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# Desert malaria "Curse of the Thar Desert" – a unique geographical endemicity of malaria and combating it with modern technology

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**Abstract**: *Introduction: This study focuses on the Malaria endemic in the Thar Desert- The most populated desert in the world. Malarial endemicity in a desert environment is a unique and rare geographical presentation, as malaria is usually common in areas where there is rainfall and water stagnation - like ponds, fields, etc. In this study, we want to highlight the unique clinical presentation, lab findings, and reason behind the existence of malaria in the desert. Most importantly we also would like to share our innovative idea to eliminate breeding sites using Quadcopters and drones.*

*Materials and methods: Study type – Prospective observation study, Study duration – October 2020 to December 2020, Sample size-103 cases, Inclusion criteria – all smear-positive Malaria cases, Exclusion criteria – Cases Referred to higher centers because of complications.Tools used for breeding site identification – Quadcopters and Drones with HD cameras. Since the area to be surveyed was vast (>30km), it was very difficult to do a manual survey in the harsh desert climate. The patients' demographics, Clinical Presentations, and laboratory parameters were collected systematically in a predesigned format and entered into an excel sheet. The finding of our study was compared with the malaria cases from different parts of the country.*

*Results: All malaria was identified as Plasmodium vivax. The mean age group was 36 years (min-21 and max-56). Clinical features- out of 103 cases, 78% of the patients presented with all 4 symptoms of fever, chills, headache, and bodyache.22% presented with atypical isolated symptoms of abdominal pain, vomiting, myalgia, severe joint pain. 77% of patients had mild hepatosplenomegaly, 7 patients presented with hypotension, and 2 were in sepsis. Lab parameters – 88% of the patients had anemia, of which 5% had severe anemia, 40% had leucopenia while 6% had leucocytosis.87%had thrombocytopenia, out of which 56% had a platelet count less than 50,000/ml. 2% had mild AKI, bilirubin levels were elevated in 53%, and 36% had transaminitis. Using technology, the survey of the entire area was done in 1 week and all the breeding sites were eliminated on the same day of identification and a drastic drop in malaria cases was noted.*

*Conclusion: We conclude that desert malarial presentation of Plasmodium vivax is unique in clinical presentation and lab derangements compared to other malarial cases. Usage of technology like quadcopters and drones for breeding site identification played a major role in curtailing cases drastically in a very short period in an effective way.*

**Keywords**: *desert malaria, Plasmodium vivax, drone surveillance for breeding site*

## INTRODUCTION

Desert Malaria, yes you have read it right! As commonsense dictates, malaria is common in tropical countries and areas, where the mosquito breeding site is more commonly seen in places where water gets stagnated during the rainy season, e.g., ponds, ditches, and marshy areas which serve as a

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temporary breeding ground for mosquitoes. Malarial endemicity in a desert environment is a unique and rare geographical presentation of this disease.

The Great Desert of Thar is the most widely populated desert in the world, with a population density of 83 people per $km^2$, which is located in the northwestern part of India [1]. Desert ecosystem, which has its peculiarities to offer, is yet another operating system for malaria.

Malaria is one of the oldest diseases known to mankind. In ancient India, malaria was described in The Compendium of Sushruta, a Sanskrit medical treatise. The World malaria report 2019 estimates that globally, there were an estimated 228 million cases of malaria in 89 countries. The estimated number of malaria deaths in 2018 and 2019 stood at 411,000 lives in 2018 and 409,000 lives in 2019 respectively [2]. In 2012, it was estimated that the total economic burden of malaria in India was around US$ 1940 million, with 75% from lost earnings and 25% from treatment costs borne by households. Besides saving lives, eliminating malaria in India would also avert these socioeconomic losses [3].

Malaria is caused by a protozoan parasite, Plasmodium, and transmitted by the vector anopheline mosquitoes. Malaria parasite in India has two major human malaria species, Plasmodium falciparum, and P. vivax. Approximately 65% of those at risk for becoming infected with malaria in Southeast Asia are individuals residing in India (WHO 2010). The central and eastern regions of India report the most malaria. An. culicifacies is responsible for 60–65% of the malaria burden [4]. The three most important challenges for malaria control in India are difficulties in control implementation and logistics, insecticide resistance, and antimalarial drug resistance. Being the world's second-most populous country, and having a faster rate of urbanization, adds to the challenges. India contributes 77% of total malaria in Southeast Asia. Multi-organ involvement/dysfunction is reported in both Plasmodium falciparum and P. vivax cases [4]. In this study, we did a detailed analysis of the unique presentation of desert malaria and compared it with other studies of malaria presentation in a tropical ecosystem.

**MATERIALS AND METHODS**

This is a prospective study done from Oct to Dec 2020, where 103 cases of malaria cases were studied.

Inclusion criteria – all smear-positive malarial cases

Exclusion criteria – cases referred to higher centers because of complications.

Patients' demographics, clinical presentations, and laboratory parameters were collected in a systematic method and the collected data was analyzed in windows excel sheet.

For malarial surveillance, we had used quadcopters and drones with HD cameras for regular and periodic surveillance, as it was very difficult to do breeding site surveillance manually due to the extreme temperatures and scattered sites.

The photos from the drone and quadcopters were collected and given to the respective head of units in the areas and necessary action was taken within 24 hours of target identification to eliminate the breeding sites.

**RESULTS**

103 diagnosed cases of plasmodium vivax malaria were admitted, out of which all were males. The minimum and maximum age of the patients reported was 21 and 56 respectively, with a mean age group of 36 years. Duration of the hospital stay ranged from a minimum of 2 to a maximum of 18 days.

The average temperature of the patients was 101.5 F, maximum temp was 103 F. 78% of the patients presented with all 4 symptoms of fever, chills, headache, and body ache. 22% presented with atypical isolated symptoms of abdominal pain, vomiting, myalgia, severe joint pain. 77% of patients had mild hepatosplenomegaly, 7 patients presented with hypotension, and 2 were in sepsis.

Lab parameters – 88% of the patients had anemia (Hb 9-11 g%), of which 5% had severe anemia (6.5-8.5 g%), 40% had leucopenia while 6% had leucocytosis. 87% had thrombocytopenia, out of which 56% had a platelet count less than 50,000/ml. 2% had mild AKI, bilirubin levels were elevated in 53%, and 36% had transaminitis.

Using technology, the survey of the entire area was done in 1 week and all the breeding sites were eliminated on the same day of identification and a drastic drop in malaria cases was noted. It was a very effective and time-saving modality.

Figures 2 and 3 show open tanks on the roofs of apartment buildings, as well as abandoned open manholes behind these buildings where people don't frequent and were therefore unnoticed by the residents.

One of the main breeding sites of Anopheles could also be the long canals that run for kilometers through the desert, providing a haven for the larvae, as shown in Figure 4.

**DISCUSSION**

Our results were comparable to that of a study done in south India by Madhu Muddaiahet al. [5], in which males (81%)

outnumbered females (19%) and Plasmodium vivax was the major parasite type (52.54%). In their study incidence of malaria increased from June onwards coinciding with monsoon season, contrary to our study, where caseload was more in October-December. A study by Pankajala Amritha et al. [6], also had 94.71% of P. Vivax cases, and the mean duration of hospital stay was 5.17±3.31 days.

**Figure 1:** The area identified using a quadcopter. The area seen in the photo was highly inaccessible; Red arrow marks show the sites of waterlogging and the Yellow outlines show the breeding sites of Anopheles mosquito where the larva develops, and the shady environment gives mosquito cover from the extremely hot weather

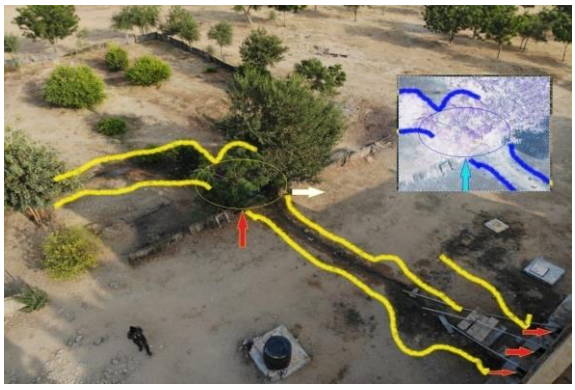
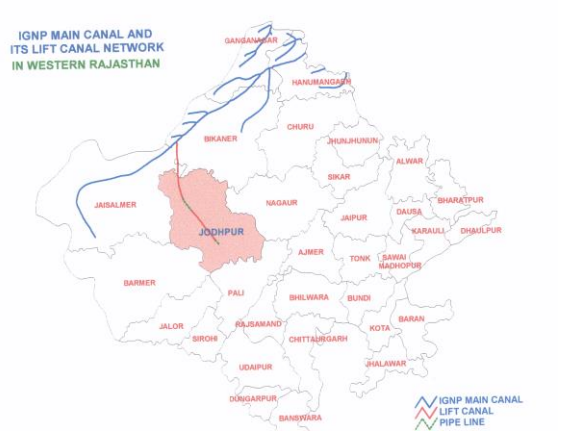


**Figure 2**

**Figure 3**

**Figure 4**




In a multicentre study done in Columbia [7], 92.5% of patients presented with fever, chills, headache, sweating, myalgia/ arthralgia, similar to our study. Mild hepatomegaly and splenomegaly as well as abnormal transaminases were mostly observed in P. vivax malaria patients.

A meta-analysis of malarial cases in Malaysia and Australia by Cho Naing et al. [8] provided evidence of the clinical relevance of severe thrombocytopaenia in P. vivax malaria which was in line with our result. In our study thrombocytopenia, anemia, and altered liver function were seen, contrary to study results found by Wajihullah Khan et al. [9] where anemia, jaundice, convulsions, and acute renal failure were significantly high (3-4 times) in subjects infected with P. falciparum than with vivax.

But a in study done in AIIMS Rishikesh by Jagdish Prasad Goyal et al. [10], there was no statistically significant difference found in complications such as anemia and thrombocytopenia between P. vivax and P. falciparum. Similarly in a Columbian study [11], anemia and thrombocytopenia were common in both.

A study was done in Aligarh Muslim University [12] in central India also showed that in P. falciparum infection, the incidences of anemia, splenomegaly, renal and liver dysfunction, and jaundice were higher compared to those in P. vivax infection. Several complications such as acute kidney injury, jaundice, severe anemia, metabolic acidosis, shock, hyperpyrexia, hypoglycemia, generalized tonic-clonic convulsions, etc. were found to be more prevalent in patients with P. vivax infection. These symptoms were until recently known to be associated with falciparum malaria [13].

Malarial surveillance programs by the government are adversely affected by an insufficient number of sanctioned posts of health workers and other program staff in different

parts of the country. For instance, there are about 40000 multipurpose health workers (MPWs) against approximately 80 000 sanctioned posts for nearly 150000 sub-centers (SCs) across the country [14]. Over the past fifteen years, the fight against malaria improved dramatically. Insecticide-treated bed nets and indoor residual spraying resulted in an enormous reduction in the number of children dying of the disease [15]. Unfortunately, it is not enough.

For the first time, drones were tested to help fight malaria in Tanzania, on the island of Zanzibar, off the coast of Mozambique. High-tech 'Anti-Malaria Drones' drones were used to spray a silicone-based liquid gel (Aquatain) in endemic areas where malaria-carrying mosquitoes lay eggs, and where there are large concentrations of stagnant water with the hope that the new substance will stop mosquitoes' eggs from hatching. It is part of a program by the Zanzibar government, looking towards eliminating malaria by 2030 [16].

**CONCLUSION**

We conclude that desert malarial presentation of Plasmodium vivax is unique in its clinical presentation and lab derangements compared to other malarial cases. Doing manual surveillance for breeding sites is very difficult because of the large areas to be covered, the time involved, and the requirement of a lot of manpower. Using drones and quadcopters is a cost and time-effective method which helps in the very early identification and eradication of breeding sites.

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