other vector control programme has been institutionalised in 2016 onwards.[3] In last National malaria conclave 2023, Govt of Tripura also given commitment to become malaria free by 2027.[4] It has been more than five years where major outbreak took place in Tripura and all control measures were applied upto community level including LLIN distribution and periodic indoor residual spray with DDT.

But, on 20th June, 2023 one malaria case, a girl child of 15 years has been registered under Mohanpur Block from Tulabagan Gram Panchayet area under West Tripura District (source: hospital admission register). She has history of fever, headache, loss of appetite, weakness for 3-4 days has been reported to the nearest Mohanpur Community health centre which a rural health training centre under Agartala Govt Medical College. Subsequently, Rapid diagnostic kit testing done which has shown plasmodium falciparum positive and managed as per malaria treatment protocol. As per M4 report for malaria, in the present calendar year no malaria cases were reported from this part of west district of Tripura but suddenly appeared foci of malaria suggesting of focal outbreak of malaria and weak surveillance mechanism under the administrative area of Mohanpur block. Hence, it is imperative to do epidemiological investigation to linkage the malaria re-establishment with associated factors leading to it and to control the disease transmission as earliest which will be an opportunity to analyse the response of existence health system and strengthen thereby.The epidemiological investigation aims to identify the source of the outbreak in order to apply control measures that will prevent future episodes of disease consequences. This study was conducted with few primary objectives to ascertain the reason of the re-establishment of foci malaria in a low endemic area and to study the vector dynamics for focal outbreak in a low endemic area of Tripura. The study also aimed at to evaluate health system response to counteract this focal outbreak and the level of knowledge among the community on malaria and its control and prevention measures.

II. Material And Methods

For epidemiological investigation, it is decided to take interview of one adult member (male or female) from each household who are willing to participate in the survey. For fever surveillance, all suspected fever cases irrespective of duration from the study site those who were willing to consented to provide blood sample were included. Those who are already diagnosed and treated with malaria (confirmed by RDT and or blood slide examination) preceding one month were excluded. All members form the household of Tulabagan within 1.5 kilometers radius from hotspot/epi-centre (The house of a malaria case,15 years girl child of Tulabagan area, primary case).

A descriptive cross-sectional survey was conducted at Tulabagan comprising ward 12,13,14 of Mohanpur Municipal Council covering a population of 2101 where majority peoples are belongs to Bengali community for a period of 7 (seven) days among the resident of Tulabagan (ward 13 & 14) of Mohanpur Municipal Council. As a study tool Interview schedule, Rapid Diagnostic Kit for malaria (PF+ PV), Blood Slide for thick and thin smear, CDC Light Trap, Aspirator, Water Collection pot, Environmental Assessment questionnaire and Health System Response Assessment (Pretested) tool were used. For entomological surveillance, CDC Light trap was set up in different household of Tulabagan for trapping of locally prevalent mosquitoes and their species identification at evening hour and it was collected next day morning by team of Entomologist and entomological study was done at Entomology Laboratory, Model Rural Health Research Unit, Khumulwng. Medical survey team comprising Doctors, paramedics, entomologist including local volunteers were visited the study site. Using different study tools household and their members were interviewed. Local health sub-centre was also visited for health response assessment using assessment checklist for malarial control program. Household and a radius of 1.5 kilometre from epi-centre were observed on environment and sanitation and different breeding site. From all suspected and risk populations blood slide smear were taken among those who consented to participate in the study. Informed verbal consent was obtained from all respondent. Data analysis was done using SPSS 25.0 version and expressed in text, tables, graphs using descriptive statistics.

III. Result

An interview was done among 100 respondents under Tulabagan area where adult members from each household were interviewed using interview schedule who are randomly chosen if more than one adult member is present and accordingly knowledge on malaria and its prevention were assessed. The mean age of the participants 44.4 ±12.41 years where male and female ratio was 2:1. 75% of the participants were educated upto matric. 30% of the household were priority groups. All residents are belonging to schedule caste of Bengali community group.

it shows that knowledge among the majority respondent was adequate (Table 1).

Table 1: Knowledge assessment (N=100)

Knowledge question	Response	
	Correct, n(%)	Incorrect, n(%)
Have you ever heard or aware about malaria?	100.0	0.0
How is malaria transmitted?	79.0	21.0
In which season/period of the year malaria may occur?	71.0	29.0
At what time of the day mosquito bites more?	60.0	40.0
Where does mosquito breed usually?	89.0	11.0
What can you do to control/prevent mosquito bites or malaria?	91.0	9.0
Is malaria treatment available? Is it curable?	45.0	55.0
What are the symptoms of malaria can be?	74.0	26.0
How malaria is diagnosed or confirmed?	35.0	65.0
Is malaria, can lead to serious illness even death?	28.0	72.0

Rapid fever survey was done in all households where total 340 blood slide sample for laboratory examination was taken to identify the parasite (Table 2) and all shows negative for malarial parasite.

Table 2: Report of rapid fever survey

Fever Survey report	Rapid Diagnostic test (RDT)	Blood Slide taken	Test result
20 (symptomatic)	-	20 (100%)	Negative for MP
320 (asymptomatic)	320(100%)	320 (100%)	Negative for MP

Entomological study of mosquitoes:

It shows that mosquitoes species which are predominant in the locality was *Anopheles subpictus*, which it is a potential natural vector of malarial parasite Plasmodium falciparum and Japanese encephalitis virus. It is highly susceptible to insecticide deltamethrin and resistant to DDT.

Image (1-4): CDC mosquito trapping by entomology team, MRHRU, Khumulwng

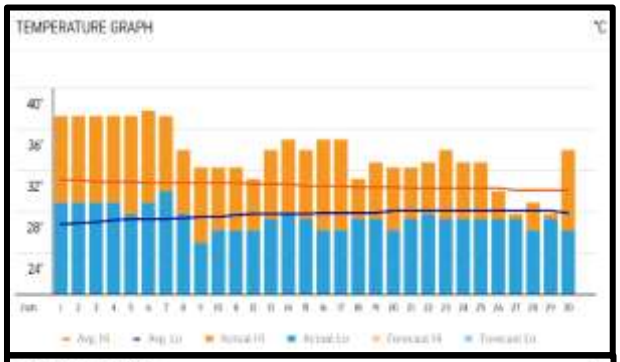
Above Images denoted that entomology team of MRHRU, Khumulwng were engaged in mosquito trapping by using CDC mosquito trapping machine which were installed at the house of primary case and nearby houses at evening hour and collected on next day morning by team mates. Subsequently, after examination, it was found that *Anopheles subpictus*were present predominantly.

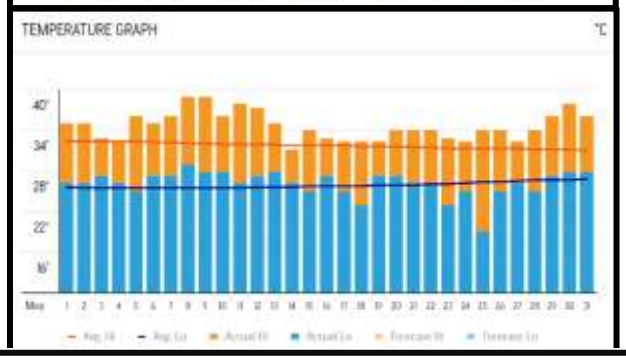
Ecological / Environmental assessment:

Humidity and rainfall – Overall Tripura have faced huge humid and sudden heavy rainfalls intermittently during the preceding month of May and June, 2023.[5,6] Average wind was 4 mph which was intermittent in nature most favorable for mosquito dispersion.

Surrounding environment – 45% of the household found to be with kitchen waste accumulation, 72% of the household having 1 or more water bodies or breeding sites in their surroundings, 2/3rd of their locality was

surrounded by rubber plantation or forest land and 65% of the household having cowsheds or animal houses and 50% of them found with dirt or shed.

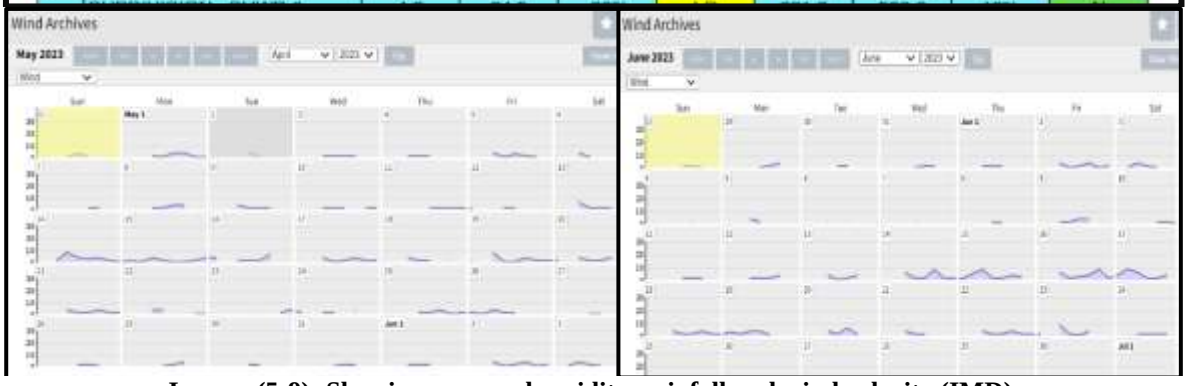




India Meteorological Department
Hydromet Division, New Delhi

DISTRICT-WISE RAINFALL DISTRIBUTION

S NO	MET SUBDIVISION/UT/STATE/DISTRICT	Day :06-07-2023 ACTUAL (mm)	NORMAL (mm)	%DEP.	CAT.	Period:01-06-2023 To 06-07-2023 ACTUAL (mm)	NORMAL (mm)	% DEP.	CAT.
1	AIZAWL	20.1	11.9	68%	LE	323.0	472.3	-32%	D
2	CHAMPHAI	1.7	9.2	-82%	LD	247.5	401.3	-38%	D
3	KOLASIB	33.3	14.4	131%	LE	357.0	508.4	-30%	D
4	LAWNGTLAI	9.2	15.1	-39%	D	344.6	557.2	-38%	D
5	LUNGLEI	6.7	18.3	-63%	LD	315.3	546.0	-42%	D
6	MAMIT	30.6	13.3	130%	LE	356.8	484.7	-26%	D
7	SAIHA	12.2	16.7	-27%	D	355.6	584.6	-39%	D
8	SERCHHIP	100.8	10.4	869%	LE	444.1	502.0	-12%	N
	STATE : TRIPURA	15.4	9.6	61%	LE	476.1	497.3	-4%	N
1	DHALAI	28.7	8.8	322%	LE	594.7	476.4	25%	E
2	GOMATI	2.4	12.7	-81%	LD	325.7	501.0	-35%	D
3	KHOWAI	15.0	7.5	99%	LE	391.3	488.4	-20%	D
4	NORTH TRIPURA	30.5	7.9	286%	LE	581.2	483.5	20%	E
5	SIPAHIJALA	1.7	10.6	-84%	LD	388.4	464.0	-16%	N
6	SOUTH TRIPURA	0.1	15.2	-99%	LD	303.8	595.7	-49%	D
7	UNAKOTI	43.2	9.4	360%	LE	600.0	523.6	15%	N
8	WEST TRIPURA	2.8	5.8	-51%	D	646.0	434.9	49%	E



Images (5-9): Showing average humidity, rainfall and wind velocity (IMD)

Pictures of potential breeding sites for mosquitoes (1-11)

Health system response analysis:

It is the SWOT analysis of existence health system where focal malaria outbreak took place regarding malaria and/or vector control activities during pre and post outbreak of malaria case. Human resource including rapid response team (RRT): one Community health officer (CHO), ANM were working at nearest Health sub-centre and all respective wards of Tulabagan area were placed with one ASHA. Rapid response team (RRT) was formed comprising CHO, ANM and ASHA but without Medical officer. RRT were basically involved fever survey only including blood slide collection in the affected area. Surveillance mechanism: Both active and passive surveillance were going on by concern Health sub-centre but in average 2% of the population were screened for fever and blood slide / RDT were done in recent 3 (three) years. However, no single malaria cases were reported in the past from this survey site. Quality of blood slide smear collected were very poor and microscopic examination was not performed timely indicating poor surveillance and case finding activity by health functionaries. Information Education Communication (IEC) activities: A very poor IEC activities on malaria were done by the concern local health authority. IEC display like flex banner and leaflets were not found during the survey. No records of conducting community meeting, health camp, awareness generation camp was found in the health centre. It was verified while interviewing the community members. However, ASHA do visit house to house for immunization, ANC etc. Process evaluation (Training, orientation and meeting): Process evaluation was done by interview and record review in the health centre. But it was found unsatisfactory. Health workers did not receive any residential training specifically on malaria, even ASHAs were shown how to do rapid diagnostic kit testing in monthly ASHA Vorasha Diwas meeting only as one the ASHA expressed. One of the health workers said that they received the orientation during their study course only. There was no record found related to activities on malaria except M4 register which is inappropriately filled. Community involvement: Village health sanitation and Nutrition committee (VHSNC) and Jan Arogya Samiti (JAS) has been established as told by the CHO, but there was no such record or activities could be shown on malaria. One of the community members said that they hardly engaged with any activities in the field with ANM/CHO/ASHA, when they are ill, they just preferred to go Mohanpur CHC usually, occasionally only they visit the Tulabagancentre. Ward member (elected) and Panchayet leaders do involve for any awareness program. But hardly such awareness program conducted on malaria as there were no records and CHO and ANM also admitted that. But they were involved during mosquito nets distribution 2-3 years back. Infrastructure and logistic supports: Very limited RDT kit and blood slide were present in the centre. Anti-malaria drugs were available but only single dose ACT-AL and Primaquine were observed. Health worker expressed that since there was no malaria case reported, they hardly keep the medicines. **Health Response activities:** After reporting a case of malaria (Pf variety) from Mohanpur CHC, the concern place / locality and health functionaries of primary case was identified and informed. A RRT was formed without Medical Officer and approximately around 100 households nearby of primary case were screened for fever and blood slides were collected from 320 people. Rapid diagnostic kit testing also performed simultaneously. Students from one of the schools where the primary case was studying also screened. Daily surveillance and reporting mechanism has been developed. However, no community meeting, awareness campaign, focal DDT spray and other IEC activities other than monitoring for fever occurrences. The concerned ASHA, ANM and CHO were oriented by Medical Officer in-charge, Mohanpur CHC immediately for continuous monitoring for fever cases.

Figure 1 explain on conceptual framework of foci malaria re-establishment in such a low endemic place of endemic State of Tripura. The study finding demonstrated that the relationship between climate change, environmental risk and weak surveillance mechanism.

Strengths 1. Human resources were in place 2. Adequate knowledge among community people on malaria 3. Close proximity to HWC, higher health centre 4. Availability of anti-malarial drugs & testing items	Weaknesses 1. Un-trained workers 2. Poor surveillance activities 3. Inadequate awareness activities in the field 4. No DDT spray since 2 (two) years
Opportunities 1. Outbreak- lession learning 2. Training & conducting field activities 3. Gearing up of surveillance activity 4. Research and Entomological study	Threats 1. Outbreak in a non-endemic area 2. Uncommon vector identified - *anopheles subpictus* 3. Poor immunity among community for being non-endemic area

Box: SWOT analysis of health system response in relation to recent focal outbreak of malaria

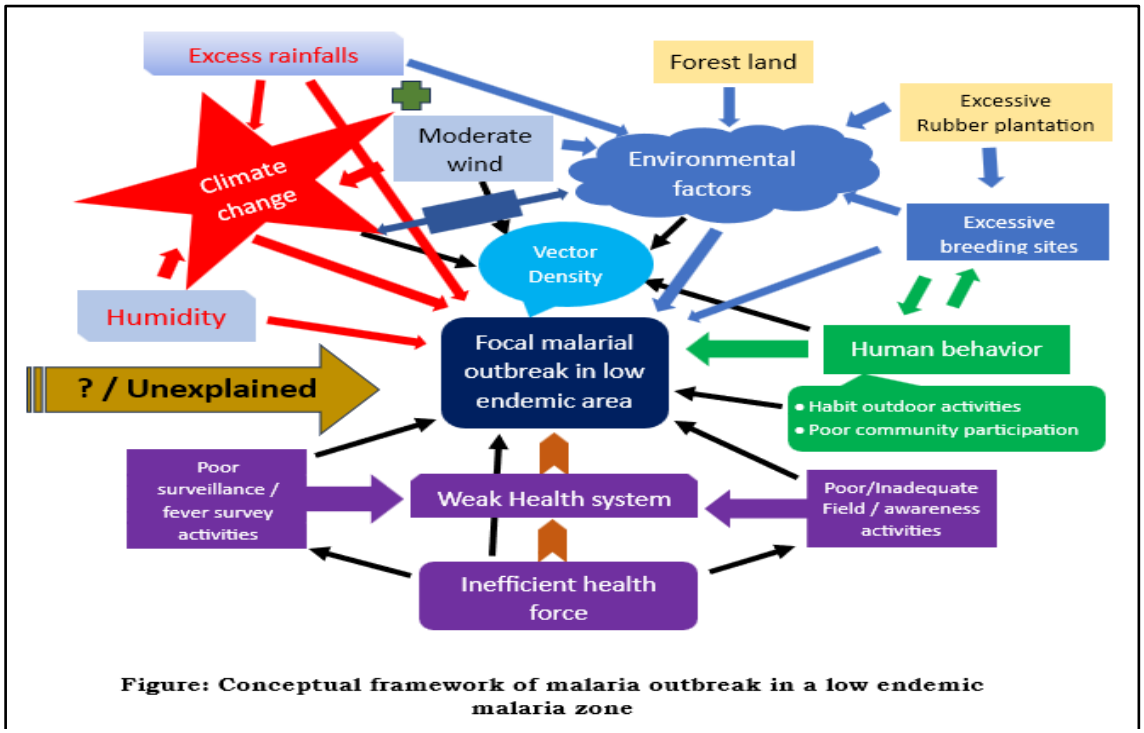


Figure: Conceptual framework of malaria outbreak in a low endemic malaria zone

IV. Discussion

In malaria elimination settings, surveillance includes case and foci investigation and classification to provide information for response to identify all infections and to prevent onward transmission. Part of case and foci investigation involves active case detection when an index case is reported.[3]In this regard, an epidemiological case-based investigation was carried out in the low endemic area of Tripura. The knowledge about malaria and its prevention was adequate specially in low endemic zone of malaria. This finding is incorporated with many national and international literature.[7-10] However, practices on control measure were relatively inappropriate and inadequate as per the environment and sanitation assessment where many breeding places such as water collection body, stagnant water were present. Hsiang MS et al[11] demonstrated similar findings in a low endemic zone of malaria stated that practices and environment factors were big issues in the re-establishment of foci of malaria. Many evidence cited that climate change with dry climates and heavy rainfall related with re-establishment of foci malaria.[11-14]The present study also found similar calamities during outbreak season as there was heavy rainfall with intermittent hot and humid climates in particular area of the district.[5,6]Being a zone of low endemicity, there was poor surveillance and preventive or control activities were observed though human resources and logistics were in place which may lead to hibernation of the parasite. This particular features also seen during pre-elimination phase. And these health system factors were similar to the many literatures published earlier.[15-18] The entomological study revealed the new species for the State of Tripura as there was no history suggestive of malaria cases due to *anopheles subpictus*bites which directing for proper environmental and vector study and their dynamics in near future. Despite thorough epidemiological investigation including vector study and knowledge assessment and health system response analysis, the re-establishment of the foci malaria, plasmodium falciparum is not clear in such low endemic area of one the North-eastern state and district, West Tripur. This finding is somewhat similar to the study conducted in the State of Meghalaya during 2020 by Sarkar R et al.[19]

Malaria continues to be a major public health problem globally with an estimated 229 million cases reported from 87 endemic countries.[20] India's the largest population at risk of malaria, with an estimated 162.5 million people living in high-transmission areas.[21,22] Despite this, India has achieved a slow decline in the annual incidence of malaria from around 20 million in 2000 to 6 million in 2019, i.e., an absolute reduction of 73%.[20]However, environmental, climate vulnerability, socio-cultural and behavioral beliefs and practices, undetected transmission from asymptomatic individuals, importation of infection from endemic areas, poor disease surveillance, resistance to antimalarial drugs and insecticides, and healthcare delivery and access issues may arise to re-establishment focal malaria and later on, adversely affect the elimination efforts.[23-25]

V. Conclusion

The epidemiological study, entomological study, environmental assessment and health system response analysis shown that *anopheles subpictus* mosquito may be solely responsible for focal malaria (PF) outbreak where the outbreak may be because of climate calamities, unfavorable surrounding environment and weak surveillance system and inadequate IEC activities in the field. Though the relationship between outbreak of focal malarial case and the existence plasmodium falciparum in the mosquitoes could not be established particularly in such very low endemic area of Tripura. It is highly recommended that the area should be kept under strict continuous monitoring with an opportunity to strengthen the existence health response system with proper training, adequate logistics and extensive awareness / BCC activities in the field. Further, observational analytical studies can be conducted in future.

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