Malaria in the Twenty-first Century

I. Malaria Disease and Transmission

Malaria is caused by a parasite with the genus Plasmodium. There are only four known species of Plasmodium that cause malaria: *P. falciparum*, *P. vivax*, *P. ovale* and *P. malariae*. The vectors that transmit malaria are female mosquitoes of the genus *Anopheles*. There are over 430 known genus species of *Anopheles*, but only about 30-50 of them can actually transmit the parasite.

Normally malaria is a curable disease, but only if treated properly. After an infectious bite there is an incubation period in the host that varies depending on the species of Plasmodium, before there is an onset of symptoms. The symptoms of malaria that a human host will go through can be categorized as either uncomplicated or severe. With uncomplicated malaria, the symptoms last between 6-10 hours and include a cold stage, a hot stage and then finally a sweating stage. Symptoms occur in a mixture of fever, chills, sweats, headaches, nausea, vomiting, body aches, and general malaise.

Severe, or complicated, malaria occurs when a human host is infected by *P. falciparum* and it is complicated by organ failure or irregularity in the host's blood or metabolism. This kind of infection usually occurs in patients that have little or no immunity to malaria, this most often occurs to those who live in an area with low (or no) malaria infections.

Relapses can occur in *P. vivax* and *P. ovale* infections. This is because they have dormant liver stage parasites, called hypnozoites that may reactivate months or years later. There are no symptoms between relapses, and there is also treatment to avoid such occurrences.

The life cycle of Malaria consists of two hosts: humans and *Anopheles* mosquitoes. In humans, the parasite grows rapidly in the liver cells at first and then moves to the red blood cells. During this growth, the red blood cells are destroyed and release daughter merozoites that will go on to invade more red blood cells. It is during this blood stage that the symptoms of malaria are present.

When a human infected with the malaria parasite during this blood stage a female *Anopheles* mosquito takes a blood meal from the human host and it can pick up a certain forms of blood stage parasites. The parasite then proliferates in the mosquito and after 10-18 days the parasite exists as a sporozoite. When the mosquito goes to take a blood meal from another human, the sporozoites are injected with the saliva of the mosquito and thus infecting the human.

II. The State of the Problem

There are about 300-500 million malaria cases per year throughout the world resulting in 1.5 to 2.7 million deaths. It is one of the leading causes of sickness and death in developing countries. Forty percent of the world's population, about 200 billion people, is at risk in over 90 countries. In the 1960s, only ten percent of the world's population was at risk for malaria. The risk rose to forty percent as mosquitoes developed resistance to pesticides and malaria parasites developed resistance to treatment drugs.

Although prevalence of malaria has increased substantially worldwide since the 1960s, in recent years it has begun to stabilize slightly. In the early 1990s, many countries tried a new strategy against malaria that ended up causing higher rates of incidence. Since these countries went back to using pesticides, malaria incidence has decreased dramatically. In conclusion, the problem is worse overall, but it has improved in recent years.

III Control of Malaria

Malaria control does not aim to eliminate malaria permanently because right now it is not realistic. A program for malaria control would have to include treatment to individual cases using antimalerial drugs, vector control, bed nets and treatment for pregnant women.

Vector control is a successful method of control, and it lead to the eradication of malaria in the United States, USSR and southern Europe between the 1940s and the 1960s. The insecticide most widely used for house spraying has been DDT, although it has been banned from us in some countries. DDT is known as a carcinogen, but there is no solid evidence that it causes significant harm to those exposed. DDT has substitutes such as organophosphate or carbamate insecticides and pyrethroids. Bed nets are another form of vector control while people sleep, but they can be less effective when mosquitoes can bite through. Therefore, bed nets are then treated with pyrethroids to add a chemical barrier. It has been found that bednets treat with pyrethroids are more effective than those that are not.

IV. Should the U.S. government be involved in controlling the spread of malaria?

Malaria was once very rampant in the United States, until the 1940s where DDT was used to eradicate it in this country. The mosquitoes that transmit malaria (*Anopheles* genus) are still very widespread in the US. While there are approximately

1,200 cases of malaria in the United States per year, all but five were contracted from other countries before entry into the US. The five that were contracted here show that malaria can without doubt be once again prevalent in the US. If the United States government allows incidence of malaria to continue to grow in other countries, then it is very possible that the US can once again have malaria circulating here.

A U.S. International Anti-Malaria Program can be very costly, yet it must be done in order to protect the United States from the disease itself. Funding for malaria control in developing countries has been decreasing due to fewer donations, which are needed due to the miniscule budget these countries have to work with. Developing countries cannot yet afford the alternatives to DDT, and they are having enough trouble as it is affording DDT as insecticide to spray homes.

Between 1993 and 1995, many countries in Africa and South America (not Ecuador) significantly decreased the amount of spraying done in their countries. They implemented a new malaria control strategy which did not call for vector control at all. Afterwards however, the incidence of malaria rose tremendously in these countries. Ecuador, however, increased the amount of spraying of DDT and they were the only country to accomplish a decrease in malaria incidence in 1994. Removing vector control has a high cost of increased incidence rates of malaria; therefore vector control is the most imperative element of malaria control.

Insecticide spraying is recommended for the Anti-Malaria Program due to its cost efficiency. DDT will mainly be used, but pyrethroids will be used in cases of DDT resistance because they are the least costly after DDT. A malaria control program in South Africa alone in 2002 was $102,000 US dollars (Tren and Bate, 2004). In order to protect the United States, I would recommend that one million US dollars per year be spent on vector control in South Africa and South America. Since spraying is only involved with the homes, rural areas do not need as much as urban ones. Spraying an entire continent sounds unreasonable, but in perspective is it not.

Also one million dollars per year should be spent on treatment of malaria, primarily because it cannot be transmitted if there are not sick people. Another million dollars will be used to treat those coming into the United States from S. America and S. Africa to avoid transmission in our country. This bring the total cost of the plan to three million dollars, far less than what our government is currently spending. There should be a plan to support malaria control for many years, in order to keep it stabilized.

Malaria Program

Currently the United States is involved with "The President's Malaria Initiative", which is the President's plan for malaria relief. This initiative has the same basic points as the plan I have suggested; vector control through spraying homes, insecticide treated bed nets, administer treatments for those ill, and treatment for pregnant women. The main difference between the plans is that the President's initiative is dramatically more costly.

According to usaid.org, the President's initiative is spending 1.2 billion dollars over five years, which equates to 240 million dollars per year. The plan I have proposed is much more cost efficient, more aimed at hitting the problem dead on. The President's plan *only* targets certain countries, such as Angola, Tanzania, Uganda Malawi, Mozambique, Rwanda, and Senegal. With my plan, all of the countries in S. America and S. Africa will be targeted, continuously over many years.

The President's initiative does not mention using DDT, nor does it have an alternative in the cases of DDT resistance (or other insecticide resistance). It is not known right away when DDT resistance occurs, which is one drawback to the plan to use an alternative.

The plan that I have proposed will not involve agents from the United States to go over to these countries. US involvement internationally will purely be a donation aspect. The plan will call for the US to purchase the treatments, DDT (along with supplies needed for spraying) and the pesticide treated nets. The treatments for those traveling into the United States will be purchased and administered in the US by agents of the US government. Though it may not seem reasonable to just send the supplies over without having US officials monitor their use and administration, it is much more cost efficient. The President's initiative has such an enormous cost mainly because it is incorporating the funding for US agents to administer the treatments and insecticides. Malaria is a problem in these developing countries, but it is also a looming problem. It has been there for a while, and it will still be around for a while.

There are bigger issues at stake in the US than malaria and able bodied people can be put to better use. One such issue is the war in Iraq, where many soldiers are still needed. Another issue would be the Hurricane Katrina disaster. Many people are still without a home and there is only a few months left before they have to return their FEMA trailers. I strongly urge that there is an anti-malaria program, but it should not be costing as much American dollars as the President's Initiative and we should not be sending Americans over to help at this time.

V. Cost/Benefit and Comparative Analysis of a US International Anti-

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