Karen Logan, PhD,
Target Malaria,
London, England

Biting Back

Erasing mosquito-borne diseases requires teams to educate stakeholders and root out schedule risks.

BY NOVID PARSI
PORTRAITS BY JON ENOCH

The team at Eliminate Dengue Brazil, part of the World Mosquito Program

The world's deadliest animal doesn't have claws or teeth—and it's tiny.

Each year, blood-sucking mosquitoes kill 830,000 people by carrying and spreading disease. Malaria is by far the deadliest mosquito-borne disease, causing about 430,000 deaths a year, most of them children under age 5.

But there's a global effort afoot to swat down the fatal bugs, led by project teams devising innovative, tech-driven solutions. The Bill & Melinda Gates Foundation has pledged more than US$1 billion to fund tech projects designed to eradicate malaria, but it's just one of many sponsors around the world eager to make a difference. Projects range from deploying new types of bed nets to unleashing genetically modified mosquitoes whose progeny no longer can pass on diseases.

"We need different tools to address the behaviors of different mosquitoes."

—Erin Stuckey, PhD, Bill & Melinda Gates Foundation, Seattle, Washington, USA

Children learn about mosquito breeding sites as part of a dengue awareness campaign in Vietnam.

Last year, scientists at Michigan State University completed a US$1 million project to open a facility in Mexico that's capable of producing 1 million male mosquitoes per week. When those male mosquitoes mate, they make the area's existing females sterile—thus reducing the transmission of diseases such as dengue and Zika.

But first the project teams must secure the approval of regulators and understandably wary communities not yet familiar with the new technologies. And in the face of unknowns involving both stakeholder acceptance and the technology itself, project managers need to have a flexible approach to their plans. With no universal approach, teams must take a strategic approach to deploying innovations that will end the various diseases carried by mosquitoes.

"We need different tools to address the behaviors of different mosquitoes," says Erin Stuckey, PhD, program officer, Bill & Melinda Gates Foundation, Seattle, Washington, USA. "The mosquito species that transmits dengue is different from the one that transmits malaria, so we might not be able to use the same tools even though the species might be in the same place."

SPREADING SUPPORT

Before these initiatives can help potentially millions of people, their project managers first must gain the approvals of a wide range of stakeholders—from funders to regulators to residents. "We don't run any projects until they have formal government regulatory approval as well as support from the local affected community," says Scott O'Neill, PhD, director, World Mosquito Program (WMP), Ho Chi Minh City, Vietnam. Since 2011, WMP has launched projects in 12 countries to introduce naturally occurring bacteria into mosquito populations to prevent them from transmitting viruses. WMP's ultimate goal: "We hope to be able to successfully transfer the new technology to the governments of at-risk countries," Dr. O'Neill says.

The objectives are similar for Target Malaria. Comprising more than 145 team members from 14 organizations in Africa, Europe and North America, the organization aims to eliminate malaria in sub-

830,000

Number of people killed each year by **mosquito-borne diseases**

430,000

Number of people killed each year by **malaria spread by mosquitoes**

Source: World Health Organization

Saharan Africa by developing a new tool for vector control. The ultimate goal is to produce a genetically modified mosquito that will be able to persist in the environment and pass the modification from generation to generation, eventually resulting in the reduction of the targeted mosquito population and reduction in the number of cases of malaria.

To ensure both government regulators and community members accept the safety and efficacy of its technology, the project team is taking a phased approach to introduce the new tool. For instance, when Target Malaria produces and releases sterile male mosquitoes, the team gets approval for a contained use permit before requesting permission for small-scale releases.

"It's the most risk-averse step," says Karen Logan, PhD, senior project manager, Target Malaria, London, England. "It introduces stakeholders to genetically modified mosquitoes that are not able to survive in the environment and with no transfer of modified genetic material to the wild population of mosquitoes."

The phased approach offers two primary advantages. It helps the team hone its technology and process so that, when Target Malaria finally executes the gene-drive phase, it can do so efficiently and effectively. A phased approach also helps regulators and local stakeholders understand and accept the technology before it's implemented.

"Our initial steps allow us to train and develop not just our own teams but also inform and engage with regulators and communities," Dr. Logan says. "The phased approach gives stakeholders time to be comfortable with and confident in the technology and the project."

"By far the biggest project management risk we have involves the novel nature of the technology."

—Scott O'Neill, PhD, World Mosquito Program, Ho Chi Minh City, Vietnam

Some teams take a grassroots approach to earning buy-in. When Verily Life Sciences, a unit of Google parent Alphabet, launched a project last year to breed sterile male mosquitoes, the team set up an outreach booth with a cage full of male mosquitoes. Community members could put their hands inside and see firsthand that males don't bite. Target Malaria has project teams in each African country where it has a project. Within those teams are engagement officers who live in some project sites as resident project representatives to help reassure local residents of the team's commitment to success, Dr. Logan says.

BEGINNER'S RISK

Implementing any new technology introduces risk. But when innovation is being tested in remote locations—far from teams' core research facilities and in areas with socio-economic and political uncertainties—the list of unknowns is even longer. Burkina Faso was the first country to grant the Institut de Recherches en Sciences de la Santé, Target Malaria's partner institution in-country, permission to complete its first phase and release genetically modified, sterile male mosquitoes. "This has never been done not just in Africa but anywhere," Dr. Logan says.

The University of California, Irvine Malaria Initiative (UCI MI) is developing a genetic modification that will render mosquitoes unable to transmit malaria, a trait they will pass on to their progeny. The five-year proof-of-concept project that's scheduled to be completed in 2022 is designed to eliminate malaria in one sub-Saharan Africa village. Yet the UCI MI team has to identify the local stake-

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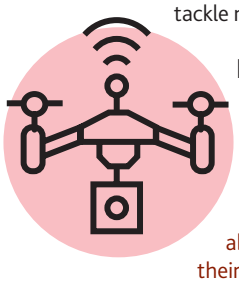
Proactive Prevention

These tech projects are helping to tackle mosquito-borne diseases:



Project Premonition

Microsoft's Project Premonition builds smart mosquito traps deployed by unmanned aerial vehicles, or drones. The traps' sensors collect data about the mosquitoes, such as their species and behaviors, and the drones deliver and retrieve the traps for lab analysis. The latest pilot deployment for this program was launched last year by researchers in Pittsburgh, Pennsylvania, USA. To ensure success, the project team now must develop software that makes the drones crash-proof, an essential feature as they navigate difficult terrain like swamps and savannahs.

SensoryGen

Researchers at the University of California, Riverside in the United States are aiming to devise a safe, naturally occurring scent that repels mosquitoes. Last year, the team developed artificial intelligence software that analyzes half a million potential chemical compounds and identifies natural chemicals that both repel mosquitoes and please humans.

AGS-v Vaccine

Typically, vaccines target specific viruses carried by mosquitoes. But there is no widely available vaccine for malaria. The AGS-v vaccine triggers an immune response to mosquito saliva to prevent infection from whatever virus the mosquito happens to contain. A trial study of the vaccine is expected to be completed by the end of 2019.

holders from whom it must secure approval—a challenge that requires persistence and an adaptive approach to risk.

"Sometimes the government changes, and the person you meet initially will be out of office the next time you call," says Sentelle Eubanks, project manager, UCI MI, Irvine, California, USA. "It's a moving target."

To help zero in on that target, the team hired a community engagement consultant and will hire a local full-time community engagement staff member who interacts with regulatory and local stakeholders. "Our project requires cooperation across many government agencies, towns, scientists and people," says Ms. Eubanks.

Developing a new technology also introduces uncertainty—and thus requires flexibility. "By far the biggest project management risk we have involves the novel nature of the technology," Dr. O'Neill says.

For the WMP team, the biggest risk is developing and deploying a cutting-edge technology that ensures success in different environments. Precise planning of resources for each project is challenging, Dr. O'Neill says. "As a result, we have to keep revising our projects' scope to match our available resources."

For example, it's difficult for teams to determine how many weeks of releases will be required for successful deployment of a technology at a given location, he says. As a result, some locations might not need to release as many mosquitoes as expected while others might require more than originally planned. "So with a fixed amount of money for a project, the land area we can cover needs to be continually assessed and reassessed," he says.

For the UCI MI team, the growing public interest in these tech-driven projects means it has to spend more time and effort on stakeholder management. "The primary risk at this point is public perception," Ms. Eubanks says. "There are people [from nongovernmental organizations] attempting to shut down the science because they don't like genetically modified things, much less mosquitoes."

To address such skepticism, she crafted a communications plan that identifies the team members who can respond to various queries and situations. It also involves a slew of materials, such as a website

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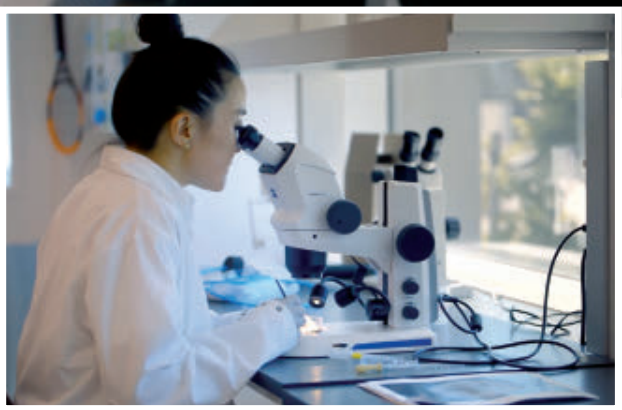
The team at Debug Fresno, a project from Verily Life Sciences, in Clovis, California, USA



and brochures, that accessibly convey the project's objective and process to the public. Moreover, the team actively engages public stakeholders, offering them tours of the UCI MI lab. The team will continue that work in the field, providing tours to African schoolchildren.

"We want to be open and transparent to everyone," Ms. Eubanks says. "If people see the process for themselves, they know there's nothing to fear."

FLEXIBLE FOUNDATION

As a result of such extensive community engagement, project managers have to take a flexible approach to their schedules. "It's very difficult to put the regulatory and stakeholder engagement on a Gantt chart because the length of time people need to absorb and be comfortable with the technology drives the project's schedule," Dr. Logan says. "We can't move forward until stakeholder acceptance is adequate."

In addition to analyzing local feedback to gain buy-in, the team uses lessons learned from previous projects to identify possible schedule obstacles, Dr. Logan says. The team translates the strategy into work packages that assess frequency of engagement, set key performance indicators to ensure engagement is satisfactory and establish indicators for when it's time to move to the next step, she says.

"Every project needs some flexibility, and as project manager, the important piece is understanding the steps that need close monitoring and feedback from those carrying out the work packages to ensure everything stays on track," Dr. Logan says.

Yet having to take a flexible approach, whether to schedule or scope, doesn't mean doing away with a planned approach. The Target Malaria team works on a five-year plan with 12-month rolling cycles involving regular reports on project progress, Dr. Logan says. For parts of the project that can't be controlled or influenced, the team has to be satisfied with time estimates—and convey that to project sponsors and key community stakeholders in a way that maintains their confidence, she says.

"We're going slowly because we know that's what we need to do, and that's the pace the project needs. But it's one of the things we struggle with the most, because people living with malaria rightly want solutions and want them now." **PM**

"There are people attempting to shut down the science because they don't like genetically modified things, much less mosquitoes."

—Sentelle Eubanks, University of California, Irvine Malaria Initiative, Irvine, California, USA