

Malaria Control and Prevention: A Global Perspective**Introduction:**

Historical Background: Malaria is one of the oldest diseases known to man. It is believed that it may have infected humans for 50000 years, and to have been a human pathogen through this entire period (1). Historians and archaeologists have found evidence of the disease's existence in the Xian Dynasty and Medieval Europe (2). The linguistic origin of the word "malaria" stems from medieval Italian "Mala aria" meaning "bad air", since it was believed to be caused by putrid marsh air (3).

The parasite of malaria was first viewed inside red blood cells by a French doctor working in the army stationed in Algeria in 1880, his name was Charles Laveran. Laveran was also the first to propose the notion of protozoa as causes of disease. He later received the Nobel Prize for his discovery. In 1898, proof that malaria was transmitted by mosquitoes was finally established by Sir Ronald Ross, a physician in the British army in India. He was able to isolate the malaria parasite from the salivary glands of mosquitoes that bite malaria infected birds and then transmit the parasite to healthy birds. Sir Ross won the Nobel Prize in 1902.(4)

The process of control and prevention of malaria in the United States began in 1914, when the US Public Health Service (USPHS) petitioned the Congress for funds for anti-malaria efforts. The funds granted to the service were used to establish malaria control activities all over the US and even the military bases located in high risk regions in the southern US to ensure continuous training of soldiers in those areas.(5)

Epidemiology:

According to the World Health Organization (WHO), malaria causes 300 to 500 million illnesses and one million deaths worldwide every year. Most of these are among children less than 5 years old. This puts 40 percent of the world's population at risk (6) . Developing countries are hardest hit, especially sub-Saharan Africa, South and Southeastern Asia, Oceania and Haiti, where *P.falciparum* malaria prevails. *P.vivax* is prevalent in India, the middle east and Central America. Though much less frequent in the United States, malaria cases do occur. According to the Centers of Disease Control and Prevention (CDC), 1337 malaria cases were diagnosed in 2002, almost all of which were linked to travel to endemic areas (7) . Since 1986 , only one outbreak of malaria occurred in the US. This was in west palm beach, florida, in 2003, where seven cases of vivax malaria were diagnosed in unexposed individuals. (8)

There is a rising trend in malaria infection in recent years, proposed reasons include:

- Emergence of treatment resistant parasites
- Resistance of anopheles mosquitoes to common insecticides
- Global warming and associated climate changes
- Globalization and international tourism to malaria endemic areas.

The WHO estimated that by the end of 2004, 107 countries were at risk of malaria transmission. People living in these at risk areas are estimated around 3.2 billion.(9)

Falciparum malaria is implicated in over one million fatalities annually. It also is a secondary cause of many deaths mostly in young children through a synergistic effect with other infections.

In malaria-endemic countries, transmission is highest in rural areas. Although seasonal variations exist, the highest rates of disease transmission are seen towards the end of the rainy season. However, higher altitudes are associated with less disease transmission.

The highest rates of malaria transmission globally are found in Oceania and sub-Saharan Africa, followed by the Indian subcontinent, Southeast Asia, South America and Central America. (10)

Sub-Saharan Africa is burdened by the heaviest toll of malaria globally with 60 percent of cases, 75 percent of falciparum malaria cases, and 80 percent of deaths worldwide occurring in this region. *P.falciparum* is the leading species of malaria infection in sub-Saharan Africa and causes 18 percent of deaths in children under five.(11) who Malaria is a leading etiology of anemia both in children and pregnant women, as well as low birth weight, premature babies and infant mortality.

Around 30000 people from developed countries contract malaria due to travel to endemic areas annually. The risk of transmission is affected by many factors, most importantly the amount of disease transmission in the region, and whether the individual received prophylactic drugs or not. The risk of acquiring malaria for exposed individuals by region is

- Oceania — 1:30 or higher
- Sub-Saharan Africa — 1:50
- Indian subcontinent — 1:250
- Southeast Asia — 1:1,000
- South America — 1:2,500
- Central America — 1:10,000 (12)

Transmission of malaria:

The malaria parasite is transmitted by the female *Anopheles* mosquito bite. The highest biting rates occur at night from sunset to sunrise. Malaria may also be transmitted congenitally from mother to fetus, through sharing of contaminated needles, and transplant of contaminated organs. In the United States, different species of *Anopheles* can be found in all states excluding Hawaii.

Autochthonous malaria: occurs when a mosquito bites a person with malaria then transmits the infection by biting a non-infected person.

Airport malaria: occurs when mosquitoes are transported from endemic areas by airplane to non-endemic areas where they can bite susceptible individuals.

Malaria transmission and infection differs greatly between countries and even within a single country. This is due to differences in malaria parasites and vectors, fluctuating ecological conditions and socioeconomic factors like poverty, health care standards and accessibility and prevention efforts.

Pathophysiology: malaria is caused by a protozoan parasite genus named *Plasmodium*. The genus has many species but disease in humans is mainly caused by the *P. falciparum* and *P. vivax* species, which cause 80 percent of cases and 90 percent of deaths (13). *P. ovale*, *P. malariae* and *P. knowlesi* also cause disease in humans, though much less frequently. The parasite is transmitted to humans through the bite of a female *Anopheles* mosquito.

Symptoms of malaria include fever, shivering, joint pain, vomiting and anemia. Life-threatening severe malaria can cause spleen and liver enlargement, severe headache, cerebral

ischemia and renal failure (black water fever) (14). Malaria is diagnosed by thin blood film microscopy.

The malaria parasite is a one-celled organism that belongs to the phylum Apicomplexa, named because it possesses an apical complex. All *Plasmodium* species feed on the hemoglobin in the red blood cells (erythrocytes) of their host by taking up cell cytoplasm through the micro pores and forming a food vacuole. Heme, a toxic metabolic byproduct of the hemoglobin digestion, is polymerized by heme polymerase into harmless hemozoin pigment and is deposited into the erythrocytic cytoplasm (Slater, 1992).

The life cycle of the human-infecting *Plasmodium* species can be broken down into two different stages -the vector (mosquito) stage and the host (human) stage. The sexual stage of the parasite is found in the female mosquito of the genus *Anopheles* and the asexual stage is found in humans for *P. falciparum*, *P. vivax*, *P. malariae*, and *P. ovale*. Transmission of the parasite occurs when a female mosquito takes a blood meal from an infected host. The male- and female-equivalent parasite forms capable of sexual reproduction (macrogametocytes, or gametes), both inactive in the host, are taken up in the blood meal. Here the red blood cell material surrounding them is broken down by the digestive juices of the mosquito, and the gametes are released into the lumen of the stomach. The microgamete undergoes a maturation process at this stage by a process called exflagellation. During exflagellation, the nucleus undergoes three divisions. The nuclei formed from these divisions migrate to the cell

edges and attach to portions of the cell structural components (centrioles). From this center an axoneme arises and the nucleo-axonemic complex detaches as a flagellate microgamete. The microgamete approaches the macrogametes formed by the macrogametocyte and penetrates the membrane-derived fertilization cone.

The fertilized macrogamete elongates after 12 to 24 hours to become a mobile form of the parasite called the ookinete, which passes through the stomach lining of the mosquito and embeds itself. Here the ookinete enlarges to 4 or 5 times its original size and develops into a cyst-like form, visible on the side of the mosquito gut (Bogitsh, 1990). Within the oocyst, storage pockets form that enlarge and segment the oocyst into smaller segments called sporoblasts. Repeated division within the sporoblast produces long, spindle-shaped structures called sporozoites (Bruce-Chwatt, 1980). When the engorged oocyte ruptures, these sporozoites are released into the mosquito and make their way into the salivary gland. At this point the mosquito becomes infective.

Whenever the mosquito takes another blood meal, the sporozoites are injected into the blood stream of the person via the saliva. Inside the host, the sporozoites that are not killed by the immune system travel to the cells of the liver, marking the beginning of the exo-erythrocytic phase of the parasite. Inside the liver the parasites change forms again, into something called a trophozoite and begin the pre-erythrocytic stage (Krier, 1980). The trophozoite duplicates non-sexually, producing thousands of forms called merozoites that fill the tissue of the trophozoite cell that ruptures when fully

developed. These merozoites flood the surrounding tissue and enter the blood stream under most common circumstances; however, with some variants, the merozoites reenter the liver cells for what is called a secondary pre-erythrocytic stage (Bruce-Chwatt, 1980; Garnham, 1966). It is not currently known whether late relapses of the disease are caused by a dormant primary pre-erythrocytic parasite or a clinically undetectable secondary pre-erythrocytic system (Bruce-Chwatt, 1980). It is difficult to correlate the later hypothesis with the clinical course of the infection, as rupturing of tissue parasites is commonly associated with the first course of fever. Individuals often go decades without any signs of infection, i.e. fever, between the time of primary infection, their first exposure to the parasite, and their relapse, but the cycle for the pre-erythrocytic stage is two weeks at most.

The release of merozoites into the bloodstream begins the last stage in the life cycle of the parasite called the erythrocytic stage. Although multiple parasitism is highly common, the simplest model is that single merozoites actively invade the cytoplasm of the erythrocytes, a process that requires the presence of surface Duffy antigens. According to Burton Bogitish at Vanderbilt University, parts of the parasite secrete substances that cause the erythrocytic membrane to stretch and fold in on itself, creating a storage chamber (vacuole) that surrounds the parasite. At this point the parasite begins to feed on the hemoglobin molecules within the red blood cell and convert the byproducts into a non-toxic pigment called hemozoin, as mentioned above. Young parasite forms in the cytoplasm of red blood cells possess a large food vacuole that pushes parasitic cytoplasm to the periphery.

When viewed under light microscopy, this stage resembles a ring, a phenomenon that gives this morphology the name "signet ring stage". The immature ring stage continues to feed on host cytoplasm and develops into a mature trophozoite whose food vacuole is responsible for little of the cell's volume. The nucleus then undergoes multiple fission (asexual reproduction), followed by a process of cell substance division producing a variable number of merozoites, depending on the species of malaria. After rupture of the red blood cell, merozoites can either reenter a naive erythrocyte and begin the erythrocytic cycle anew, or, in some models of malaria development, become a gametocyte if it is the product of a cycle late in the erythrocytic stage of infection. These gametocytes remain inactive in the bloodstream of the host, but begin to differentiate morphologically if taken up by a mosquito, starting the whole cycle again.

Immunity to Malaria:

Most people develop a degree of immunity following an attack of malaria. People living in endemic areas are prone to recurrent infections and thus develop some partial immunity (semi immunity). However, they still get infections after a bite of an infected mosquito, but the symptoms are much less severe, despite the presence of parasitemia. This state of partial immunity disappears quickly upon departure from endemic areas. Residents of endemic areas who move away from their countries for sometime need to take prophylactic precautions like all visitors to these areas as they incur the same risk of developing symptomatic malaria.

Treatment of malaria:

Anti-malarial drugs: the oldest antimalarial known to man is the bark of the cinchona tree (15). Today, a myriad of drugs is available for treatment and prophylaxis, like quinine, chloroquine, and mefloquine.

Anti-malarial drugs used to prevent infection from occurring in an individual (Bruce- are termed schizonticidal because they attack the pre-erythrocytic stages of parasites. The goal of causal prophylactic drugs is not to prevent sporozoites from reaching the liver of the inoculated individual, but, rather, to attack the early stages of the parasite while it is still confined to the liver parenchymal cells and to prevent these parasites from releasing merozoites into the bloodstream. An example of this type of antimalarial is proguanil which, although it has slow schizonticidal action on erythrocytic forms of the parasite, is highly effective on tissue schizonts (Clyde, 1987). Proguanil, or primethamine, a close relative of proguanil, is preferred in endemic areas because of their safety and absence of side-effects. Proguanil is rapidly absorbed by the upper gastrointestinal tract and is eliminated slowly through urine and feces, leaving little in the host to accumulate in the tissues. Another type of prophylaxis exists where schizogony is not prevented, but parasites are kept at a subpatent level so that no clinical symptoms are observed. This condition is known as suppressive, or clinical, prophylaxis. When the administration of drugs of this nature is ceased, system parasitemia is expected, as is the appearance of clinical symptoms. Blood schizonticides are effective as clinical prophylactic drugs (Bruce-Chwatt, 1980).

Secondly, antimalarial drugs are used for curative purposes to act on existing infections. The action of drugs used for therapeutic purposes is primarily on blood schizonts, preventing the erythrocytic cycle to continue. Therapeutic drugs can either result in temporary cure with a temporary suppression of symptoms or temporary cure in which the parasite is completely removed from the host system. Drug treatment for malaria species that often result in relapse or recrudescence is usually followed by an anti-relapse drug like primaquine or pyrimethamine (Bruce-Chwatt, 1980). All eight of the common antimalarial compounds - quinine, mepacrine, chloroquine, amodiaquine, primaquine, proguanil, pyrimethamine, and the sulphones/sulphoamines - have blood schizonticidal activity, although some have greater effects than others.

Public Health and malaria:

Burden on the economy: malaria is a disease that is caused by and is a cause of poverty. It damages the already vulnerable economies of endemic areas through loss of workdays, disease management costs, and decreased tourism . Malaria is responsible for 25 to 25 percent of all outpatient clinic visits, 20 to 45 percent of hospital admissions, and 15 to 35 percent of hospital deaths. This puts a huge load on the weak health care systems of these countries. (16)

PREVENTION: malaria prevention has two major components :

- Prophylaxis
- Mosquito avoidance techniques.

PROPHYLAXIS:

Africa

Most of the recent travel-associated malaria cases in the US (about 60%) were due to travel to sub-Saharan Africa, particularly east Africa.(17) There is high risk in that area of acquiring chloroquine resistant falciparum malaria, the only exception is the city of Nairobi where the risk is low. The recommended regimens include mefloquine, malarone, and doxycycline taken for two to four weeks before travel to affected areas.

Oceania

Travelers to Papua new guinea, west Irion, the Solomon islands, and Vanuatu should take the same regimens as those traveling to Africa. Since the transmission risk of chloroquine resistant malaria are very high

China and southeast Asia

Generally, travelers to Asia do not need to take prophylaxis especially if they are visiting urban areas, or if they only have daytime activities in rural areas. Prophylactic measures like those for Africa travelers are only merited if rural outdoor evening exposure is anticipated.

South America: Travel to rural areas, night time exposure and certain urban areas like the coast of Ecuador necessitates prophylaxis like Africa travelers.

Indian subcontinent

Travel to India, Pakistan and Bangladesh entails a high risk of chloroquine resistant falciparum malaria. The prophylactic recommendations are similar to those traveling to Africa.

PROPHYLAXIS DURING PREGNANCY Malaria infections are more serious during pregnancy, and put both the mother and fetus in danger. The risk for abortion and stillbirth increase with the infection. A study reported that “ Pregnant women attracted twice the number of Anopheles gambiae complex--the predominant African malaria-carrying mosquito--than did their non-pregnant counterparts. We postulate that physiological and behavioural changes that occur during pregnancy are responsible for increased attractiveness, which could be important in intervention strategies aimed at protecting this high-risk group against malaria.” (effect of pregnancy on exposure to malaria mosquitoes, Lindsay S. et al., Lancet 2000 Jun 3;355(9219):1972) (18). Thus, the best advice for pregnant women is to defer travel until after delivery.

MALARIA VACCINE — Research for an effective malaria vaccine is ongoing. The goal of current research is to protect against sporozoites, which develop into merozoites in the liver. Currently, many vaccines are being tested for efficacy.

A study on children from Mozambique between one and four years of age, where children were randomized to receive one to three doses of a vaccine found a reduction of 30 to 60 percent of a first attack of severe malaria over six months. The prevalence of new falciparum malaria infection decreased from about 19 to 12 percent. (Efficacy of the RTS,S/AS02A vaccine against Plasmodium falciparum infection and disease in young African children: randomised controlled trial. , Alonso PL et al, Lancet 2004 Oct 16;364(9443):1411-20) (19). Effectiveness of the vaccine will likely be affected by several factors like level of parasitemia, level of immunity (none versus partial immunity).

GENETIC IMMUNITY TO MALARIA: some genetic abnormalities in the red blood cells have been found to confer immunity to falciparum malaria.

- Preventing merozoites from entering the erythrocytes examples are duffy antigen, polymorphic glycoporphins, ovalocytosis.
- Preventing or delaying parasitic growth and multiplication inside the red blood cell examples are hereditary spherocytosis, hereditary elliptocytosis, sickle cell disease
- Preventing cellular and membrane breakdown of the erythrocyte post-maturation and the subsequent release of merozoites into the blood , an example is the thalassemas .(20)

MOSQUITO AVOIDANCE: Since malaria is transmitted through the bite of the Anopheles mosquito, which is most active at night, it recommended that exposure at night be reduced by

- Staying indoors in screened spaces
- Using permethrin impregnated mosquito nets
- Covering up with clothing when going outside to minimize biting
- Using insect repllents. utd

INSECT REPELLENTS: The centers of disease control and prevention recommends the application of insect repellents to the skin when anticipating the exposure to mosquitoes. The specific repllents recommended are DEET. Picaridin and PMD. UTD

Permethrin: permethrin does not repel mosquitoes. However, it has a toxic effect on the mosquitoes nervous system although it is not toxic to humans and mammals. The recommendations are to treat mosquito nets and clothing with permethrin. This should be

effective for more than a week even with washing and repeated use. Permethrin is widely available in outdoor supply stores.(21)

DEET: an insect repellent that is effective against mosquitoes and many arthropods. It has the widest spectrum of coverage and longest duration of action among all insect repellents. It is available in various concentrations, but higher concentrations should be reserved for situations where high insect exposure is anticipated. Unwanted effects include damage to clothing, dermatitis, allergic reactions, and neurotoxicity. It is safe for use in children and pregnant women.(22)

Picaridin: is the CDC recommended alternative to DEET. Picaridin is less irritant than DEET and more tolerable though not available in the same high concentrations as DEET in the US. (23)

PMD (P-MENTHANE-3,8-DIOL): another recommended alternative to DEET. However, PMD has only half the effectiveness of DEET. Eye contact with PMD must be avoided.

Conclusion: malaria has been plaguing humanity for centuries now. Yet it still lingers on. It is a disease of poverty, lack of knowledge, and limited resources. (24)

INSECTICIDE TREATED NETS (ITNs)

According to the WHO, in 2000 African countries agreed to a commitment to provide insecticide treated nets (ITNs) and anti-malaria treatments for 60 percent of the population at risk. The countries also agreed to provide intermittent preventive treatment (IPT) to pregnant women. The plan was intended to be completed by the end of 2005, but the process was hindered by limited resources and supplies. However, some countries have attained or surpassed some of these

targets with more funding, while other countries are starting to increase their efforts, but the challenges still exist.

Usually, wealthier urban households were more likely to use ITNs than poorer rural households, despite the risk of infection being higher for the latter. Recently, this trend was successfully altered in some African countries. Examples of such programs with high coverage rates include in Ghana and Nigeria subsidized ITN distribution programs in collaboration with public health services, and in Togo the national project distributing free ITNs for children under five at the time of measles immunization, these programs have resulted in high coverage rates in the population.(25)

INDOOR RESIDUAL SPRAYING: Indoor residual spraying (IRS) is a potent method of vector control. It is especially useful during epidemics and emergencies since it rapidly reduces malaria transmission when administered at the proper time and in the correct coverage capacity. In high transmission areas, IRS long-term benefits can be comparable to ITN. Yet ITNs are still preferred in such regions since they are more sustainable.

A major problem with this technique is the availability of safe and cheap insecticides. While no new insecticides were developed in the past two decades for public health purposes, there is more vector resistance to the insecticides currently in use. The Stockholm Convention on Persistent Organic Pollutants was put in effect in may, 2004. The convention's aim was to implement measures to control environmental damage due to organic pollutants. However, the convention still recommended DDT for vector control in some areas. The WHO, along with 12 other insecticides, recommends DDT for IRS taking into account the local situation of the country where it is being used.

All the countries in Asia, North and South America and about half of Africa all have national policies for vector control using IRS as part of the anti-malaria efforts.(26)

EPIDEMIC AND EMERGENCY MALARIA CONTROL: About one sixth of the world's population, or one billion people, lives in regions with endemic malaria or at risk of epidemic malaria. A large proportion of malaria fatalities occur in war zones and conflict areas. In 2005, there were 18 conflict zones in Africa alone. Emergency situations increase malaria infections and fatalities through population displacement, malnutrition and non-malarial infections which increase susceptibility to malaria, bad housing conditions or lack of housing altogether, poor health services and supplies, rampant vector breeding due to lack of sanitation and poor environmental conditions.

An effective monitoring and warning system must be in place to prevent malaria epidemics. The WHO recommends that monitoring and control systems include weekly disease surveillance for early detection, and preparedness action plans and funds for immediate deployment of control measures like drugs, IRS and ITNs. Monitoring and warning systems can forecast epidemics based on data from satellite observations of seasonal climate changes, seasonal rainfall and temperature fluctuations. Weekly disease surveillance can detect any unusual rises in malaria cases in durations as short as two weeks. Thus allowing immediate effective control measures to be taken.

Almost all countries in Africa and Asia where large areas are at risk of seasonal and epidemic malaria have malaria- combating policies which include emergency preparedness plans to manage epidemics. Fifteen of the twenty five countries at risk of malaria epidemic in Africa have systems for weekly reporting of malaria cases. Eight African countries are in the development

stages of early- warning systems for malaria. (27) These systems are part of disease surveillance systems or implemented in monitoring guard sites. Putting the data collected from these systems to use in planning interventions is still a subject for research, however. Optimal implementation and prioritization of interventions during emergencies so the plans are feasible remains a challenge both in the short and long term.

in emergencies the recommendations are to manage cases with artemisinin-based combination therapy (ACTs), therefore ACTs should be available for health services and populations at risk. The ultimate, effective malaria prevention measures are a combination of extensive coverage vector control and a cooperative relationship between control agencies.

A good summary of prevention measures of malaria is provided by the following table adapted from the WHO's "World Malaria Report 2005" :

Priority malaria control strategies, by epidemiological setting

| Epidemiological setting | Control strategy |
|--|---|
| Stable endemic malaria Examples: large parts of East, Central and West Africa, Papua New Guinea, Solomon Islands and Vanuatu | Prevention – ITNs for children under 5 years of age, pregnant women and people living with HIV/AIDS – IRS, where appropriate – IPT in pregnancy Treatment – Early and effective case management including presumptive treatment for suspected cases and home management where appropriate |
| Unstable malaria Examples: parts of Southern Africa, Transcaucasia, Central Asia and the Americas; highland and desert fringe areas, some urban areas, plantations, irrigation schemes | Prevention – IRS – Larviciding – Environmental management – ITNs Treatment – Early and effective case management in suspected cases – Diagnostics to confirm cases, if possible before treatment |
| Free of malaria Examples: parts of Southern and North Africa, Ethiopian and Eritrean highlands and Transcaucasia | Prevention – For travellers going to malarious areas, chemoprophylaxis and personal protective measures against mosquitoes Treatment – Early and effective case management in suspected cases – Diagnostics to confirm cases, if possible before treatment |

MALARIA AND HIV:

Recent approaches to malaria prevention and treatment focus on HIV infected adults, children under five years old and pregnant women. Malaria increases HIV/AIDS related mortality and morbidity due to the synergistic effect of both infections in sub-Saharan Africa. An attack of malaria in an HIV/AIDS infected individual can cause temporary increases in HIV viral load.

Providing malaria treatment and prevention can decrease this effect, therefore limit the transmission and spread of HIV as well as improve the health status of such individuals immediately.(28)

The WHO Global Malaria Program:The global malaria program is a division of the WHO concerned with malaria control and prevention world wide. The program has regional offices all over the world, which coordinate the implementation of the current recommendations, collection of monitoring data, organization of resources and allocation of funding. The GMP publishes an annual report “Roll Back Malaria” with the most recent trends and recommendations for effective malaria prevention.

The WHO Global Malaria Program mission statement (29)

“The WHO Global Malaria Program is responsible for malaria policy and strategy formulation, operations support and capacity development, and coordination of WHO's global efforts to fight malaria. The Department establishes and promotes — based on evidence and expert consensus — WHO policies, normative standards and guidelines for malaria prevention and control, including monitoring and evaluation.

“Capacity development for Global Malaria Programme builds on the current capability in countries at all levels to prevent and control malaria through:

“Provision of an enabling environment (e.g., political commitment; development and implementation of appropriate recruitment and career policies; provision of facilities and resources; strengthened training institutions);

“Intensification of training and retraining of personnel;

“Technical support mechanisms (e.g., information, communication and supply systems to support trained personnel, supervision, monitoring and evaluation).

“Lack of human resources or capacity at country / inter-country level is the key constraint to developing, implementing and sustaining malaria control. Lack of capacity can be addressed through several options (e.g. pre or in-services activities) targeting different key actors in the field. To increase national capacity, one important function of WHO is to develop and make available standardized documents based on the best up to date practices (training packages, software and tools) adjusted to intervention levels (from national to communities), as well as to organize national and international training courses and workshops with partners.

Communication and continuous information from and to member states are essential parts of capacity building on agreed upon innovative strategies supported by WHO.

With greatly increased availability of funds, the needs are moving from planning towards implementation, monitoring and evaluation. The focus must be on the district level, but national institutional back-up is also essential.”

Malaria Partnerships for Prevention

The CDC recommends the collaboration of the following establishments to achieve effective malaria control: ministries of health, international organizations, the government, non-governmental organizations, private companies and establishments, and the community.

Malaria Prevention Activities:

Necessary components of interventions are:

- Public education about the simple measures that can limit the spread of the disease
- Human resources training and supervision especially health workers
- Availability of interventional supplies and equipment (30)

BARRIERS TO MALARIA CONTROL

Several problems have traditionally impeded or lessened the effectiveness of anti-malaria interventions

- Drug resistance: a major problem since the emergence of drug-resistant malaria cases slows the prevention efforts because they require different less available, more expensive, and potentially unsafe medications for management
- Vector resistance to commonly used insecticides makes interventions like ITNs and IRS useless
- Weak, overwhelmed health systems in poor endemic countries makes the implementation of interventions ineffective
- Poverty: malaria thrives in poor regions aided by lack of knowledge and education. People in these regions commonly do not know how to prevent malaria, or can not afford drugs and ITNs and other preventive measures. (31)

CONCLUSION:

Malaria is a disease that has plagued humans for centuries. Yet it still lingers on today. It is a disease of poverty, lack of knowledge, and limited resources. Malaria is still thought of as a disease of developing, impoverished populations, but this view is posed to change in the coming years. Globalization, immigration and the ease of travel make the transmission of malaria feasible and rapid. Malaria still claims many lives every year, and affects many more through loss of wages, disability and health care costs.

An effective public health campaign for malaria prevention would require a global initiative mandating the participation of all countries, endemic and non-endemic, regardless of their local burden of malaria. Proper allocation of resources to planning, training of workers, supply of anti-malarial medications, bed nets, and insecticides, and research is essential. Funding however, is a constant issue with such campaigns, due to the large scale of these programs, and the poor economies of the countries most affected with the disease. The Global Malaria Program of the WHO is one such ambitious initiative hindered by the limited participation of developed countries and the lack of sufficient funds thereof. The emerging threat of the combined HIV/AIDS and malaria infection paints a grim picture of new drug resistant HIV and malaria strains and a sweeping global pandemic that is unfathomable.

For More Information:

<http://www.who.int/malaria/index.html>

<http://www.cdc.gov/malaria/>

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