

Learning From the Past: The Future of Malaria in Africa



Melissa Graboyes

What can failure teach you about the future? According to a diverse group of experts debating the future of malaria control in Africa — a lot. In fact, the group of malariologists, entomologists, historians, economists and public health workers all agreed that an analysis of the *failures* of past malaria eradication programs could help set a realistic direction for future malaria control.

In April 2009, Boston University’s African Studies Center was the lead sponsor of a two-day event titled “Africa 2060 A.D.: What We Don’t Know About Malaria, and When Didn’t We Know It.” (See box on page 5). Based on the discussion that took place among the experts gathered over the two days, this paper explores the theme posited in the event’s title. In particular, the paper is framed by conversations that centered on the benefits of “failure analysis”— a rigorous study of the failures of past eradication attempts. The logic was that figuring out what *hasn’t* worked in the past might help us determine what *could* work in the future.

Past-Present Connections

Historian James Webb from Colby College offers two correctives to our current thinking about malaria. First, he says that it is wrong to think Africa was excluded from the first global eradication campaign. Second, we should not be fooled into thinking the only real attempt to control malaria in Africa is happening right now.

Malaria was the first disease the World Health Organization (WHO) tried to eradicate in the 1950s, and it was also WHO’s first failure at global eradication. When the WHO announced its intention to wipe malaria from the face of the earth, there was a heady optimism. The new

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drug chloroquine and the insecticide DDT (dichloro-diphenyl-trichloroethane) seemed to be unstoppable in killing both the malaria parasite and the transmitting mosquito. Africa seemed poised to become malaria-free.

But that never happened; Africa never did become malaria-free. The global campaign stumbled when drug resistance developed faster than expected, and mosquitoes and parasites adapted to the new technologies. Scientists and public health workers had underestimated the complexity of the disease. Africans were left with abandoned projects and malaria returned with a vengeance —sickening and killing people who had lost their immunity. Public health workers were humbled, but few lost their zeal.

That zeal — or zealotry — has returned after being dormant for almost half a century. The malaria eradication and control campaigns being waged today are distressingly similar to those failed campaigns of the 1950s. Although, the WHO is no longer going it alone. A

phalanx of international organizations such as the Roll Back Malaria Partnership, the Global Fund to Fight AIDS, TB and Malaria, and the well-funded Bill and Melinda Gates Foundation have joined together. Their goals are big, and they are not afraid of making ambitious claims. A video on the Gates website asks, “Can we really eradicate malaria?” After five minutes highlighting some of their funded projects, the video concludes by answering that they will, indeed, “eventually rid the world of this disease.”

Such a bold claim is stirring, but it is naïvely optimistic, and could ultimately be dangerous. Failed eradication

attempts could leave millions of Africans at risk, having lost the natural immunity conveyed to children when they are infected while young and survive a case of malaria. If malaria is “eradicated” and then returns, those people who have never gained (or lost) their immunity will be put at a far greater risk. Eradication is a meritorious goal, but falling short could lead to disaster.

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Scientific Silver Bullets?

One of the factors contributing to the optimism in the 1950s was the emergence of what appeared to be scientific silver bullets. There was a new, more detailed, understanding of the dynamics of malaria transmission. The insecticide DDT was being touted as a miracle drug for its efficacy, long life span, and low cost. The drug chloroquine was also being mass-produced and was successfully treating infected people. At that exciting time, researchers and public health workers refused to think about, or plan for, the eventuality that the drugs might lose their efficacy. When resistance to DDT and chloroquine emerged, hope of eradicating malaria vanished.

Today we feel similarly blessed by science. Artemisinin is the new wonder drug that is highly effective against deadly *falciparum* malaria. The mass production of artemisinin-based drugs and the dispersal of insecticide treated bed nets (an old-fashioned solution with a high tech spray of chemicals) are our new silver bullets. But our expectations — that bed nets and new drugs will lead to eradication — are short-sighted. Even before most African countries have switched over to providing artemisinin combination therapy as the standard treatment for malaria, the parasite is already adapting. Artemisinin resistance already has been seen in Asia — the same place the earliest chloroquine resistance was found.

History shows us that nature keeps pace with science. Biological adaptations of the malaria parasite and changes in mosquito behavior have bested some of our most touted technological achievements. And it is not just the parasite that scientists have to worry about. For years research has shown that most malarial mosquitoes in East Africa bite between midnight and three in the morning. However, as more people use bed nets, the mosquitoes have changed their biting behavior. In Dar es Salaam, Tanzania, malarial mosquitoes have been found biting as early as five in the evening, and scientists expect this trend to accelerate.

Programs That Worked

The earlier claim that malaria eradication in tropical Africa failed is true, but that is only part of the story. Even though malaria was not eradicated, there were places where it was controlled. Ironically, many of these successes did not happen at WHO pilot eradication sites. Malaria was effectively managed in privately controlled areas where there was a strong economic interest in reducing the number of sick days caused by malaria. Mines in southern and eastern Africa are a prime example of such success.

Burt Singer, Professor of Demography and Public Affairs at Princeton University, and one of the United States' most respected malariologists, says that the colonial-era copper mines in Northern Rhodesia (now Zambia) were a good example of how strict rules could produce good results. The mines adopted an integrated approach to malaria control. Mosquito breeding areas such as swamps were drained, sick workers were quickly tested and treated, and bed nets were issued to all workers. The companies created working and living conditions that resulted in healthier, more efficient — and ultimately cheaper — workers. Yesim Tozan, Assistant Professor of International Health at BU's School of Public Health and former member of Columbia University's Earth Institute, found the copper mines' control programs to be "a sound investment" and that there was a "payoff for public and occupational health" (Utzing, Tozan, Douman, Singer 2002, 657).

To the chagrin of many public health workers, economic motives for implementing disease prevention measures are often more persuasive than humanitarian motives. ExxonMobil is a recent example of the private sector becoming involved in public health. While building over 600 miles of pipeline from Chad to Cameroon in West Africa, the company quickly realized malaria was an economic issue. They estimated that they could lose up to \$4 million in malaria-related project delays over the three-year construction period if they didn't do something to address the disease. They stated clearly that the aim of their malaria program was to "reduce the malaria disease burden on project employees, contractors and the community, while reducing the financial impact of the disease" (WEF 2002).

ExxonMobil's approach was a multi-pronged attack that targeted both the vector and the parasite. In order to lessen the number of mosquitoes in the area, all employee housing was sprayed with insecticide twice a year (indoor residual spraying) and the surrounding environment was drained of standing water and cleared of bush. The parasite was attacked in infected employees who were rapidly tested and treated (free of charge), and prevention was encouraged through general education campaigns and the free distribution of insecticide-treated bed nets. Within a year, the cases of malaria among the 8,000 African workers laboring on the project had been reduced by 70 percent.

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There's no denying that these groups have little (or no) humanitarian interest in improving workers' lives. But, in this case, the economic interests of the company — to have healthy workers — coincided with real improvements in public health. Despite this documented history of success, many current malaria control programs have not partnered with the private sector in meaningful ways.

What to Do — Nothing?

Richard Pollack, a public health entomologist at the Harvard School of Public Health, who has worked on vector-borne diseases around the world, asks a simple question: given the history of malaria failures, is it best to do nothing?

“Malaria vaccines, new drugs, and genetically modified mosquitoes may be the best chance for controlling malaria in the future.”

Other experts acknowledge that while failures have been the norm, that doesn't mean we should abandon all efforts to control the disease. Calestous Juma, Professor of the Practice of International Development at Harvard, suggests that we can do more with less. He argues that future attempts to deal with malaria should not involve more medicalization of the problem, but less. The way forward is not with public health experts, he says, but with a greater awareness of what technology can do on the continent.

Among those who believe increased medicalization is a dead-end, technological solutions hold great appeal. Malaria vaccines, new drugs, and genetically modified mosquitoes may be the best chance for controlling malaria in the future.

A Technological Future?

Technological solutions to malaria are appealing — a high tech, sleek, scientific answer to an ancient disease; a triumph of human ingenuity over ecological complexity. One of the technological hopes is a malaria vaccine. But while the most optimistic supporters promise that success is just around the corner, most other experts acknowledge a viable vaccine is still years away. Vaccines have been discussed as a future possibility for decades. In 1975, it was going to be available in 1990, and even today, most people believe it will be at least a decade before a vaccine could be used in Africa. Time has passed, but the vaccine has remained stuck as a vague future possibility.

The vaccines use a few different approaches to addressing malaria. One uses an attenuated parasite, with the hope that people who are exposed to it will become immune but not sick. Another approach focuses on the malaria vector — the mosquito — by killing the parasite inside the mosquito, preventing further transmission. Vaccines that target the mosquito are considered “altruistic vaccines” because they block transmission of malaria from an infected person to a non-infected person, but they don't actually prevent the infection in the person who's been vaccinated.

There are a lot of “ifs” standing between vaccines and their use in Africa to reduce rates of malaria. Even the drug companies' own promotional materials can't hide how uncertain the future is. *If* phase two trials are successful, *if* all goes well, *if* the results are accepted by regulatory agencies... Not only are there a lot of *ifs*, but they are big *ifs* revolving around the results of large-scale clinical trials in Africa.

A Gathering of Experts on the Future of Malaria in Africa

On April 3 and 4, 2009, Boston University's African Studies Center held an unusual event on the topic of malaria. The Center's annual Bradford Morse symposium, "Africa 2060 A.D.: What We Don't Know About Malaria, and When Didn't We Know It" brought together malariologists, entomologists, historians, economists and public health workers to discuss the future of malaria in Africa. The focus of the symposium was a vision of malaria's future in the next half-century. What will malaria look like in Africa in the year 2060 A.D.?

Featured speakers at the April 3 symposium included James Webb, Professor of History and Director of the African Studies program at Colby College; Burt Singer, a prominent malariologist and Professor of Demography and Public Affairs at Princeton University; and Calestous Juma, Professor of the Practice of International Development and Director of the Science, Technology and Globalization Project at Harvard University's Kennedy School of Government. Jim McCann, Professor of History and Associate Director of the African Studies Center at Boston University, chaired the event. The Fredrick S. Pardee Center for the Study of the Longer-Range Future at Boston University co-sponsored the sessions.

During the two-hour symposium attended by faculty, students, and the public on April 3, and a three-hour conversation the following day among a small group of experts, the discussion moved in unusual directions. As one entomologist who attended stated bluntly, "you wouldn't hear this sort of conversation at a typical tropical medicine conference."

One of those unusual conversations centered on the benefits of "failure analysis"—a rigorous study of the failures of past eradication attempts. The logic was that figuring out what hasn't worked in the past might help determine what would work in the future. Professor McCann asked participants to consider what the malaria situation would look like in 2060 — will we be facing a problem exponentially larger than we face today, or merely reminiscing about a disease that once vexed us? Based on the discussion among experts over two days in April 2009, this paper explores the answer to that question.

Even the vaccines that are in the testing phase have some serious limitations. The vaccines must be very localized. Not only are there different species of malaria parasites, (*falciparum*, *vivax*, *malariae* and *ovale*) but there are variant strains within each species. A vaccine would only target one of the parasites, which could be a problem since many children suffer from multiple types of malaria infections at the same time.

One question is still waiting to be convincingly answered: who is the vaccine really for? Many of the vaccines are only effective for about six months. While the companies developing the vaccines claim they are targeting Africans living in malarial areas, the short period of protection means they may be more realistic for short-term visitors. Another stumbling block is that some of the vaccines are difficult to administer, requiring up to 12 different shots given over more than a year. Finally, there are also big questions about efficacy. In the tests to date, even the most effective vaccine has only reduced cases of malaria by 50 to 60 percent — far from offering full protection.

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A Genetically Modified Future?

Another technological solution is the creation and use of genetically modified insects. There are a few different ways to modify a mosquito to help control malaria. One possibility is to change the physiology to prevent transmission even if the mosquito becomes infected with malaria. Another option is to shorten the mosquito lifespan to lower overall rates of

In the Grip of Malaria in Africa



Sources: A. Platt McGinn, Malaria, Mosquitoes and DDT, *Worldwatch* vol. 15 no. 3, May-June 2002.
http://maps.grida.no/go/graphic/in_the_grip_of_malaria_in_africa
Delphine Digout, UNEP/GRID-Arendal

transmission. A mosquito needs to be alive two weeks or more before it can transmit the malaria parasite. That's just enough time for it to bite an infected person, for the parasite to develop in the gut of the mosquito and migrate to the mosquito's salivary glands, and then for the mosquito to bite another person to pass along the infection. By shortening life expectancy by even just a few days, rates of transmission can drop significantly.

An Australian laboratory has received \$10 million from the Bill and Melinda Gates Foundation to try to accomplish this goal. They have focused on the *Wolbachia* bacterium that occurs naturally in many kinds of mosquito. Mosquitoes infected with the bacteria live for a shorter amount of time than non-infected ones. *Wolbachia* has been successfully used in the lab to affect the black flies and mosquitoes that transmit diseases such as river blindness. The most significant scientific hurdle is that *Wolbachia* do not naturally infect *Anopheles* mosquitoes — the malaria vectors. The goal is now to see if *Wolbachia* can be introduced and maintained into *Anopheles* populations, and if it will serve as a useful tool to combat malaria.

In addition to scientific hurdles, technological answers to malaria also face logistical, political and cultural hurdles. For instance, even if *Wolbachia* were

successfully introduced into *Anopheles* mosquitoes, there would be a question of how to make theoretical findings practical — or to make what works in the lab work in the wild. In this case, it would require millions of laboratory-raised and *Wolbachia*-infected mosquitoes to be released in the wild to mate with normal mosquitoes. Although there are “fly factories” that are capable of producing such large quantities of mosquitoes, such efforts are expensive and difficult.

Finally, even if genetically modified insects could be produced in laboratories on a large scale, countries would still need to agree to the release of those mosquitoes. Given many African countries' reluctance to accept genetically modified foods, this could be a problem. The sheer logistics of getting millions of genetically modified mosquitoes into the wild would be

a challenge. This kind of intervention would need to be tried first on islands (geographic or ecologic), and may never be suitable for non-island settings where mosquitoes from other areas could re-enter and begin transmitting the malaria parasites.

Malaria: In a Class of its Own?

In thinking about diseases that might be comparable to malaria, cholera, polio, sleeping sickness, and HIV/AIDS all come to mind. But none of these comparisons is especially satisfactory — primarily because none of them capture malaria’s dynamism, or its complexity.

If we take lessons from the polio campaign, we see that even if you have an effective vaccine, that doesn’t mean you’ll be able to eradicate the disease. If a malaria vaccine is developed, other issues arise: how to produce affordable vaccines, how to vaccinate millions of people, and how to convince people of the value of being vaccinated? Technology doesn’t provide all the answers; it merely opens up another set of questions.

As with HIV/AIDS, successful control of malaria requires behavior change. While unprotected sex exposes people to HIV, sleeping without a bed net and allowing standing water to remain around one’s home also increases the risk for malaria. And as with HIV, public health workers have struggled to figure out how to encourage people to make these types of lifestyle changes.

But malaria is more of a challenge than HIV in at least one way. The behavior of other community members changes the likelihood of you getting malaria, through no fault of your own. In this way, malaria is comparable to cholera. As a water-borne disease, cholera is easily spread by one person dirtying the village’s water supply. Once the water is dirty, all who use it are at increased risk for getting cholera, no matter how scrupulous their own practices. For malaria, when a person allows for standing water outside their home or isn’t treated for malaria when infected, the risk increases for that person’s neighbors.

Sleeping sickness is another disease where comparisons can be drawn. It is very rooted in local ecology, relies on a vector, and has evaded scientists’ past attempts at both control and eradication. Additionally, sleeping sickness control campaigns have taken a technological turn by using sterilized tsetse flies. Large fly factories have been built and run by the International Atomic Energy Association, where tsetse flies are produced and then irradiated to sterilize them. These flies are then transported by plane to small island settings and dropped off to breed with the local populations, with the goal of eventually eradicating the tsetse fly population.

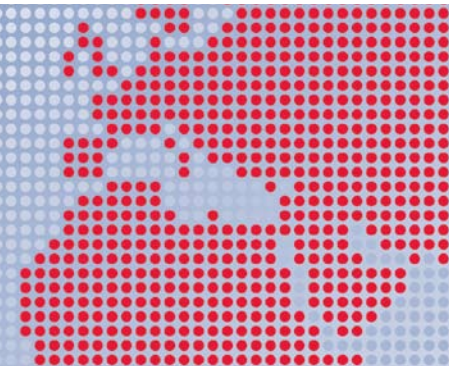
After examining the possibilities, experts conclude there really isn’t anything quite like malaria. Perhaps it is captured best by a famous comparison of malaria to the game of chess: “Everything about malaria is so moulded and altered by local conditions that it becomes a thousand different diseases and epidemiological puzzles. Like chess, it is played with a few pieces, but is capable of an infinite variety of situations” (Hackett 1937, 266).

Still, experts agree that even the chess analogy is a vast understatement of the disease’s complexity. Boston University Professor of History Jim McCann sums up the situation by describing a young Ethiopian woman who falls asleep in 2009 and wakes up in 2060. Upon waking, she asks what has become of malaria. The answer? “Go back to sleep.”

The challenge confronting malaria experts in the coming years is to find a way to offer a different response. ●

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— Lewis Hackett, 1937



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