CLINICO-HEMATOLOGICAL PATTERN OF MALARIA IN RAJKOT CITY (GUJARAT, INDIA).

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Abstract

Background: This study was done to correlate clinico-hematological pattern of Malaria infection, its relation with rainfall & various affiliated demographic profile in Rajkot district, Gujarat, India. This study was conducted at P.D.U. Government Medical College, Rajkot from year 2008 to 2011.

Methods: Thick and thin peripheral blood smears were made from each patient with fever and chills and body temperature ≥ 37.5°C (on medicinal thermometer). The stained slides were examined microscopically for malaria parasites. All patients who were admitted in the clinical ward from year 2008 to 2012 with fever were considered for this study. Patients were registered specially by their residential location for demographic data and rainfall pattern was noted.

Results: A direct relationship is observed between malaria infection transmission and average monthly rainfall. Two peaks of high parasite density were observed in September & October, each peak was coinciding with high rainfall pattern of rainy season. There was a positive and significant correlation between parasite density and rainfall and breeding places of mosquitoes, suggesting that malaria is more common during heavy rainfall season and with poor living standards. There is also a significant positive correlation between parasite density and body temperature.

Conclusions: Our study proves that malarial infection has got direct relationship with average rainfall during monsoon. As well as water stagnation & accumulation plays a major role in mosquito breeding and subsequent spread of malaria. Poor sanitation in lower socioeconomic class has maximum number of malaria cases.

Keywords: Malaria; Rainfall; Socioeconomic status; Residential area.

1. Introduction

Malaria is a very common infection occurring in the Gujarat State (Western India). The occurrence & existence of malaria is closely related to naturally existing environmental and climatic conditions. The incidence, severity and distribution of malaria are also affected substantially by human activities such as water and agricultural developments and by urbanization. Estimates indicate that 90% of the global burden of malaria is attributable to environmental factors. Occurrence of malaria is generally more common amongst the people who live in the slum areas where mosquitoes breeding places are more, where in-house crowding is more and mainly in the lower to lower middle class families. The most pronounced effects of climate on vector-borne diseases such as malaria would undoubtedly occur in places where the disease is newly introduced and are at the edges of the vector range, and where the population has built little immunity against malaria. In Rajkot, high temperature and rainfall experienced in 2010 brought malaria into the community where higher number of slum areas and more breeding places for mosquitoes were noticed. The effect of recent changes in climatic and environmental conditions experienced in many malaria endemic countries also, could affect disease incidences, prevalence, severity, transmission, and infection intensity amongst others. These aspects have not been sufficiently studied; in this study we investigated the malaria prevalence and intensity of infection in slum areas. We further, correlated malaria infection amongst the socioeconomic classes and among the houses where crowding per house is more and fewer to age groups of residents and to monthly rainfall, to get an insight of the peak period and time of occurrence of peak malaria transmission in the specific area. The study aims at underlining some of the important indicators that could be useful for public health monitoring of malaria infection intensity.

Severe malaria caused by Plasmodium falciparum (PF) infection may occur as a result of delay in treating uncomplicated falciparum malaria. In children, severe malaria may develop very rapidly. Recognition and prompt treatment of uncomplicated Plasmodium falciparum malaria is therefore of vital importance in averting incidence of severe malaria. A patient with severe malaria may present with confusion or drowsiness with prostration. In addition, the patient may develop other symptoms such as
cerebral malaria manifestation, generalized convulsions, severe anemia, hypoglycemia, acidosis, high fever, jaundice and hyper-parasitemia3, 4, 5, 6. This severe manifestation may occur singly as a result of heavy parasitemia or more commonly in combination in some patients. Pregnant women constitute a special group with specific symptoms due to lowered immunity coupled with parasitization of the placenta. In high transmission areas, the risk of severe falciparum malaria developing is greatest among young children and visitors of any age coming from non-endemic areas. In non-transmission and low-transmission areas the risk of developing severe malaria is greatest among travelers returning with undiagnosed malaria infection from areas where Plasmodium falciparum transmission has occurred6.

Clinical manifestation of the symptoms of malaria is a result of parasitization and destruction of the red blood cells. The developmental stages of the parasite in the liver, or its persistence as hypnozoites, mainly in Plasmodium vivax (PV) and Plasmodium ovale do not produce any symptoms7.

Initial symptoms of the disease are quite variable, particularly in children, and may include irregular fever, general malaise, headache, muscular pains, sweats, chills, nausea, vomiting, and sometimes diarrhea. If untreated, the fever may progress to periodic bouts alternating with less or no fever. The fever paroxysms depends on the species of the malaria parasite and goes through three stages of: cold shivering rigor, hot burning fever with dry skin temperatures reaching up to 40–42°C, intense sweating and lowering of body temperature. In Plasmodium vivax and Plasmodium ovale the cycle of fever is referred to as tertian while in Plasmodium malariae it is quartan and Plasmodium falciparum malignant. Plasmodium vivax and Plasmodium ovale selectively invade young erythrocytes and Plasmodium malariae selects the old erythrocytes, while Plasmodium falciparum in discriminatively invades any red blood cell. The untreated acute attack of Plasmodium falciparum is shorter than that of Plasmodium vivax, in fatal cases death often happens 2–3 weeks, although in some cases it may occur as early as 2–3 days after onset of symptoms. Repeated infection gives rise to immune responses of the host, which eventually controls the disease and the infection. Most anti-malarial drugs are effective against erythrocytic stage of the parasites, but not against the hypnozoites in the liver and gametocytes in the blood8, so that while Plasmodium falciparum and Plasmodium malariae could be fully cured, Plasmodium vivax and Plasmodium ovale may produce true relapses by new invasion of the blood from latent hypnozoites, even after complete clearance of parasites from the blood. The elimination of hypnozoites and gametocytes requires long treatment periods (14 days or more) using primaquine or related drugs. Any untreated or incompletely treated infections will therefore produce several recrudescences. In the absence of reinfection, untreated P. falciparum may persist for 1–2 years, Plasmodium vivax for 3–4 years and Plasmodium malariae recrudescence up to 52 years9.

2. Material and Methods
We had screened and studied for malaria parasite from the blood sample of patients who presented with fever (i.e. body temperature = 37.5°C, WHO Scale), with chills & rigor from the different locations of Rajkot city from year 2008 to year 2011 & who were admitted in our P.D.U. Government Hospital, Rajkot. We elicited their history (age, sex, residence, socioeconomic status) along with blood sample for malarial parasite detection was drawn. For each blood sample taken, two peripheral blood smears both thin and thick were made and stained with Romanowsky stains- Fields stain A & B as well as Leishmans stain. The thin smears were used to identify the species of the malaria parasite while the thick smears were used to find the scantly parasitemia.

| Table-1: Year 2008 Malaria Positive Cases |
|------------------------------------------|
| **Month** | **Total Blood Smears examined** | **Plasmodium falciparum** | **Plasmodium vivax** | **Total Positive cases** |
|-------------|---------------------------------|--------------------------|---------------------|-------------------------|
| January     | 856                             | 10                       | 1                   | 11                      |
| February    | 903                             | 7                        | 4                   | 11                      |
| March       | 817                             | 0                        | 4                   | 4                       |
| April       | 903                             | 2                        | 4                   | 6                       |
| May         | 1004                            | 3                        | 9                   | 12                      |
| June        | 1049                            | 2                        | 18                  | 20                      |
| July        | 1242                            | 12                       | 21                  | 33                      |
Table-2: Year 2009 Malaria Positive Cases

| Month   | Total Blood Smears examined | Plasmodium falciparum | Plasmodium vivax | Total positive cases |
|---------|-----------------------------|-----------------------|------------------|---------------------|
| January | 1676                        | 9                     | 3                | 12                  |
| February| 1069                        | 3                     | 1                | 4                   |
| March   | 1211                        | 4                     | 3                | 7                   |
| April   | 1098                        | 3                     | 1                | 4                   |
| May     | 1196                        | 2                     | 12               | 14                  |
| June    | 1276                        | 6                     | 14               | 20                  |
| July    | 1575                        | 3                     | 3                | 6                   |
| August  | 1719                        | 19                    | 11               | 30                  |
| September| 2110                       | 64                    | 34               | 98                  |
| October | 2055                        | 39                    | 16               | 55                  |
| November| 2183                        | 49                    | 7                | 56                  |
| December| 1992                        | 42                    | 3                | 45                  |
| Total   | 19160                       | 243                   | 108              | 351                 |

Table-3: Year 2010- Malaria Positive Cases

| Month   | Total Blood Smears examined | Plasmodium falciparum | Plasmodium vivax | Total Positive cases |
|---------|-----------------------------|-----------------------|------------------|---------------------|
| January | 1679                        | 5                     | 2                | 7                   |
| February| 1624                        | 9                     | 4                | 13                  |
| March   | 1715                        | 3                     | 11               | 14                  |
| April   | 1606                        | 2                     | 9                | 11                  |
| May     | 1686                        | 0                     | 21               | 21                  |
| June    | 2059                        | 3                     | 28               | 31                  |
| July    | 2375                        | 5                     | 22               | 27                  |
| August  | 2598                        | 45                    | 40               | 85                  |
| September| 3693                       | 170                   | 172              | 342                 |
| October | 3563                        | 239                   | 142              | 381                 |
| November| 3233                        | 438                   | 106              | 544                 |
| December| 2737                        | 281                   | 57               | 338                 |
| Total   | 28568                       | 1200                  | 614              | 1814                |

Table-4: Year 2011-Malaria Positive Cases

| Month   | Total Blood Smears examined | Plasmodium falciparum | Plasmodium vivax | Total Positive cases |
|---------|-----------------------------|-----------------------|------------------|---------------------|
| January | 2142                        | 45                    | 5                | 50                  |
| February| 2180                        | 5                     | 5                | 10                  |
| March   | 2333                        | 23                    | 8                | 31                  |
| April   | 2031                        | 18                    | 32               | 50                  |
| May     | 2296                        | 11                    | 60               | 71                  |
| June    | 2361                        | 1                     | 80               | 81                  |
| July    | 2122                        | 12                    | 82               | 94                  |
| August  | 2394                        | 49                    | 60               | 109                 |
| September| 3062                       | 206                   | 148              | 354                 |
| October | 2888                        | 74                    | 51               | 125                 |
| November| 2912                        | 68                    | 21               | 89                  |
| December| 2910                        | 58                    | 22               | 80                  |
| Total   | 29631                       | 570                   | 574              | 1144                |
Figure-1: Month wise classification of total malarial cases of four year duration [2008-2011]

![Bar Chart]

X Axis- Month, Y Axis- Total Number of Malaria Cases of four Years.

Table-5: Year wise rainfall and positive malaria cases (2008-2011)

| Sr. Number | Year | Rainfall (In Inches) | Malarial Cases |
|------------|------|----------------------|----------------|
| 1          | 2008 | 32.48                | 162 120        |
| 2          | 2009 | 22.92                | 243 108        |
| 3          | 2010 | 39.00                | 1200 614       |
| 4          | 2011 | 20.00                | 570 574        |

Table -6: Age wise distribution of malaria

| AGE               | PF   | PV   | TOTAL |
|-------------------|------|------|-------|
| Children(<15 years) | 1415 | 848  | 2263  |
| Adult(>15 years)  | 760  | 568  | 1328  |
| Total             | 2175 | 1416 | 3591  |

Table- 7: Socio economic class wise distribution of malaria

| Socio Economic Class | Plasmodium falciparum | Plasmodium vivax | Total positive Cases |
|----------------------|------------------------|-----------------|---------------------|
| Lower                | 1068                   | 772             | 1840                |
| Lower middle         | 788                    | 452             | 1240                |
| Upper middle         | 295                    | 166             | 461                 |
| Higher               | 24                     | 26              | 50                  |
| Total                | 2175                   | 1416            | 3591                |

Figure-2: Plasmodium Falciparum & Plasmodium Vivax in different socioeconomic classes.

![Pie Chart]
3. Results
The geometric means of malaria infection exhibited major peaks in September, October & November, which corresponds with the pattern of equatorial rainfall seasons in the months of September to November (Table-1, 2, 3, 4). This rain pattern creates several breeding sites for mosquitoes. As the vector population increases, the transmission of malaria increases. The result further shows that children below 15 years have higher peaks of disease than adults (table-6) The study also shows the pattern of malaria is higher amongst the subjects who lives in slum area compared to people who lives in the urban area (Table-8) and also more common in people coming from relatively lower socioeconomic class (Table-7).

4. Discussion
The present study shows that there is a statistically significant relationship between malaria and the pattern of rainfall from year 2008 to year 2011 (Table 5). Parasite rises soon after the start of the first rain season in July reaching peak in August & September because the rains provide good breeding sites for mosquito vectors. As vector population increases, transmission of infection subsequently rises. As rainfall decreases and breeding grounds of mosquito vector dries up at the end of the rain season around October, then falls reaching a minimum after November, probably due to a reduction in mosquito vector population. The finding in this study corroborates our laboratory case records, which indicate that two weeks following the fall of the first rains usually registers increased cases of malaria infection.

The higher incidence of malaria is observed in children (Table-6) is a result of a less developed immune system, which is incapable of clearing parasites more effectively as in adults. Therefore, malarial infection in children seems to give a true picture of the intensity of an infection than of adults, this may be a useful indicator for purposes of monitoring disease intensity.

Descriptive epidemiological studies of malaria infection in some slum areas of stable transmission have revealed distinct age-specific pattern of parasite prevalence and density as detected by positive blood slide smears. Data from our study is consistent with the age-related patterns of prevalence of infection (Table-6). The prevalence of infection decreased with increasing age or age group. The observed decline in infection is most likely due to the development of non-sterile clinical immunity over time [10]. This background immunity regulates infection and is usually pronounced in children above 15 years and in adults. These are people who have been exposed to mosquito bites over the years, hence to malaria many more times. Such limited immunity enables the individuals to tolerate severe malaria infection without getting ill even though they may get malaria fever [10, 11].

The explanation to such clinical presentations like fever, shivering & chills and responses to untreated malaria or treatment failures is a classical fever paroxysm, which may ensue every two or three days depending on the parasite species. This malaria pathogenesis leading to fever is due to rupturing of erythrocytic shizonts releasing their pyrogens in the blood [12].

Advanced studies on endogenous pyrogens by Dinarello, revealed them as subsets of cytokines that act on the thermoregulatory center in the hypothalamus to promote fever [11]. The body's thermostat becomes set at a higher point and the thermoregulatory center acts to keep the temperature at precisely this point. At the end of the fever paroxysm, the thermoregulatory center returns the body thermostat to normal set point, and the individual feels hot and perspires profusely until temperature has fallen accordingly. The subsets of cytokines that are thought to act on the hypothalamic thermostat in this manner include tumor necrosis factor (TNF), interleukin-1 beta (IL-1β), interleukin-1 (IL-1α), interleukin-6 (IL-6), interferon-α and lymphotoxin-α and macrophage inflammatory protein-1 [13]. The pyrogenic properties and roles of these cytokines in the pathogenesis of malaria fever have been well demonstrated in animal models by Dinarello [4]. Therefore, the significant correlation observed between parasite density and body temperature in this study demonstrates that

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Table 8: Area wise classification of malaria

| Residential Area | Plasmodium Falciparum | Plasmodium Vivax | Total positive cases |
|------------------|-----------------------|-----------------|---------------------|
| Slum Area        | 1682                  | 1089            | 2771                |
| Urban Area       | 493                   | 327             | 820                 |
| Total            | 2175                  | 1416            | 3591                |
the fevers are malaria induced rather than of other causes.

Conclusion
Our study proves that malarial infection has got direct relationship with average rainfall during monsoon. As well as water stagnation & accumulation plays a major role in mosquito breeding and subsequent spread of malaria. Poor sanitation in lower socioeconomic class has maximum number of malaria cases.

Recommendation
Our study on Malaria pattern wishes to create awareness at health sector level, municipal corporation level, panchayat level & individual level to take disciplinary action in monsoon season as well as government authority should find out the probable breeding sites of mosquitoes, slum areas, etc places which has to be cleaned regularly and water accumulation and stagnation should be avoided to prevent mosquito breeding. Individual awareness can create miracle, if we try to fight malaria at individual level we can win the fight against this common infection which can convert into serious life threatening infection.

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