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RESEARCH ARTICLE

MALARIA: AN EPIDEMIC IN ASSAM

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ABSTRACT

The study primarily deals with malaria disease and the scenario of malaria in the world as well as in India and Assam. The general symptoms of man suffering from malaria parasite are paroxysms of chills, fever, headache, pain and vomiting. The most important risk factors of malaria incidence are host and environmental factors. In Assam, both Plasmodium falciparum and Plasmodium vivax occur in abundance, but Plasmodium falciparum (the killer parasite) accounts for > 60% of the cases. . Malaria inflicts all months of a year in Assam, but it varies from time to time and place to place.

INTRODUCTION

Malaria is a life-threatening parasitic disease, originating in Africa and spreading as people migrated to other lands. The disease has got its name from an Italian word "mala aria" which means "bad air". Malaria was first discovered to be a parasitic disease in 1880 in Algiers by Laverran, a French Army Surgeon. The disease is caused by four species of Plasmodium pathogens, namely Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, and Plasmodium malariae. The general symptoms of man suffering from malaria parasite are paroxysms of chills, fever, headache, pain and vomiting. Fever is the first symptom. Several hours later, the fever drops and chills set in. Two to four days later, the cycle repeats. More serious forms of malaria can affect the brain and the kidneys. The length of time between the infective mosquito bites and the first appearance of clinical signs of which fever is most common is called incubation period. The period is usually not less than 10 days. The duration of the incubation period varies with the species of the parasite and in natural infections this is 12 days for Plasmodium falciparum, 14 days for Plasmodium vivax, 28 days for Plasmodium malaria and 17 days for Plasmodium ovale malaria. With some strains of Plasmodium vivax, the incubation period may be delayed for as long as nine months, this may also occur with other species in persons who have been taking suppressive antimalarial drugs. Progression of symptoms from initial fever to death can take as little as 24 hours.

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The symptoms of malaria can be non-specific and mimic other diseases like viral infections, enteric fever etc. Malaria should be suspected in patients residing in endemic areas or who have recently visited endemic area and presenting with above symptoms. All clinically suspected malaria cases should be investigated immediately by microscopy and/or Rapid Diagnostic Test (RDT). The malaria parasite undergoes two cycles of development - the human cycle (asexual cycle) and the mosquito cycle (sexual cycle). Man is intermediate host and mosquito the definitive host. The mode of transmission of malaria parasite to human is three types. First malaria is transmitted by the female Anopheles mosquito, one of the most capable vectors of human disease, from one host to another, which is called vector transmission. This was discovered by Ronald Ross in 1897, while he was working in Secunderabad (Andhra Pradesh, India) and a year later, in 1898, in Calcutta (now Kolkata). He received the Nobel Prize in 1902. The mosquito is not infective unless the sporozoites are present in its salivary glands. Secondly, malaria may be induced accidentally by hypodermic intramuscular and intravenous injections of blood or plasma, e.g., blood transfusion, which is called direct transmission. Blood transfusion poses a problem because the parasites keep their infective activity during at least 14 days in blood bottles stored at 4^0C. Persons who have lived in an endemic area and anyone who has had malaria should not be accepted as blood donor until three years afterwards. Thirdly, congenital infection of the newborn from an infected mother may also occur, but is comparatively rare. Its prevention and treatment have been targeted in science and medicine for hundreds of years. Since the discovery of the parasites which cause it, research attention

has focused on their biology, as well as that of the mosquitoes which transmit the parasites. For thousands of years, traditional herbal remedies have been used to treat malaria. The first effective treatment for malaria came from the bark of cinchona tree, which contains quinine. After the link to mosquitoes and their parasites were identified in the early twentieth century, mosquito control measures such as widespread use of DDT, swamp drainage, covering or oiling the surface of open water sources, indoor residual spraying and use of insecticide treated nets was initiated. Prophylactic quinine was prescribed in malaria endemic areas, and new therapeutic drugs, including chloroquine and artemisinins were used to resist the scourge.

Risk factors of Malaria incidence

The natural transmission of malaria depends on the presence of, and relationship between the three basic epidemiological factors: the agent, the host and the environment. However, the impact of these factors varies from time to time and place to place. From these, the most important risk factors are host and environmental factors. Host factors are age, sex, race, pregnancy, socioeconomic development, housing, population mobility, occupation, human habits, immunity etc. and environmental factors are season, temperature, humidity, rainfall, altitude and man-made malaria.

Malaria in world

Malaria is one of the most widespread diseases in the world. Malaria seems to have been known in China for almost 5,000 years. Sumerian and Egyptian texts dating from 3,500 to 4,000 years ago mention about fevers of malaria. It is belived that malaria reached the shores of the Mediterranean Sea between 2,500 and 2,000 years ago and northern Europe probably mainly between 1,000 and 500 years ago. By the beginning of the Christian era, malaria was widespread around the shores of the Mediterranean, in southern Europe, across the Arabian Peninsula and in Central, South and Southeast Asia, China, Manchuria, Korea and Japan. Malaria probably began to spread into northern Europe in the Dark and middle Ages via France and Britain. The growth in international trade in the sixteenth century contributed to the spread of diseases, as international traders introduced new sources of infection. Europeans and West African introduced malaria in the new world at the end of 15th century AD. Plasmodium vivax and Plasmodium malariae were possibly brought to the new world from South East Asia by early trans-Pacific voyages. Plasmodium falciparum probably reached the Americas through the African slaves brought by the Spanish colonisers of Central America. At first the Caribbean and parts of Central and South America were affected and from the mid 18th century, it spread across the North American continent. Over the next 100 years, malaria spread across the United States of America and Canada. At this time, malaria was common in Italy, Greece, London, Versailles Paris, Washington and even New York City.

Thus by 19th century, malaria reached its global limits with over one- half of the world's population at significant risk and 1 in 10 affected expected to die from it. During the past 100 years, nearly 150 million to 300 million people would have died from the effects of malaria, accounting for 2-5% of all deaths. In the early part of the century, malaria probably accounted for 10% of global deaths. At present malaria is a major public health problem in the tropical developing countries in the world. Malaria is endemic in 91 countries with about 40% of the world's population at risk. Each year malaria infects 300-500 million people and kills 1.5-2.7 million people (Park, 1997).The exact statistics are unknown because many cases occur in the rural areas where people do not have access to hospital. Consequently, many cases are treated at home and are not documented.

Malaria in India

Malaria is one of the major micro parasitic infections causing human mortality in many areas of the world including many areas of India, except in areas 5000 feet above the sea level. Long before the British colonized India, malaria was a serious problem for the country, imposing enormous economic costs and a great deal of human misery. Malaria epidemics occurred throughout India with varying intensity. In 1852, one malaria epidemic wiped out the entire village of Ula and then spread across the Bhagirathi River to Hooghly. The development of the Indian railways under the British administration contributed to the spread of malaria. While the construction of railway embankments provided a number of breeding sites for the malaria vectors, the labourers probably introduced different strains of the parasite to the areas in which they worked. The city of Mumbai suffered greatly from malaria epidemics. The construction of railroads or bridges was often associated with increases in malaria, probably due to imported labour from malarious areas. There were significant outbreaks of malaria during the construction of the Colaba causeway between 1821 and 1841 and during the construction of Alexander Dock. Malaria epidemics in Punjab and Bengal both show a startlingly high morbidity and mortality. In the early 1920s, Bengal suffered a severe malaria epidemic which resulted in over 730000 deaths in 1921 alone. Thereafter, the number of deaths from malaria slowly decreased to within 300000 to 400000 per annum. During the Second World War however malaria deaths rose again, particularly in 1943, when Bengal recorded over 680000 deaths and in 1944 when there were an appalling 763220 deaths from the disease. Historically, the highest incidence of malaria in India occurred in the 1950s, with an estimate of around 360 million population, every year around 75 million people suffered from malaria and approximately 800000 died from the disease.

DDT was first used in India by the armed forces in 1944 for the control of malaria and other vector borne diseases. In 1945, DDT was made available for civilian use in Mumbai to control malaria and produced some remarkable results within a very short period. Usefulness of DDT prompted the launch of the National Malaria Control Programme (NMCP) in 1953, resulted in a significant decline in the number of reported cases of malaria incidence. The problem of malaria was virtually eliminated in the mid sixties but resurgence led to an annual incidence of 6.47 million cases in 1976. Modified Plan of Operation was launched in 1977 and annual malaria incidence started declining. The cases were contained between 2 to 3 million cases annually till 2001 afterwards the cases have further started declining. Since then, confirmed cases have gradually decreased to 1.5 million cases and approximately 767 deaths in 2010 (Das *et al*., 2012). India's geographic position and climatic conditions had been, for long, favourable to the transmission of malaria. Now, it is becoming

even a greater problem than before. India accounts around 85% of the total reported cases in South-East Asia region in 1995. During 1996 also, India contributed 83% of total malaria cases in South-East Asia Region (Lal *et al*., 2004). As per WHO report 2010, India contributes about 70% of malaria in the South East Asian Region. NBVDCP (2012) reported that 90% of malaria cases in the country for the year 2011 were reported from 12 states namely Odisha, Jharkhand, Chhattisgarh, Maharashtra, Madhya Pradesh, Gujarat, West Bengal, Uttar Pradesh, Assam, Rajasthan, Andhra Pradesh and Haryana. Similarly, 90% of Plasmodium falciparum cases are reported from 8 states namely Odisha, Chhattisgarh, Jharkhand, Assam, Madhya Pradesh, Andhra Pradesh, Meghalaya and Maharashtra. Also, 90% of deaths in 2011 are reported by 9 states. Gujarat was the highest contributor (16.9 %), followed by Maharashtra, Madhya Pradesh, Odisha, Meghalaya, Assam, Rajasthan, Chhattisgarh and Mizoram. NE states contributed 13.09 % to Plasmodium falciparum cases, 8.69 % to total malaria cases and 21.51% to the deaths due to malaria reported in the country in 2011.

Another report of NVBDCP (2014-2015) revealed that during 2011, the malaria incidence was around 1.31 million cases, 0.67 million Plasmodium falciparum cases and 754 deaths; while during 2012, 1.01 million cases, 0.53 million Plasmodium falciparum cases and 519 deaths were reported. About 91% of malaria cases and 99% of deaths due to malaria are reported from high disease burden states namely North-eastern (NE) States, Andhra Pradesh, Chhattisgarh, Gujarat, Jharkhand, Karnataka, Madhya Pradesh, Maharashtra, Odisha, Rajasthan and West Bengal. However, other States are also vulnerable and have local and focal upsurge. During 2013, out of 0.88 million cases, 0.46 million Plasmodium falciparum cases and 440 deaths have been reported. During 2014 (till October), out of 0.85 million cases, 0.54 million Plasmodium falciparum cases and 316 deaths have been reported. Around two million laboratory confirmed cases of malaria are reported in India annually. As per NIMR records, the burden of malaria is generally higher in males than females in all age groups and children in the states like Assam, Arunachal Pradesh and Rajasthan had higher incidence of malaria than adults, whereas in the indo-gangetic plains the situation was reverse. Also, this study revealed that mortality across all ages was comparatively higher in males than in females and malarial deaths increased up to the age of 44 years in both the genders and then declined thereafter. Although the deaths in infants and children <14years of age accounted for 20.6%, in the higher ages (15–54 years), it accounted for 56.1% and the rest 23.3% were in >55 years of age. As a result, it may be concluded that most of the burden of malarial mortality was borne by the economically productive ages. The climatic diversity influences the distribution of vectors and species of malaria parasite; as a result, malaria in India takes a number of different forms, including forest/tribal malaria, rural malaria, urban malaria, malaria in project areas and border malaria.

Forest malaria: The disease is prevalent in the forests, forested foothill and hill, forest fringe areas. Due to indiscriminate exploitation, forests are now more accessible and the movements of population with low immunity into such areas result in malaria epidemics. Forest related malaria remains a serious problem causing 30% of all malaria cases in India.

Tribal malaria: About 44 million populations of tribal areas of Andhra Pradesh, Madhya Pradesh, Gujarat, Maharashtra, Bihar, Rajasthan, Odisha and North Eastern states are contributing about 50 percent of Plasmodium falciparum cases of the country. Infants, young children and pregnant women have been identified as malaria high risk groups followed by mobile tribal population engaged in forest-related activities. Limited health infrastructure and lack of drugs at village level are the factors responsible for high morbidity and mortality from malaria.

Rural malaria: These include irrigated areas of arid and semiarid plains of Haryana, Punjab, Western Uttar Pradesh, part of Rajasthan and Madhya Pradesh, plain desert areas and plain coastal areas of Odisha, Andhra Pradesh and Tamil Nadu. Malaria is of moderate to low endemicity. An. culicifacies is the main vector and Plasmodium vivax is predominant during lean period and Plasmodium falciparum during periodic exacerbation. In these the health infrastructure is moderately developed.

Urban malaria: 15 major cities including 4 metropolitans account for nearly 80 percent of malaria cases covered under urban malaria control scheme. The cities are Delhi, Bombay, Madras, Calcutta, Hyderabad, Bangalore, Ahmadabad, Bhopal, Jaipur, Lucknow, Chandigarh, Vadodara, Vishakhapatnam, Vijayawada and Kanpur. This covers about 42.39 million populations. Important features of malaria are moderate to low endemicity with Plasmodium vivax predominance and focal Plasmodium falciparum transmission. Anopheline culicifacies is the main vector. The health infrastructure is well developed. In semi-urban areas malaria situation is influenced by poor sanitary conditions and low socio-economic groups living in unplanned settlements prone to periodical epidemics.

Malaria in project areas: Project areas are those areas where construction and developmental activities are taken up and temporary tropical aggregation of labour takes place bringing in different strains of malaria parasite and non-immune population. These results in disturbance in eco-system, prolific increase in vector breeding places and increased man-mosquito contact favouring high malaria transmission. These pockets contribute a large number of malaria cases, which are highly disproportionate to the relatively small population groups inhabitating the area. One or more major vectors are involved in malaria transmission. A limited health facility for prompt treatment is invariably associated with chloroquin resistant malaria parasite. Hence specific control strategy is required for such areas.

Border Malaria: These are the high malaria transmission belts along the international borders and state borders. These areas have their own problems in regard to malaria control because of mixing of population and poor administrative control. The two major human malaria species in India are Plasmodium falciparum and Plasmodium vivax; Plasmodium malariae has been reported in the eastern India state of Odisha (Sharma *et al*., 2000) and Tumkur and Hassan districts of Karnataka (Park, 1997), while Plasmodium ovale appears to be extremely rare if not absent. Intriguingly, the two major infecting species vary in proportion across India. Historically, Plasmodium vivax, has been the primary pathogen responsible for malaria (Park, 1997). But, Das *et al*. (2012) suggested that over the past several years Plasmodium vivax cases have

decreased: the ratio of Plasmodium falciparum versus Plasmodium vivax malaria was 0.60 in 1995, gradually increasing to 1.2 in 2009. There are about 400 species of anopheline mosquitoes throughout the world, but only 60 species are vectors of malaria (Lal *et al*.). In India, out of about 45 species of anopheline mosquitoes, only a few are regarded as vectors of primary importance. These are Anopheline culicifacies, Anopheline fluviatilis, Anopheline stephensi, Anopheline minimus, Anopheline philippinensis, Anopheline sundaicus and Anopheline maculates. The vectors of major importance are Anopheline culicifacies in rural areas and Anopheline stephensi in urban areas (Park, 1997). In the absence of a vaccine, vector control is the only practical approach to malaria control.

Malaria in Assam

Assam is the most populous (27.85 million) and area wise second largest (78,523 km^2) of the eight states in the north eastern region of India. It is bounded by the hill states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura and shares an international border with Bhutan and Bangladesh. It is a place with lot many geographic variations. Most areas/districts in the state (Assam) have heavy rainfall, ranging from 2 to 3 meters and floods occur annually in some districts like Lakhimpur, Dhemaji etc. Minimum precipitation associated with monsoon occurs from May to September and is preceded by pre-monsoon showers in March and April. The relative humidity ranges from 60% to 85%. Temperatures range from 10^0C to 26^0C in winter (Nov- Feb) and from 23^0C to 33^0C throughout rest of the year (Dev *et al*., 2004). At present malaria is a major public health concern in the northeastern states of India. In case of Assam also, it is regarded as one of the major epidemics in the region. The annual reports provide evidence that the magnitude of malaria across Assam is high and varies with location. It contributes more than 5% of the total cases recorded in the country annually.

In Assam, both Plasmodium falciparum and Plasmodium vivax occur in abundance, but Plasmodium falciparum (the killer parasite) accounts for > 60% of the cases (Dev *et al*., 2004 &Dev *et al*., 2006). Similar observation was also reported by Pal-Singh-Pardal *et al*. (2009). According to 2012 annual report of NVBDCP (2012), approximately 72% and 73% of the total malaria cases were estimated to Plasmodium falciparum cases for the year 2010 and 2011 respectively. But, some particular areas of Assam (e.g. Nagoan district) were found having more Plasmodium vivax cases than Plasmodium falciparum cases (Gupta *et al*., 2014). Almost all districts of Assam report malaria attributable morbidity and mortality every year, and are vulnerable to focal outbreaks of the disease. Every death reported to have been due to malaria was confirmed to have been associated with a Plasmodium falciparum infection. Approximately 36 and 45 people died in malaria in the year 2010 and 2011 respectively (NVBDCP, 2012). Resistance to chloroquine in Plasmodium falciparum was first detected in the Karbi Anglong District, Assam in 1973. Chloroquin resistant malaria is widespread in the state, and decreased sensitivity to other anti-malarials has been documented. One hundred three of 156 primary health centers in Assam are identified as being high risk for malaria based on the selected epidemiologic criteria, and nearly 65% of the total population of the state is estimated to be living in high-risk areas (Dev *et al*., 2004). Amongst the species of Anophelines, Anopheline minimus and Anopheline dirus, the major vector of malaria in North-eastern region of India (Das *et al*., 2007), but in Assam Anopheline minimus was most abundant (Dev *et al*., 2004 & Dev *et al*., 2006). Interestingly, another study for Sonitpur district of Assam has resulted in a different report. This study captured seven species namely Anopheles annularis, Anopheline culicifacies, Anopheline dirus, Anopheline fluviatilis, Anopheline minimus, Anopheline philippinensis (Anopheline nivipes) and Anopheline varuna at varying densities depending on season. Of these, Anopheline philippinensis was found to be more predominated specie than other species (Baruah *et al*., 2007). Districts bordering other states in the northeastern region or countries including Bhutan and Bangladesh, and population groups living close to the border/forest fringe are at a greater risk of focal outbreaks due to inadequate health infrastructure and lack of coordinated vector control operations (Dev *et al*., 2015). The disease is unevenly distributed across the state and associated with varying intensity of malaria transmission and risk factors. Malaria is a disease which is incident in all the seasons of a year but the incidence peaks during May - June, which corresponds to the month of heavy rainfall (Dev *et al*., 2004).

Concluding Remarks

Malaria is serious health problem in of Assam. Malaria inflicts all months of a year in Assam, but it varies from time to time and place to place. In other words, temporal and spatial factors play an important role in incidence of malaria. It is observed that the areas sharing with interstate border has many more cases compared to those sharing inter districts border. These borders are highly porous and health care facility is very poor. The highest malaria incidence occurs during the monsoon season.

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