Malaria

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Transmission
Malaria is an infectious disease usually transmitted through the bite of a female *Anopheles* mosquito and caused by parasitic protozoans. There are 30 important malaria vectors and most of these vectors bite between dusk and dawn. When the mosquito bites its victim, the parasites are transported to the liver. In the liver, these parasites mature and reproduce. The intensity of transmission is dependent on the human host, the environment, the vector and the parasite. *Anopheles* mosquitoes lay their eggs in water, the eggs later hatch into larvae and develop into adult mosquitoes. In regions where mosquitoes live long, transmission is more intense. Most of the malaria cases occur in Africa due to the long lifespan of the African vector species. Climatic conditions such as rainfall patterns, temperature and humidity also impact transmission. Transmission may be seasonal with peak transmission occurring immediately after the rainy season. Human immunity also impacts transmission. Individuals are able to develop partial immunity after years of exposure. Malaria might also be transmitted through blood transfusions and organ transplants (1).

Reservoirs
Humans are the main reservoir for the type of malaria that is infectious to humans. Children have the highest parasite and gametocyte densities and as a result make up a larger proportion of the infectious reservoirs (7). In addition, Macaque monkeys also transmit a form of malaria that is infectious to humans (2).

Etiological agent and historical information
*Plasmodium* is the etiologic agent for Malaria. *Plasmodium falciparum, Plasmodium malariae, Plasmodium ovale, Plasmodium vivax* and *Plasmodium knowlesi* are the main *Plasmodium* species infectious in humans. The parasite responsible for *Plasmodium falciparum* has been in existence for over 50,000 years (1). There is also some evidence indicating that *Plasmodium falciparum* originated in gorillas. The name malaria is of Italian origin; *mala aria* meaning bad air. Malaria was originally called marsh fever because of its association with stagnant water bodies such as marshlands and swamps. The earliest record of the name malaria in English literature is from 1829 (3).

Characteristics and tests for identification
The parasitic protozoans causing malaria belong to the family Apicomplexa, genus *Plasmodium*. There are several different species that are infectious to humans. *Plasmodium falciparum* is the most lethal form of malaria. *Plasmodium falciparum* develops quickly in its victim and can result in severe complications, however, with quick medical intervention, this infection is usually treatable. Of all the species, *Plasmodium vivax* is the most geographically widespread and can cause a relapse for up to 3 years after infection. *Plasmodium knowlesi* is least prevalent in humans. Malaria is usually diagnosed by using blood films or antigen-based rapid diagnostic tests to microscopically examine the blood. When blood smears are used to test for malaria, a Giemsa stain is usually used and observed under 100X oil immersion. It is possible to observe the characteristic ring shape evident in the early trophozoite form of *Plasmodium* in red blood
cells. A less widely used technique involves using polymerase chain reaction (PCR) to identify the parasite’s DNA (4).

**Signs and Symptoms**

Patients typically experience malaria signs and symptoms 8-25 days after infection. However, individuals who take antimalarial medications as prevention may experience symptoms later. Flu-like symptoms, vomiting, headache, joint pain, fever, jaundice and hemolytic anemia are some of the symptoms of malaria. Paroxysm which involves abrupt coldness and shivering followed by fever and swelling is one of the most common symptoms of malaria. Paroxysm occurs every three days in *Plasmodium malariae* patients and every two days in *Plasmodium ovale* and *Plasmodium vivax* patients. In addition, *Plasmodium falciparum* infection may result in recurrent fever every 38 hours. Individuals who have cerebral malaria display neurological symptoms such as abnormal posturing, conjugate gaze palsy and nystagmus (1).

**Virulence Factors**

The mechanisms that contribute to the disease process of the *Plasmodium* species are their ability to carry out antigenic variation of surface proteins and the release of malaria toxins. The malaria toxins made during the erythrocytic cycle create the inflammatory response. *Plasmodium falciparum* is the most dangerous species because it replicates rapidly in the blood and also infects red blood cells, changes their shape and causes sequestration which may cause oxygen deprivation. Blockage of microcirculation by parasitized red blood cells results in various complications such as renal failure and cerebral malaria (5).

**Control/Treatment**

The most effective treatment for *Plasmodium falciparum* is artemisinin-based combination therapy. Before administering treatment, the World Health Organization recommends testing using parasite diagnostic testing which can be confirmed in less than 30 minutes. It is important to confirm the disease before administering treatment to prevent increasing drug resistance. Fast acting artemisinin-based compounds are used with a companion drug from a different class. These drugs include mefloquine, lumefantrine etc. Vector control is the most effective way to control malaria transmission. It involves the use of Insecticide-treated mosquito nets, indoor residual spraying and treating stagnant water bodies with larvicides (1).

**Vaccine/Prevention**

The most effective way to prevent malaria is through vector control. Insecticide-treated mosquito nets are the preferred method encouraged by the World Health Organization. It is important to ensure that people at risk or malaria sleep under a treated and well maintained mosquito net every night. Indoor residual spraying with insecticides is another effective method for preventing malaria transmission. For the most effective use of this technique in a community, at least 80% of the houses have to be sprayed. Spraying is efficient for 3-6 months depending on the insecticide formulation. Antimalarial drugs are also used to prevent malaria. Chemoprophylaxis suppresses the blood stage of malarial infections and is mostly used by travelers. Sulfadoxine-pyrimethamine is used by pregnant women at antenatal visits after the first trimester. There currently is no effective vaccine for malaria. Mosquirix which is an injectable vaccine that provides partial protection against malaria is currently being developed and evaluated on individuals in sub-Saharan Africa (1).
Current Outbreaks
Most of the malaria cases in the United States occur in recent travelers. In 2011, there were 1925 malaria cases which is the highest number in recent years. There were 63 outbreaks of locally transmitted mosquito-borne malaria between 1957 and 2015. Worldwide, there were 216 million clinical episodes of malaria and 445,000 deaths in 2016. Of these deaths, it is estimated that 91% of them occurred in Africa (8).

Bibliography