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Epidemiology, Prevention, and Treatment of Malaria

Muqaddas Saqib[1], Warda Qamar[2*], Rafia Gulnaz[1]

1. Department of Pharmacy, University of Agriculture Faisalabad
2. Department of Parasitology, University of Agriculture, Faisalabad

*Corresponding Author: **wardaqamar17@gmail.com**

ABSTRACT

A protozoal infection causes malaria. It primarily spreads to people when a female Anopheles mosquito bites them. Other reasons malaria spreads through are contaminated instruments and transfusions of blood. Human malaria is caused by five plasmodium parasite species. These species consist of *Plasmodium knowlesi*, *Plasmodium malariae*, *Plasmodium vivax*, *Plasmodium falciparum* and *Plasmodium ovale*, Both *P. vivax* as well as *P. falciparum* are extremely dangerous. Malaria is most frequently characterized by a high body temperature, headache, and shivers. During a week or two after having been bitten by an anopheles mosquito that is infected, symptoms typically appear. Malaria of some varieties can result in serious disease and even death. High risk groups include newborns, kids under 5, pregnant mothers, and HIV-positive individuals. Malaria's serious signs include great exhaustion, loss of consciousness, numerous convulsions, breathing difficulties, and irregular bleeding. By using mosquito nets when sleeping in malaria-prone locations, icaridin-containing insect repellant, coils and vaporizing devices, protective clothing, and screens for windows can all lower the risk of contracting the disease. Early discovery and treatment can lower the risk of illness and stop fatalities. There are numerous antimalarial medications available for the management of malaria. These medications include artemisinin-based combination treatments, the most popular of which being artemether-lumefantrine. For P. vivax infections, chloroquine is advised, and primaquine can be suggested to prevent *P. ovale* as well as *P. vivax* parasite infections from relapsing.

Introduction

The protozoan illness malaria is spread to people by female Anopheles mosquitoes. *P. knowlesi, P. malariae, P. ovale, P. vivax*, and *P. falciparum* are the five species of the unicellular protozoa parasite genus Plasmodium that are responsible for this disease. A significant number of malaria deaths are caused by *P. falciparum*, which is also the most common species in Sub-Saharan Africa. The capability of Plasmodium falciparum to interfere with its host's physiology while in the blood throughout its life cycle makes it the most lethal form of the human malaria parasite. It has a 7 to 14-day time frame for incubation (the interval between being exposed to an infection and the onset of symptoms). *P. vivax* is known as the most common and extensively spread plasmodium parasite responsible for recurrent malaria because it possesses special characteristics that assist in its continued existence in a variety of ecologies and climates. It is less dangerous than *P. falciparum* but it has the ability to form dormant liver-stage infections called hypnozoites, which can be reactivated and cause malaria relapse weeks, months, or even years after initial infection that make *P. vivax* more problematic to control and eradicate comparatively speaking to other sorts of malaria. it has an incubation period of 12 to 17 days but it can be a lot longer, months or years in some cases due to longer liver stage. *P. malariae* has incubation period of 18 to 40 days that is longer than the incubation period of other species of plasmodium. *P. ovale is another species of parasitic protozoa that cause malaria in humans. It is primarily found in west and central Africa and has incubation period of 12 to 18 days. Like P. vivax, P. ovale also exhibits hypnozoites stage so its incubation period can be longer. P. knowlesi*, in particular, causes zoonotic malaria in monkeys it rarely result in disease in humans (1).

Malaria parasite life cycle:

When a person is bitten by a contaminated Anopheles mosquito (female), plasmodium parasites can be injected into him in the form of sporozoites. Once the parasite enters the body, it will move to the liver and cause malaria. Merozoites, the parasite's reproductive form, are released from liver cells and travel in sacs through the heart and the lungs before settling in lung capillaries. Eventually, the vesicles will separate, enabling the merozoites to enter the bloodstream. For the next 7 to 10 days, sporozoites multiply asexually within the liver without producing any symptoms. When the merozoites enter red blood cells (erythrocytes), the cells rupture and the merozoites dwell and proliferate in the bloodstream. They then infect other erythrocytes, and the cycle is repeated, resulting in fever each time the parasites escape free and infect blood cells (2).

Because certain contaminated red blood cells break this cycle of asexual proliferation, the merozoites in such cells will mature into the sexually active form of the parasite known as **gametocytes**, which flow in the blood stream, rather than replicating. An infected person bites a mosquito, which then consumes the gametocytes, which developed into gametes, or mature sex cells. The female gametes (eggs) that have been fertilized become rapidly motile ookinetes that pierce the midgut wall of mosquitoes and mature into **oocysts** on the outside of the insect. Many thousands of viable sporozoites grow inside the oocysts. Eventually, the oocysts burst, sending sporozoites into the mosquito's bodily cavity and onto its salivary glands. When a mosquito bites a different individual, the vicious circle of human disease starts over (3).

Other mode of transmission:

Due to the fact that the parasites responsible for malaria target red blood cells, people can also contract the disease through coming into contact with contaminated blood, including blood that has been transfused or that has been injected with medications, sharing needles, and from mother to fetus (4).

Risk factors:

Living or traveling in tropical and subtropical regions of Pacific islands, Asia (south and southeast), Africa (Sub-Saharan), Central America, and northern South America pose a significant risk for contracting malaria. The danger of disease prevalence and ease for propagation is increased in these areas by the existence of water bodies, such as marshy terrain, open canals, and deserted pool areas, as well as by the warm climate, expanding urbanization, and high people density. Complete travel advice is provided by the Centers for Disease Control for these regions. Some persons, such as small children, pregnant women, and people who originate from regions where malaria is uncommon, may have a significant risk of sickness because their immunity seems to be weakened. By staying in air-conditioned accommodations, avoiding camping by still water, wearing body-covering clothing, using insect repellant, and sleeping under bed nets that have been treated, travelers can lessen their risk of getting bit by mosquitoes (5).

Epidemiology:

Early diagnosis may be able to manage and treat malaria within some areas. But many counties lack the resources necessary to conduct efficient screening. The number of malaria cases worldwide increased from 245 million in 2020 to 247 million in 2021, according to the most recent reports. In 2021, 619000 malaria fatalities are anticipated, down from 625000 in 2020. Although malaria is increasingly uncommon in the United States, about 2000 cases are still diagnosed annually, usually among travelers returning from countries where it is still widespread. a WHO Africa continues to bear a significant portion of the burden of malaria worldwide. 95% of the total cases of malaria and 96% of the deaths caused by malaria in 2021 occurred in the region. 80% of malaria

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deaths within the area were where the children were under the age of five. Just over half of malaria deaths globally occurred in four African countries: Nigeria (31.3%), the Democratic Republic of the Congo (12.6%), the United Republic of Tanzania (4.1%), and Niger (3.9%) (6).

Symptoms:

Malaria's primary early symptoms and indications are a high body temperature, headache, and chills. Following 10-15 days of having been bitten by an anopheles mosquito with an infection, symptoms typically appear. For some people, particularly those who have previously had malarial illness, symptoms may be minor. Malaria occasionally causes serious sickness and even death. The risk is higher for newborns, kids, pregnant women, and those with weakened immune systems. Severe symptoms include extreme fatigue, loss of awareness, multiple seizures, breathing issues, black or bloodshot urine, jaundice (liver condition leading to yellowing of eyes and skin), and unusual bleeding. Malaria may cause burst of spleen, harm the kidneys, or lead the liver or kidneys to become damaged. Brain swelling or stroke may result from small blood arteries to the brain being blocked by parasite-filled blood cells (cerebral malaria). Latency or mortality may follow from cerebral malaria. Pulmonary edema, in which fluid accumulates on the lungs, can be brought on by malaria (7).

Recurrent malaria:

After varied amounts of time without symptoms, malaria symptoms can return. Depending on the cause, recurrence might be classified as revival, resurgence, or reactivation. Recrudescence, or the reappearance of symptoms after a spell without them, is brought on by parasites that lingered in the blood mostly as a result of inadequate or ineffective treatment. Relapse occurs when symptoms return once the parasites were successfully removed from the blood, and the source of the recurrence is active parasites that had been present in liver cells as latent hypnozoites. Relapse often happens after 8 to 24 weeks. It is frequently observed in *P. vivax* and *P. ovale* infections. However, hypnozoite activation may have been more than-attributed to relapse-like *P. vivax* recurring events. Some of these could represent extra-vascular or merozoite origins, which would classify those recurrences as recrudescence rather than relapses. Erythrocytic variants within the bone marrow and spleen are recently recognized, non-hypnozoite, potential causative factors to repeated peripheral P. vivax parasitemia. Relapses of *P. vivax* malaria typically begin a year after the initial insect bite in temperate locations because hypnozoites overwinter there. Reinfection occurs when the parasites that caused the previous infection were removed from the human system, yet a new parasite (or parasites) has been introduced. While recurrence of malaria infection over two weeks following therapy for the initial malarial symptoms is often associated with unsuccessful treatment, reinfection cannot be easily differentiated from relapse and recrudescence. But doing this is not necessarily correct. People may develop some immunity when exposed to frequent infections (8).

Diagnosis:

An early diagnosis is crucial for malaria recovery. Anyone experiencing symptoms should consult a physician as soon as feasible. A **full blood count** to check for hemoglobin (anemia), rapid diagnostic testing (**RDT**) for parasites, that may give results in 2 to 15 minutes, and microscopic analysis of blood cells are among the blood tests recommended for the correct diagnosis of malaria. RDT test kits are only accessible through laboratories. Recent developments in malaria molecular diagnostics have made **PCR**-based approaches one of the most accurate and sensitive methods for diagnosis. Although PCR can be used to identify drug-resistant parasites and mixed diseases, it is not frequently employed in underdeveloped nations due to the testing's complexities and a lack of funding. The **LAMP** approach is a quick and low-cost molecular diagnostic test for malaria that finds P. falciparum's conserved 18S ribosomal RNA genes. Compared to PCR, LAMP seems to be simpler, more sensitive, faster, and less expensive. To validate the viability, additional clinical investigations and assays that require refrigeration are needed (9).

Prevention from malaria:

Avoiding mosquito bites and using medications like chemoprophylaxis before visiting locations where malaria is prevalent can both help prevent the disease. Use nets to repel mosquitoes when sleeping in malarial areas, DEET, IR3535, or picaridin insect repellents after nightfall, coils and vaporizers, window screens, and protective clothing to reduce the risk of mosquito bites. Vector control is another malaria prevention strategy. It is essential to the prevention and eradication of malaria. Insecticide-treated nets and residual spraying indoors are the two main therapies, although they are ineffective at preventing malaria because to lack of availability and net degradation from daily pressures outpacing replenishment. To stop malaria A few weeks prior to departure, patients should counsel their doctors about traveling to endemic areas. They will advise on the best chemoprophylaxis medications. These medications may need to be begun 2 to 3 weeks prior to travel. In order to supplement continuing malaria prevention efforts, such as vector control measures, rapid detection of suspected malaria, and the therapy of reported cases with antimalarial drugs, preventive chemotherapy practices like intermittent malaria prevention in pregnancy, seasonal malaria chemoprevention, perennial malaria chemotherapy and school-aged children, post-discharge malaria chemoprevention, and mass drug administration have been developed (10).

Treatment of malaria:

Early malaria detection and therapy reduce transfer, lessen illness, and reduce mortality. Based on the kind of plasmodium that causes malaria, if the malaria is drug-resistant, the body mass index or age of the individual who is infected with malaria, and whether or not the person is pregnant, different medications are employed for the prevention and treatment of malaria. Chloroquine, primaquine, artemisinin-based therapy, hydroxychloroquine and atovaquone-proguanil are the medications against malaria that are used the most frequently. The most successful medications are typically those based on artemisinin, such as artemether-lumefantrine. Only in regions where the P. vivax parasite is still susceptible to this medication is chloroquine advised for the therapy of infection caused by this parasite. To avoid recurrences of *P. vivax* and *P. ovale* infections, primaquine ought to be given to the primary treatment. Although most medications are taken as pills, some are also accessible as injectables. Since October 2021, WHO has advised children living in areas with medium to severe falciparum malaria transmission to receive the RTS, S/AS01 malarial vaccine in large doses. It has been demonstrated that the vaccine greatly reduces malaria, particularly lethal serious cases of malaria in young infants (11).

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