EXTRA! EXTRA!
Want to know more about malaria?
• Learn about the parasite’s bizarre life cycle
• Listen to JHMBI director Peter Agre’s insights
• Experience the research life in Macha, Zambia
magazine.jhsph.edu/extras

SAVE THE DATE, RESEARCH ADVANCES IN MALARIA CONFERENCE
Resistance to Existing Drugs and New Drug Development
June 2-3, 2011, GSK Campus–Tres Cantos, Spain
malaria.jhsph.edu/programs/conferences_workshops/

NEXT ISSUE: MEN AND WOMEN ARE DIFFERENT!
From autoimmune diseases to responses to drugs and vaccines,
sex differences play an immense but under-studied role in human health.

ALSO IN THE SPRING 2011 ISSUE
Hey, Cut It Out: A better approach to bullying.
Disaster! How do you prepare for the unexpected?
What do most people not understand about malaria?
It's a very wily organism. It's a parasite with a cycle of life that is quite complex. It undergoes dramatic changes of costume in going from insects, into the liver, into the blood and then back into the mosquitoes. There are plenty of chances for it to evade our surveillance, and that’s why it’s dangerous.

What are some of the signal achievements in JHMRI's first 10 years?
Our faculty have made a number of discoveries that are promising. Jason Rasgon has identified agents that will infect these Anopheles mosquitoes and prevent them from reproducing. George Dimopoulos has made really interesting observations on Anopheles immunology. Marcelo Jacobs-Lorena has engineered Anopheles that are prevented from actually transmitting the disease. [Former JHMRI professor] Nirbhay Kumar and Rhoel Dinglasan both have interesting observations that may lead to transmission-blocking vaccines. The work of Gary Posner in the Chemistry Department [at the School of Arts and Sciences] suggests that we might be able to counteract the resistance to artemisinins by modifying the drug. Our colleagues at the Malaria Institute at Macha, in rural Zambia, have been able to knock down the prevalence of malaria 98 percent. All of those, I think, are really significant advances.

What are your priorities for the next 10 years?
No. 1, recruiting, attracting and educating the next generation of malaria scientists because this problem will not be over in 10 years.

JHMRI was recently awarded a $14 million International Centers of Excellence for Malaria Research grant from NIH. What does this mean for the Institute?
ICEMR is a new NIH program to launch scientific approaches to field malaria activities in seven regions of the world. We’ve been funded to study malaria in Zimbabwe and Zambia. It really validates the field activities that are ongoing. And it allows us now to interact with malaria centers of excellence elsewhere in the world to see if our experiences can help guide each other.

What’s been missing from the global fight against malaria?
Two things stand out. One is a lack of coordination among the malaria efforts worldwide—groups competing with each other in different areas. And I think the single biggest problem to the management of malaria is the lack of good governance in the developing world where there are civil wars, there’s hopeless abject poverty, there’s terrorism, there’s corruption. The control of malaria will require good public health measures.

What about malaria keeps you up at night?
Well, I guess there are two questions here: Keeps me up at night because I’m worried or keeps me up at night because I’m excited with the opportunity? Either way you lose sleep. Like any other manager of an institute, I have worries. We have generous funding, but it’s finite. Can we sustain this effort? Can we make accomplishments, move forward? On the other hand, most people my age—I’m 61—they’re thinking about retirement or vacation homes. I still feel like there’s a lot of passion. I can’t think of anything more important for someone like myself to get involved in. If things continue to go well, I plan to retire when I’m 99 [laughs].

Ever regret shifting your focus to fighting a disease that’s global, parasitic and so well-entrenched in mosquitoes and humans?
There is no regret. This is the job of a lifetime. It’s rare, I think, in anyone’s professional life when they have the kind of sense in their hearts that I do, that this is absolutely the right thing to do. And while I’m pleased how things have gone over the past three years, I sense we’re just beginning. They can fire me anytime, but I won’t go out willingly. ☎️
FIVE MILLION YEARS OF MALARIA

MAP KEY: MALARIA TODAY
- Malaria-free
- Eliminating malaria
- Controlling malaria

31 Moments in History

5 million years ago, West Africa. Plasmodium malariae, P. ovale, P. falciparum, and perhaps P. vivax evolve within early hominids.

4,000–8,000 years ago, Africa. Early agricultural efforts create ideal breeding grounds for Anopheles gambiae. Later, further deforestation, animal husbandry and development of villages support the spread of P. falciparum, the most deadly of the malaria parasites.

2700 BCE, China. Malaria symptoms are described in Nei Ching, Chinese medical writings.

340 CE, China. A malaria treatment made from Qinghao, a weed known as sweet wormwood, or artemisia, is described in a Chinese medical text and ignored by the world for 16 centuries.

1638, Peru. Per legend, the countess of Chinchon is cured of malaria by a powder made from “Peruvian bark,” or quina-quina. She introduces the powder to Europe in 1640. From malaria-ravaged Rome, Jesuits monopolize the distribution of “Jesuit powders” and bark from the later-named cinchona tree for 200 years.

1854, Dutch East Indies. The first cinchona tree is brought from South America to Java. British and Dutch plantations in India, Ceylon and Java soon dominate the cinchona market.

1861–1865, USA. During the American Civil War, 50–80 percent of the soldiers contract malaria yearly.

1861, Italy. Italian researchers Giovanni Batista Grassi and Raimondo Filetti name Plasmodium vivax and P. malariae.

1880, Algeria. French army surgeon Charles Laveran discovers parasites in the blood of a malaria patient. (Nobel Prize, 1907.)

1881, Germany. German researchers Paul Ehrlich and Paul Guttmann demonstrate that methylene blue, a synthetic dye, stained malaria parasites and had antimalarial activity. (Nobel Prize, 1908.)

1889, USA. William Osler makes Johns Hopkins Hospital the first hospital in the U.S. to do routine malaria blood film analysis for all febrile patients. At the time, Baltimore had more than 1,000 cases of malaria per year.

1890, Italy. Italian researchers Giovanni Batista Grassi and Raimondo Filetti name Plasmodium vivax and P. malariae.

1891, Germany. German researchers Paul Ehrlich and Paul Guttmann demonstrate that methylene blue, a synthetic dye, stained malaria parasites and had antimalarial activity. (Nobel Prize, 1908.)

1897, Canada and USA. William MacCallum and Eugene Opie, Johns Hopkins School of Medicine students, use the blood of crows to observe a sexual process in bird parasites.

1897, USA. William H. Welch, then dean of the Johns Hopkins School of Medicine and later founder of the Johns Hopkins School of Hygiene and Public Health (JHSPH), names P. falciparum.

1905–1910, Panama. The Panama Canal project, threatened by malaria and yellow fever, is saved by a malaria program based on drainage, brush cutting, oiling of fields, larviciding and quinine.

1920s, USA. Robert Hegner, a JHSPH medical zoologist, studies the effects of quinine derivatives on malaria in female canaries purchased from Baltimore pet shops.

1924, Germany. Chemical and dye company Bayer I.G. Farbenindustrie A.G. creates plasmochin, the first synthetic antimalarial, which proves rather toxic.
1939, Brazil. Rockefeller Foundation officer Fred Lowe Soper, DrPH ’25, MPH ’23, leads elimination program against An. gambiae in northeastern Brazil. The program succeeds in 1941.

1939, Switzerland. Swiss chemist Paul Müller discovers the insecticidal properties of dichloro-diphenyl-trichloroethane, or DDT. (Nobel Prize, 1948.)

1942–1945, Pacific Theater, World War II. Malaria accounts for more U.S. casualties than combat.

1944, USA. Eli K. Marshall of the Johns Hopkins School of Medicine, a leader in antimalarial research during the war, declares that drug SN-7618 may be the drug the world has been waiting for. He dubs it “chloroquine.”

1946, USA and UK. Winthrop Chemical introduces chloroquine, a synthetic quinine. Cheap, safe and long-lasting, it is considered a miracle medicine.

1951, USA and USSR. The U.S. halts transmission of malaria. The USSR establishes a malaria elimination program and succeeds 10 years later.

Late 1950s, Southeast Asia and South America. Resistance to chloroquine begins and spreads globally in the ensuing decades.

1955, Switzerland. The WHO launches the Global Malaria Eradication Programme. Despite early success, drug and insecticide resistance and a lack of funding and community participation doom the effort, which is abandoned in 1969.

1972, China. At Vietnam’s request for help in the war against the U.S., Chairman Mao establishes a secret military project that develops an effective antimalarial, Qinghaosu, based on the artemisia plant.

1979, China. Chinese Medical Journal publishes news of the discovery of artemisinin, or Qinghaosu; no authors are listed. The West adopts its use, and by the late 1990s WHO advocates use of artemisinin-based combination therapy (ACT) to reduce odds of drug resistance.

1987, Belgium. GlaxoSmithKline develops experimental malaria vaccine RTS,S. In 2009, stage 3 clinical trials begin in Africa. The vaccine is 30–50 percent effective.

1998, Switzerland. The Roll Back Malaria partnership is launched by WHO, UNICEF, UNDP and the World Bank. Its mandate is to implement coordinated action against malaria.

2001, USA. The Johns Hopkins Malaria Research Institute is founded with a gift from Michael R. Bloomberg.

2011. Seventy-nine countries have eliminated malaria since 1945. Fifty percent of the world’s population lives in malaria-free areas. (In 1950, only 30 percent lived free of malaria.)

Timeline: Christine Grillo
For every 1,000 children who sleep under insecticide-treated bed nets, 5.5 lives are saved. Yet some 20 percent of people who own nets don’t regularly use them as protection from malaria because they find the nets hot and inconvenient, or because they don’t see mosquitoes around.

Rapid tests reliably diagnose malaria in 15 minutes. Yet some health workers who perform the tests are skeptical of their accuracy and instead rely on their own judgment to diagnose malaria.

Artemisinin-based combination therapy (ACT) is known to be highly effective in treating malaria and countering drug-resistant forms of the illness. But as many as 50 percent of patients don’t seek malaria treatment from public clinics, and the ACT drugs available from private medicine shops may be ineffective because they are counterfeit, expired or of poor quality.

The fight against malaria is a complex one, and it’s complicated by the fact that the malaria parasite doesn’t just attack the body; it preys on human behavior and the mistakes we make. People don’t consistently make full use of the tools available to protect themselves from malaria, nor do they provide or seek effective treatment in a timely fashion, even when they know they should.

“There’s this idea that we can’t eliminate malaria without a vaccine,” says William Brieger, DrPH ’92, MPH, a professor in the health systems program in the Department of International Health at the Bloomberg School and a senior malaria specialist at Jhpiego. “An effective vaccine would certainly help—we always need new tools. But if we are not even fully using the technology we already have, then we won’t control malaria.”

Access to long-lasting insecticidal bed nets (LLINs) is still an issue in many parts of the world, but large-scale distribution campaigns over the last few years have proved successful in getting hundreds of millions of free nets to people in Africa who need them. However, just distributing nets isn’t enough, says Matthew Lynch, PhD, director of the Global Program on Malaria at the Center for Communication Programs. “Nets don’t work if people don’t use them.”

Some Africans say they don’t use nets because the sleeping areas in their small homes double as living areas during the day, and the nets are inconvenient to put up and take down, says Lynch, who directs the NetWorks Project at CCP, which was founded in 2009 and funded by a five-year cooperative agreement for up to $100 million from USAID. There are also people who avoid the nets during the dry season when mosquitoes are less prevalent. That’s a dangerous mistake to make, Lynch notes. “At the beginning of the dry season the mosquitoes that are around are older and more likely to be carrying malaria,” he explains.

CCP is involved in a number of messaging campaigns around the world to help people understand why they need to sleep under LLINs. In Senegal, for example,
people are being urged through TV, radio and interpersonal communication to follow the “Trois Toutes,” or “Three Alls,” and have “all your family members under a net, all nights of the year, all year round.” A successful campaign in Tanzania featured poignant two-minute interviews with national leaders whose loved ones had died of malaria. “One of the key factors for effective communication is ensuring all of the channels reinforce each other,” Lynch says.

Brieger, who has spent decades studying tropical diseases and human behavior, emphasizes that it’s not just potential victims who make mistakes when it comes to malaria prevention and treatment. Policymakers, health providers and others in the system also bear responsibility for making high quality and affordable services available.

It’s because of the lack of FDA-type agencies in some countries that counterfeit or poor quality ACTs can slip into the supply chain. It’s poor communication that leads health workers in some antenatal clinics in parts of Africa to place pregnant women at added risk for malaria by withholding free bed nets until after they have completed preventive treatment; by using the nets as an incentive to increase antenatal care, these health workers endanger the women and their unborn children. And in Burkina Faso, some health workers second-guess the results of rapid diagnostic tests for malaria, thereby leading to misdiagnosis of patients.

“We need to look at the behavior of service providers, of policymakers, of everybody,” says Brieger. If workers at health centers, the district level or even higher up “won’t provide the services, funds and commodities needed, you can’t blame [consumers] for not doing the correct thing,” he says.

Educating health care workers can have a significant impact on the care patients receive, he says. When workers in rural western Kenya were trained in the use of intermittent preventive treatment for malaria in pregnant women, their delivery of this treatment to community members improved. “Health care workers have misconceptions that may inhibit their provision of these services, and training is one intervention that can help them perform better,” Brieger explains.

Lynch hopes that as bed nets become more widely available, more people will use them consistently. He’d like to see a cultural change, wherein providing nets for your family becomes as much of a habit as providing food or clothing.

Still, he recognizes that even people with the best intentions can be unreliable—and that for most of us it is easier to talk about changing behavior than it is to actually change it.

“Nets are not always easy to use and they require discipline and a consistent habit. That’s hard to do,” he says. “How many of us have sworn that we were going to floss every day or stick to our exercise regimens because we know it’s good for us … and yet we still don’t do it?”

—Maria Blackburn

In Falciparum’s Shadow

Funding agencies and their contributions to global malaria research reflect a long-held bias. By focusing on the most lethal parasite species, *P. falciparum*, they are neglecting the formidable *P. vivax*. Only 5 percent of malaria funding is directed toward *vivax*, yet it threatens 2.6 billion people worldwide (40 percent of the world’s population) and is harder to prevent, diagnose and treat, says biologist Rhoel Dinglasan, PhD, MPH. A recent re-audit across endemic regions (Asia, the Mediterranean and South America) shows that at least one-quarter of severe malaria patients are solely infected with *P. vivax*. “We have underestimated this species for a long time,” says Dinglasan. “It is certainly not the ‘benign malarial disease’ dictated by dogma.”

Neglecting it could doom future eradication efforts, he says. —CG
 Dreams Die Hard

Mention "eradication" among malariologists, and you likely will spark a hot debate. All agree that the goal is noble—but from there controversy ensues. Is eradication manifest destiny? Or is it a pipe dream that does more harm than good?  

Story by Christine Grillo

It’s Complicated

“I can’t stand this word,” says Clive Shiff (above, right), associate professor in Molecular Microbiology and Immunology (MMI) and a veteran of the long war on malaria. One among many, he believes that malaria is a human public health problem that will require attention for as long as we inhabit the earth. Control yes, eradication no.

In the malaria lexicon, “control” refers to vigilant, coordinated programs of drug therapy, spraying, research and education, which can reduce the disease burden to a manageable level. Further along the continuum, elimination is the interruption of malaria transmission in a region. Eradication is a global, permanent reduction to zero.

“When we talk about eradication,” says Shiff, PhD, “we relay to people in endemic areas that this is achievable, and then they think they don’t have to plan or budget for malaria control. It’s an excuse to stop the effort.”

In fact, a November 2010 Lancet series endorsed control as a near-term goal, arguing that it appears more realistic and cost-effective than elimination or eradication.

Over the last 60 years, there have been dozens of success stories in control—and stories of devastating defeat when control programs were halted. “Malaria can be controlled,” says Shiff, “with sufficient resources…. If done extensively, it will work.” New tools like cell phones and rapid diagnostic tests are enabling health officers to target interventions in real time.

Donor money can help endemic regions to bring down the parasite load, but after that, ministries of health must take on responsibility for long-term control programs. “Governments have to realize that they have to run the show,” says Shiff. “We can control malaria. But we tried eradication. It wasn’t achievable.”

Let’s Get Together

Scientists like Rhoel Dinglasan, MMI assistant professor, respectfully disagree. Victory may be 30 or more years away, but he believes that with the right cocktail of collaboration, openness and inspiration, it can happen. “Early efforts failed at eradication, but it’s not original sin. It doesn’t mean we’re going to fail,” he says.

In 2009, the molecular biologist was asked to create and co-chair the Young Investigators consultative group of the Malaria Eradication Research Agenda, or MalERA (malaria.tropika.net), to outline research priorities toward the long-term objective of eradication. The Young Investigators produced a paper specifying research that would augment current eradication efforts—urging frank conversation and the sharing of raw data.

Candid about the role of basic science in malariology, Dinglasan, PhD, MPH, admits that not all research in the discipline is directly applicable to solving the questions of elimination and eradication. “However, we also haven’t really applied ourselves,” he says. One of the goals of MalERA was to guide public and private enterprises in prioritizing the research that should get funding. One example: Use a team to complete the life cycle of the parasite in vitro so labs could test new drugs and interventions against all stages of the parasite in high throughput. “It’s not a hypothesis, it’s a to-do list,” says Dinglasan. “We want to get data and approaches to feed into this effort now, so that in five to 10 years, the community will be armed with this ‘tool’ that can quickly move discoveries from bench to the field. Then people will start to believe.”

Dinglasan may be called naïve—but he clings to his vision: “How do I continue to be optimistic and inspire people despite the huge challenges ahead? I don’t know. Maybe it’s the caffeine.”

*Chris Hartlove

*Story by Christine Grillo
**ANOPHELES’ SHIFTING DINNER TIMES**

For some female *Anopheles* mosquitoes, not just any blood meal will do. The nourishing red stuff has to come from humans.

This odd pickiness could pose an obstacle for malaria eradication efforts. Christen Fornadel, PhD, who works in the lab of associate professor Douglas Norris, PhD, MS, at the Johns Hopkins Malaria Research Institute, recently ventured to Macha, Zambia, for a closer look at the problem.

The main carrier of malaria in Macha, the mosquito *Anopheles arabiensis*, has been found to have different feeding behaviors in different African regions—suggesting that it has the capacity to shift its diet from humans to other animals if nudged. From 2004 to 2007, the government of Zambia issued insecticide-treated bed nets (ITNs) to most households in the area, and as Fornadel says, “if people were protected, since this mosquito is known to feed mostly on cows in other places, we thought maybe we’d see a shift and it would start to prefer feeding on cattle.”

Before the bed nets were introduced, studies by Fornadel, Norris and others had found that local *A. arabiensis* obtained about 90 percent of their blood meals from humans. During the 2007-2008 and 2008-2009 rainy seasons in Macha, Fornadel spent several weeks pulling all-nighters with a local team, setting up and monitoring mosquito catches, to see whether the malaria-carrying pests had acquired more of a taste for local cattle.

The bad news: “The mosquitoes we caught were still getting over 90 percent of their blood meals from people, in part by biting before bedtime,” says Fornadel.

The findings represent just a snapshot of mosquito feeding behavior, a complex phenomenon that needs more study. But the results agree with other research in Africa that has found a continued preference for human blood by *Anopheles* in some areas despite ITN introduction. Fornadel concludes, “On their own, the nets clearly aren’t going to eliminate the disease in the Macha region.”

**ANOTHER SIDE OF MALARIA MORTALITY**

Malaria is best known for its deadly cerebral complications, but a less well-studied complication hits another vital organ, the lungs. “About one in five severe malaria infections causes respiratory disease such as acute respiratory distress syndrome,” says MD/PhD student Ifeanyi Anidi.

Anidi, who works in the lab of Molecular Microbiology and Immunology Professor Alan Scott, PhD, is among a growing band of researchers now looking for ways to understand and defeat these pulmonary complications.

Just as in cerebral malaria, he says, the trouble starts when malarial parasites—typically *Plasmodium falciparum*—try to evade the spleen by getting out of the bloodstream’s circulation. The sticky proteins they produce cause infected red blood cells to cling to blood vessel walls and clog the smaller lung vessels. Either directly or by provoking a damaging immune reaction, this grab-and-hold process starts to kill the endothelial cells that make up the vessel walls. Fluid then seeps from the bloodstream into the gas-exchange chambers of the lungs, making it harder and harder for victims to breathe. “The process can keep doing damage for days after the infection has been cleared,” says Anidi. “It’s a significant cause of death in severe malaria.”

One big factor in the process is CD36, the endothelial cell-surface receptor to which malarial sticky-proteins are designed to stick. “We’ve found that mice genetically engineered to lack CD36 have much less leakage in the small vessels of their lungs,” Anidi says.

Precisely how CD36 brings about this leakage isn’t yet clear; the receptor is also expressed by invader-gobbling immune cells called macrophages, so it might be a key to the immune reaction seen in affected vessels. But, using mouse models of malaria infection, Anidi and his fellow researchers aim to discover enough about the process to start thinking about ways to damp it somehow in a clinical setting. “It’s a fairly new field and we’re learning a lot very quickly,” he says.
SOLVING CEREBRAL MALARIA’S MAJOR MYSTERY

How does cerebral malaria kill? It accounts for nearly 800,000 deaths per year, yet unlike most coma-inducing pathogens, *P. falciparum*, the cerebral malaria parasite, does not even enter the brain. “It stays inside red blood cells, within the cerebral blood vessels,” notes Monique Stins, PhD, an assistant professor of Neurology in the School of Medicine who frequently collaborates with scientists at the Johns Hopkins Malaria Research Institute.

*P. falciparum* makes its host cells stick to the linings of blood vessels because they are then less likely to circulate and be eliminated by the filtering spleen. Within the small vessels of the brain, this stickiness causes infected red blood cells to gather and restrict blood flow to some extent. But that doesn’t explain why the brain becomes inflamed and swollen—often raising intracranial pressure enough to cause seizures and death.

Stins and other researchers have been looking at endothelial cells, which form the linings of blood vessels, as the likely middlemen in this process. “We’ve found that once they come into extended contact with *falciparum*-infected red blood cells, these endothelial cells lining cerebral vessels start to release numerous inflammatory compounds,” she says.

It had been thought that these compounds are released only into the bloodstream because they are then less likely to circulate and be eliminated by the filtering spleen. Within the small vessels of the brain, this stickiness causes infected red blood cells to gather and restrict blood flow to some extent. But that doesn’t explain why the brain becomes inflamed and swollen—often raising intracranial pressure enough to cause seizures and death.

If the work pans out, she adds, it could lead to therapies that block specific signals released from these endothelial cells, thereby preventing coma while the malaria infection is treated.

MAPPING HIDDEN RESERVOIRS

Hospitalization rates for malaria are declining in Africa, but the disease is still far from being eliminated. Malaria parasites have been co-evolving with humans in Africa for millions of years, and, as Tamaki Kobayashi, PhD, MPH, explains, “in endemic areas, people who are repeatedly exposed to malaria develop a partial immunity, so they don’t feel sick even though they still harbor the parasites.”

To track these hidden reservoirs of malaria, Kobayashi, an Epidemiology research associate, has been sampling asymptomatic populations in Zambia using a blood test for antibodies against *Plasmodium falciparum*. Steadily declining levels of these antibodies in a person or a community indicate that malaria transmission has dropped off—and immunity has declined—while a sudden rise from lower levels indicates a recent exposure.

“In areas where malaria exposure is no longer so frequent, we think we can use this technique to develop a finely detailed map of its spread in asymptomatic people over time and across geography,” she says.

Kobayashi, who won a 2009 Young Investigator Award from the American Society of Tropical Medicine and Hygiene, works closely with Molecular Microbiology and Immunology Professor Greg Glass, PhD, and research associate Tim Shields, MA. The experts in geographic information systems prepare maps of target areas using satellite imagery. “They help us to identify which households to include in our studies, and also help with spatial analysis,” she says.

Kobayashi has taken samples from more than 1,500 people over the past few years. In principle, those communities in which malaria is revealed to be quietly smoldering would become the focus of antimalarial drug treatment efforts. Even communities where antibody levels have fallen steadily would be encouraged to tighten their malaria control programs because, as Kobayashi says, “their falling immunity would indicate an increased susceptibility to disease resurgence.”
The first time that I saw malaria up close was more than 20 years ago on Thailand’s northern border with Burma. I was living temporarily in the area called Tak with thousands of refugees, migrant workers and students who left Burma because of political and economic instability. Malaria was endemic in the area.

At that time, a lot of antimalarial drugs were failing. Malaria was basically a death sentence for pregnant women. They are more susceptible to malaria infection, tend to have severe complications and do not respond as well to drugs.

It was a helpless and hopeless situation. When I returned 10 years later as a medical student with the Oxford-Mahidol Research Group, things were very different. The group was leading a large clinical trial testing artemisinin combination therapy (ACT) in pregnant women in the Mae La refugee camp, which housed about 30,000 people. ACT gave pregnant women a much greater chance of survival.

However, not all pregnancies had good outcomes.

I remember a woman who was seven months pregnant. We treated her for a urinary tract infection. She tested negative for malaria, but a few days later she became very ill. Her blood pressure dropped suddenly. We urgently treated her with intravenous quinine and other therapy and then drove her to the hospital. She died of malaria. It was a tragic reminder of how quickly malaria can kill, particularly those with insufficient immunity such as pregnant women.

Fortunately, ACT helped most patients get better. It was wonderful to see researchers and others working in a concerted effort to screen women and treat them with ACT. That’s when I became excited about doing field clinical research. I witnessed the power of research in making effective changes and in reversing a situation that seemed so hopeless only 10 years before. I was inspired by these researchers.

Since then, I have focused my research on how drugs work in pregnant women. There is not a lot of data about antimalarial drugs and pregnant women. We’re starting a study in Mali now to examine how HIV and antimalarial drugs work together in pregnant women who are co-infected. It is complex because we are treating two patients—mother and fetus—simultaneously, each with a unique set of dynamic physiology and metabolism that is quite different from the general population.

We have a lot to learn.

Myaing Nyunt, MD, PhD, MPH, is an assistant professor in International Health and a faculty member in the Johns Hopkins Malaria Research Institute.

Essay illustration by Clemente Botelho