MALARIA

ABSTRACT

Malaria is one of the oldest documented parasitic diseases spread by bites of infected female *Anopheles mosquitoes*. Malaria is a major problem in tropical and subtropical regions across the world. It may show serious consequences and become fatal if untreated. Mosquito bites spread parasites, which cause illness by rupturing red blood cells after multiplication in the liver. Pregnant women, children, and tourists visiting endemic regions are at high risk. It is essential to take preventative actions to decrease transmission. These include avoiding mosquito bites, using bed nets sprayed with insecticide, and taking drugs that prevent malaria. Blood tests may be used to diagnose malaria, and treatments differ depending on the kind of malaria and the degree of infection. The presented chapter focuses on epidemiology, risk factors, life cycle, diagnosis, prevention, and control of malaria.

Authors

Himani Karnwal
Post Graduate Institute of Medical Education & Research, Chandigarh.

Anil Bansal
RIMT University, Punjab.

Himanshi Thakur
Motherhood University, Roorkee.

I. INTRODUCTION

Malaria is an infectious illness transmitted by female *anopheles mosquitoes* that affects vertebrates. Human malaria manifests symptoms that often include fever, tiredness, emesis, and cephalalgia (Headache). In extreme instances, it may result in jaundice, convulsions, coma, or fatality. Symptoms typically manifest 10 to 15 days after a bite of an infected mosquito. If inadequately addressed, individuals may have recurrences of the illness within a few months. In those who have recently recovered from an illness, reinfection often results in less severe symptoms. This partial resistance diminishes over months to years in the absence of ongoing exposure to malaria.

Historical Background

- In 1880, Alphonse Laveran discovered *plasmodium* in the RBCs of a patient in Algeria
- In 1897, Sir Ronald Ross described the sexual cycle of the *plasmodium* parasite in female *anopheles* mosquito.
- Ms TuYouyou discovered artemisinin (extract of plant sweat warm wood) which malaria parasite and use to cure falciparum malaria.
- In 1902, Alphonse Laveran and Sir Ronald Ross got the Nobel prize for their contribution in malaria. [1]

Ms. TuYouyou

Tu Youyou (born December 30, 1930) is a Chinese scientist and pharmacologist renowned for her groundbreaking work in the field of malariology. She is credited with the discovery of Artemisinin and Dihydroartemisinin, two critical drugs used in the treatment of malaria, which have saved millions of lives globally. For her significant contributions to medicine, Tu Youyou was awarded the Nobel Prize in Physiology or Medicine in 2015. [2]

Malaria Parasite Transmission

Parasites are the culprits behind the spread of malaria. Transmission occurs only via the bites of infected female *Anopheles mosquitoes*. The mosquito bite

transmits *plasmodium* from infected to healthy individuals. Via blood circulation, parasites go to the liver, where they replicate & mature. People infected with malaria often experience severe illness, including a high fever, chills, and trembling. [1]

Epidemiology: Although the illness is rare in temperate regions, malaria remains prevalent in tropical and subtropical nations. Annually, around 290 million individuals get malaria, resulting in over 400,000 fatalities from the illness. World health organization's supply prophylactic medications and insecticide-treated bed nets to mitigate malaria infections and shield individuals from mosquito bites. The World Health Organization has approved a malaria vaccine for administration to children residing in countries with elevated malaria incidence**.** [3]

Symptoms of Malaria: Fever, Chills, feeling of discomfort, Headache, Nausea, Vomiting, Diarrhoea, Abdominal pain, Muscle or joint pain, Fatigue, Rapid breathing, Rapid heart rate, Cough etc are general symptoms. A person with severe malaria may go through episodes of the disease called "attacks."Benign malaria is mild and caused by all *Plasmodium species.* While malignant malaria is severe& caused by *P. falciparum*. *P. falciparumhas* sequestering ability in deep vessels of internal organs (Kidney, brain etc). This results visceral hypoxia, congestions etc. Benign malaria is characterized by intermittent fever, splenomegaly & anaemia. [4]

Type of Malaria	Plasmodium Species	Onset of Fever	Other Clinical Manifestations	References
Uncomplicated Malaria	*Plasmodium falciparum*	Fever typically appears every 48-72 hours, often paroxysmal (i.e., sudden and intense)	Chills, sweating, headache, muscle aches, fatigue, nausea, vomiting	WHO. (2023). Malaria. WHO Malaria Facts [5,6,7]
		Fever spikes coincide with synchronous release of merozoites from red blood cells		CDC. (2023). Malaria. CDC Malaria Overview [5,6,7]
Severe Malaria (Malignant Malaria)	*Plasmodium falciparum*	Fever onset can be sudden and high, with chills and sweating	Cerebral malaria (confusion, seizures), severe anemia, respiratory distress,	

			jaundice, hypoglycemia, multi-organ failure	
Benign Tertian Malaria	*Plasmodium vivax, Plasmodium ovale*	Fever typically occurs every 48 hours (tertian pattern)	Fatigue, malaise, mild anemia, enlarged spleen (splenomegaly), occasional jaundice	WHO. (2023). Malaria. WHO Malaria Facts [5,6,7]
Quartian Malaria	*Plasmodium malariae*	Fever occurs every 72 hours (quartian pattern)	Low-grade fever, mildanemia, splenomegaly, jaundice	CDC. (2023). Malaria Overview. CDC Malaria [5,6,7,8]
Relapsing Malaria	*Plasmodium vivax, Plasmodium ovale*	Fever recurs after months to years, typically triggered by stress or immunosuppression	Splenomegaly, periodic fever spikes, malaise, fatigue	
Chronic Malaria	*Plasmodium malariae*	Fever is typically low-grade and can last for weeks to months	Mild anemia, splenomegaly, recurrent fever at low intensity	

Life Cycle of Malaria Parasite (*Plasmodium*)

The lifecycle of Malaria starts, when female *Anopheles mosquito* injects sporozoites into the skin of the healthy individual. In all *Plasmodium* species, parasites mature in the liver parenchymal cells to become schizonts (multinucleate stage of asexual reproduction), from where thousands (2000 to 4000) of merozoites arise. [9,10] In *Plasmodium vivax* and *Plasmodium ovale*, a subset of liver-stage parasites, referred to as hypnozoites, stay quiescent inside the hepatocytes. During this phase, the parasite may inactive for prolong time. Upon the rupture of liver cells, merozoites release into the circulation, where they swiftly enter in red blood cells. In RBC, *Plasmodium* consumes Hb. and develops into immature trophozoites (ring form) & then gametocyte (mature trophozoites). Trophozoites replicate to forms schizonts that disurpts RBCs. The clinical manifestation of Malaria is associated with ruptured erythrocytic schizont stage. [11,12] In malignant malaria, parasitized RBCs may obstacle capillaries and venules resulting local hypoxia. Obstacle of the microcirculation in the nervous system (cerebral malaria) and in other organs may cause severe complications. If vector *anapheles mosquito* ingests gametocytes through blood meal, the gametocytes perpetuate the transmission cycle to the mosquito.

Gametocytes develop in the mosquito gut to gametes, which undergo fertilization and mature in 2 to 3 weeks to sporozoites. Sporozoites subsequently migrate to the salivary glands of the female *Anopheles mosquito,* poised to perpetuate the transmission cycle to humans. [1]

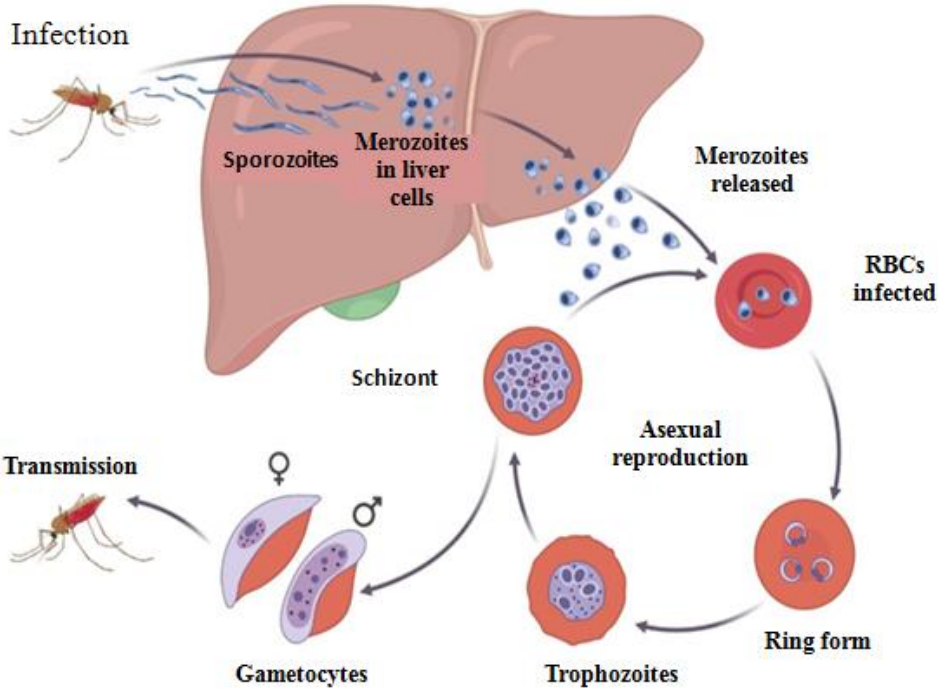

Figure 27: Life Cycle of Malaria

Prevention of Malaria

In regions where malaria is prevalent, protective measures are used to prevent mosquito bites. Mosquitoes exhibit peak activity from twilight to morning. The following preventive measures are important for malaria.

- Wear long-sleeved shirts and pants to reduce exposed skin.Tuck your shirt in, and tuck the pant legs into your socks to avoid mosquito bites.Wear light-colored clothing, since mosquitoes are drawn more by dark colors.
- Use of insect repellent cream like DEET, Picaridin, IR3535 etc prevent mosquito bites and reduce risk of malaria.
- Avoid using a spray directly on your face. Do not use products containing lemon eucalyptus oil (OLE) or p-Menthane-3, 8-diol (PMD) on children under the age of three.

- Sleep under insecticide-treated bed nets (ITNs) to prevent mosquito bites, especially while sleeping at night when mosquitoes are most active.
- Apply repellent to clothing. Sprays containing permethrin are safe to apply to clothing.[1, 13]

Laboratory Diagnosis of Malaria

Malaria diagnosis entails identifying malaria parasites or their antigens within a patient's blood. Delayed diagnosis is one of the major contributors to delayed treatment & even death in many regions. Diagnosing the disease may be challenging in areas where malaria is no longer prevalent, especially for healthcare providers who are not familiar with the diagnosis of this disease. Clinical diagnosis relies on the patient's signs and symptoms and physical findings during examination. General laboratory findings in malaria are –

- Parasite appears microscopically in stained thin & thick blood pictures
- Leukopenia with high monocyte count at afebrile stage
- Normocytic normochromic anemia with immature nucleated RBCs in blood smear
- Normocytic hypochromic anemia in chronic cases
- Basophilic stippling in Erythrocytes [14, 15]

II. CONCLUSION

In regions where malaria is prevalent, it continues to pose a serious threat to the health of those who are already vulnerable. The efficient control of the sickness requires a combination of interventions, including as immunization programs, preventative medication, and insecticide-treated bed nets. Rapid diagnosis and effective treatment are of the utmost importance in reducing mortality and morbidity caused by malaria. International funding for healthcare infrastructure, education, and research must be maintained throughout the battle against this disease and, ultimately, its eradication. If we can overcome the challenges that malaria poses, we can improve the health of millions of people and their quality of life.

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