Inside the global campaign to get rid of rabies

By Erik Stokstad

ON A SUNDAY EVENING last July, Flora Gichonge was walking with her friends to church near the village of Gesarya, Tanzania. Suddenly, they were attacked by something hellish: A rabid dog, foaming at the mouth, charged out of the dense bushes lining the dirt road. “We tried to run away, in fear,” the 25-year-old recalls. But she tripped and fell. The dog lunged and bit her in the backside before her friends drove it away by throwing stones. After Gichonge limped home, a relative urged her to travel the 16 kilometers to the nearest hospital to get immunized against rabies. Her husband, a businessman, had the $40 to buy three doses of the life-saving vaccine from a pharmacy. A few days later, she was back at work, gathering and selling nuts. She knows she was lucky, although now she’s afraid of strange dogs.

Many others are less fortunate. An estimated 59,000 people die from rabies worldwide each year, almost all infected by dogs. Malaria, HIV, and tuberculosis take much higher tolls. But the horrible suffering caused by rabies—some patients have convulsions and become aggressive, just like rabid dogs—and the fact that many victims are children led the World Health Organization (WHO) and other groups in 2015 to announce a goal to eliminate rabies deaths worldwide by 2030.
In theory, nobody should die from rabies. It’s one of the few viral diseases where administering a vaccine after exposure can still save your life. Developing countries try to provide enough doses to hospitals and clinics. Unfortunately, supplies often run out. People who can’t afford to buy the jabs from private pharmacies, or don’t get them in time, are doomed. Untreated rabies is the deadliest of all diseases, fatal almost without exception.

That’s why the global plan calls for cheaper and faster treatment for people. But its long-term bet is on vaccinating domestic dogs, which pose the biggest threat to people in the developing world. “It’s the only way you’re going to eliminate the problem,” says Louise Taylor, scientific director of the Global Alliance for Rabies Control, an advocacy group based in Manhattan, Kansas. To rid a canine population of the virus, vets aim to immunize at least 70% of dogs for several years. After that, a lower coverage level suffices to keep outbreaks at bay.

This strategy has stopped rabies as a killer in developed nations. Elsewhere, the challenges are enormous, and nowhere bigger than in sub-Saharan Africa. Poor countries can hardly pay for millions of dogs to be vaccinated, and their governments often have trouble organizing vaccination campaigns across vast rural areas—even if they have the political will. Big donors, for their part, prefer to work on diseases with a higher death toll or believe that reaching enough dogs is too complicated.

In fact, dog campaigns are relatively straightforward, but they often face obstacles. The veterinary teams that typically run them don’t work together with public health authorities and tend to prioritize cattle and other valuable livestock, which usually die of other diseases. “In Africa, what’s a dog? It’s worth nothing,” says Jens Fissenebert, who runs Mbwa Wa Africa, an animal welfare charity near Arusha, Tanzania. “The connection with saving human lives is not there.”

Now, in pilot projects underway in Tanzania, Kenya, and a few other African countries, scientists are testing strategies for reaching and vaccinating dogs more efficiently. They are also collecting data...
to pin down the toll of rabies, demonstrate the connection between dog vaccination and human health in poorer countries, and quantify the economic benefits of national campaigns.

Although the 2030 target seems improbable, if not impossible, proponents point to a few successful efforts—including the brief defeat of dog rabies in N'Djamen, the capital of dirt-poor Chad—to show that the disease can be beaten back even in Africa. “It’s not going to be fast, easy, or inexpensive,” says Charles Rupprecht, a rabies expert and consultant near Atlanta. “But it can be done.”

THE RABIES VIRUS IS A MARVEL of biological ingenuity, cruelly manipulating its host’s behavior to further its own reproduction. After a dog becomes infected, usually through a bite by another dog, the virus travels to the brain and renders the animal hyper-aggressive and excitable, with a hoarse howl. The virus also spreads to the salivary glands, which start producing saliva laden with billions of viral copies. By interfering with the pharyngeal nerves, the virus makes it hard for the dog to swallow, leading to more saliva and increased chances of transmission.

The disease is similarly gruesome in humans. In what’s known as paralytic rabies, about one in five patients slips into a coma and dies of respiratory and heart failure. Furious rabies is even worse, with symptoms including fear of water—even to drink—spasms, terror, and aggression. Human-to-human transmission of rabies is believed to be extremely rare, and has only been documented from a few organ or cornea transplants. Only 15 people are known to have survived rabies, and almost all had been at least partially immunized.

Louis Pasteur developed the first rabies vaccine, made from the dried spinal cords of infected rabbits, and famously used it to save the life of a 9-year-old Parisian boy in 1885. Today’s versions are produced from virus grown in cultures of human cells, then chemically sterilized; they are more effective, far less painful, and have fewer side effects. Three to five jabs over several weeks will prevent the virus from reaching the brain if given quickly enough. A dose of rabies antibodies is also recommended for people not previously inoculated.

Dog vaccines were first developed in the 1920s. Still, it took decades to eliminate rabid dogs as a public health threat in Europe, Japan, and elsewhere. Now, Latin America is on the verge of replicating the success (see timeline, below), following a concerted and coordinated campaign that reaches 40 million to 50 million dogs each year.

Rabies can never be wiped off the face of the planet, as smallpox was, because so many mammal species harbor it. These reservoirs pose a continuing, albeit minor risk for humans: In the United States, one or two people still die each year after being bitten by rabies-infected bats. In Eastern Europe, rabid foxes are a concern.

As with other neglected diseases, it is difficult to know the exact human toll. Asia currently suffers the highest number of deaths, an estimated 35,000. Africa has fewer, but the individual risk of dying of rabies is particularly high in sub-Saharan countries (see map, p. 241) because of the many unvaccinated dogs—they’re widely used for guarding livestock and homes—and underfunded health systems.

“DANGER! DANGER! RABIES KILLS” says the poster on the mud-brick building. A makeshift clinic has been unloaded from a battered Land Rover in Ligamba, a small village in the Mara region here, to offer free shots for dogs. In the shade of a tree, Imam Mzimbiri wields a hypodermic needle. He tells a middle-aged man to grasp
the neck of his large dog. The man digs his sandals into the sand, but the dog leaps away and nearly breaks his rope leash. Mzimbiri, a veterinarian with the Serengeti Health Initiative run by the Lincoln Park Zoo in Chicago, Illinois, casually walks off and then circles back behind the dog. He darts in and jabs the needle into its thigh. “This one was hard to handle,” he says.

Mostly, the animals cooperate. Over several hours, the team vaccinates 145 dogs. Traveling to all the villages within 10 kilometers of Serengeti National Park, Mzimbiri and his team notch up 45,000 dogs a year. They also vaccinate the occasional cat; although cats are uncommon pets in Africa and not a reservoir of the virus, they can transmit rabies to people.

The work has helped make this part of Tanzania an exemplar of progress in the fight against rabies. The campaign started out of concern for endangered African wild dogs (Lycaon pictus), which had died out in Serengeti National Park from rabies. In 2002, the U.S. National Science Foundation provided $1.5 million for a study of carnivore disease ecology in the park. As part of the work, veterinary epidemiologist Sarah Cleaveland of the University of Glasgow in the United Kingdom and colleagues started vaccinating dogs around the borders, hoping to keep rabies from spreading to other wildlife in the Serengeti.

Cleaveland quickly became equally concerned about rabies’s impact on people. “As soon as you start studying rabies in wildlife, you’re confronted by the human tragedy,” she says. Fortunately, the dog campaign helped bring down human cases and alleviated other hardships. Villagers bitten by a rabid dog can spend 25% of their annual income on inoculations, which cost an average of $60 for a full five shots. (Most people get three.) And rabid dogs can infect cattle, driving annual livestock losses across Africa that cost some $280 million a year.

In Mugumu, a dusty town on the northwestern side of the park, researchers are trying to quantify the benefits of dog vaccination. Ahmed Lugalo, a veterinary epidemiologist affiliated with Sokoine University of Agriculture in Morogoro, Tanzania, follows up on dog bites and rabies cases recorded in logbooks from clinics and hospitals. He also has a network of dozens of paraveterinary assistants in surrounding villages who keep an ear out for reports of rabid dogs, conduct interviews, and, when possible, take brain samples of dogs suspected to have died of rabies. The effort, directed by veterinary epidemiologist Katie Hampson of the University of Glasgow and funded by the Wellcome Trust, provides data that allow researchers to create and test models of rabies transmission and the effects of vaccination.

On a recent afternoon, Lugalo and a paravet drive to the outskirts of Mugumu to interview Ghati Muhingira about a serious dog bite. Her children play nearby, as scrawny chickens peck in the dirt yard. A breeze rustles corn fields. This past August, Muhingira’s oldest daughter, Asha, was bitten on her leg by a dog as she walked to school. Gazing vacantly into the distance, Muhingira says that after she saw the deep wound, she called a motorbike taxi and rushed 7-year-old Asha to the hospital. The staff only gave her a tetanus injection, because the dog’s owner said it had been protected against rabies. The staff only gave her a tetanus injection, because the dog’s owner said it had been protected against rabies.

In early October, Asha told her mother that her healed leg was aching. Two days later, when she became feverish and had trouble swallowing, her mother took her to the hospital. It was rabies. The owner of the dog had lied about its vaccination. A few hours before
she died, Asha, delirious, thought she saw her school teacher and called out: “I’m healed. I want to go home.”

Later in the day, Lugalo says that such stories take an emotional toll—he recently became a father himself. During the interview, however, he’s all business. He asks how much Muhingira spent on the hospital visit. Then he asks about the dog. It had bitten another child, Muhingira says. Lugalo advises her to get her own dog immunized, and the team leaves to interview the mother of the other victim. Not taking any chances, she had already gotten her daughter vaccinated. The dog owner, who lived next door, boarded up his house after the police started an investigation. “He has run away, like his mad dog,” says Lugalo’s co-worker Matthias Magoto, shaking his head.

IT’S PAINSTAKING WORK like this that helps clarify the true burden of rabies. Cleaveland has developed a now widely used method to estimate the death toll, using the numbers of bites by dogs thought to be rabid, as well as records of postexposure vaccine use. The best estimate for the current toll in Africa, 21,000 deaths, comes from a 2015 paper by Hampson and colleagues; it’s 100 times higher than official figures.

The initial numbers from the Serengeti were enough to turn Cleaveland into an advocate for better control of rabies and, ultimately, its elimination. She helped WHO win what became $12 million from the Bill & Melinda Gates Foundation for pilot projects in Tanzania, South Africa’s KwaZulu Natal province, and the Philippines.

Starting in 2010, government workers began to vaccinate 150,000 dogs across Tanzania’s southeast, covering about 18% of the country, and on the island of Pemba in the north. Health and veterinary workers used text message questionnaires to report dog bites and use of human vaccine, which led to better, faster, and cheaper surveillance, researchers reported in PLOS Medicine last April. By the third year, 65% of dogs in the target villages had been vaccinated, on average. The coverage was lower in remote villages.

The effort halved the number of reported dog bites overall, and rabies appears to be almost gone from about a third of the 28 districts in the program. For 2 years the dog population on Pemba was free of the virus. Unfortunately, this past August, an infected dog brought in from the mainland caused a small outbreak. “It was really disappointing,” Hampson says.

The main lesson of the pilot: Eliminating rabies in Tanzania, although feasible, may be a logistical challenge, and surprisingly expensive. An audit by Rupprecht and colleagues found that costs ranged from $7.30 to $11.27 per dog, much more than the $1 to $1.50 they had expected. Higher startup costs, such as vehicles and other equipment, contributed, but the bulk of the bill was due to per diem payments that Tanzania charged WHO for the services of government vets.

The government is now drawing up a strategy to expand the scheme to the entire country. Tanzania will have to do the job without support from the Gates Foundation, however, which funded only pilot projects, hoping that governments and other donors would then take over. The test of Tanzania’s resolve will come in September, when the next vaccination round is due to start.

A FEW OTHER CAMPAIGNS have emboldened rabies fighters in sub-Saharan Africa. A team led by Jakob Zinsstag, a veterinary epidemiologist at the Swiss Tropical and Public Health Institute in Basel, eliminated canine-transmitted rabies for 2 years in N’Djamena, although one rabid dog was detected in 2014, apparently an invader from the countryside. KwaZulu-Natal has seen success at a bigger scale. In 2007, rabies cases in dogs and humans were at their highest recorded levels; they have declined dramatically thanks to vaccination efforts supported by another Gates Foundation–funded program.

Kenya is the latest country to get on board, with growing political support. It released a national strategy for rabies elimination in 2014 and has started two pilot projects. Even national success won’t be
enough in the long run, says Thumbi Mwangi, a veterinary epidemiologist at Washington State University (WSU) in Pullman and an adviser to Kenya’s Zoonotic Disease Unit. “The day we have fully eliminated rabies in Kenya, we will start to get incursions” from neighboring countries, he says. Ultimately, Africa will need to develop the kind of regional cooperation that has worked well in Latin America.

For Africa as a whole, rabies elimination would cost between $800 million to $1.55 billion, says François-Xavier Meslin, a former director of neglected tropical diseases at WHO in Geneva, Switzerland. The price could come down, however. In 2012, the World Organisation for Animal Health started a “virtual” dog vaccine bank, which lowers prices by allowing buyers to purchase collectively. Another potential saver emerged just 2 months ago. Until now, the dog vaccine has always had to be kept below 8°C—impossible in far-flung villages without electricity. In November 2016, scientists reported that the vaccine works just as well if it has been kept for 3 months at 30°C or for 6 months at 25°C, potentially enabling remote communities to keep vaccines on hand and immunize their dogs by themselves. “It could be transformative,” says WSU’s Felix Lankester, director of the Serengeti Health Initiative, who led the study.

There may even be a way to free up millions of dollars for dog vaccinations. GAVI, the Vaccine Alliance, will consider rabies when it reviews its $1.6 billion investment strategy in 2018. GAVI does not pay for animal vaccines, yet it would save many lives by providing human postexposure vaccines to developing countries, advocates say; governments could then use some of their health budget for dog vaccines instead. Some experts worry, however, that the availability of more human vaccine could actually lower the pressure to eliminate rabies in dogs and thus perpetuate the problem.

Slow-moving governments and hesitant donors have left some advocates frustrated. “I just have this anger bubbling up about why we think it is OK to let this go on,” Cleaveland says. But Hampson is hopeful that the stories collected in the field—including those of Asha’s death and Flora’s survival—will ultimately make a difference. Africa’s rabies researchers, she says, “see things that policymakers will never see. They are able to give a voice that otherwise won’t be heard.”

“Ultimately, rabies elimination in Africa requires regional cooperation. A rabies-free Kenya is only protected from incursions from neighboring countries when they too, control for rabies”

-Thumbi Mwangi, veterinary epidemiologist at Washington State University

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