

National Geographic News

Giant Rats Trained to Sniff Out Tuberculosis in Africa

Known for detecting land mines, the rodents could also help detect disease.



Trainer Ezekiel Mwakyonde plays with Julius at the APOPO tuberculosis lab in Morogoro, Tanzania.

PHOTOGRAPH COURTESY APOPO

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for National Geographic

PUBLISHED AUGUST 16, 2014

MAPUTO, Mozambique—On a recent Friday morning, at a laboratory in southern Africa, Tariq correctly identified all six spit samples known to be positive for tuberculosis, the world's second most fatal infectious disease.

Tariq is no scientist, though. He's a lab rat—an African giant pouched rat, to be exact. Every weekday, the trained rodent and eight of his brethren take turns in a glass-sided cage at Eduardo Mondlane

University's College of Veterinary Medicine.

Underneath the cage floor, a removable tray with ten samples of human mucus is inserted. Tariq walks the length of the cage, scratching the floor when he suspects that a sample is positive for tuberculosis, an airborne bacterial disease.

He works rapidly, taking only eight minutes to get through five trays containing a total of 50 samples. "Rats are very fast," said his trainer, Catia Souto, adding that one rat can evaluate more samples in ten minutes than a lab technician can evaluate in a day. (Related: "5 Animals With Spectacular Sniffers.")

Training rats to detect TB is a relatively new endeavor for APOPO, the Belgian nonprofit organization that's best known for using rats to find land mines. APOPO began using TB rats in Tanzania in 2008 and in Mozambique in 2013. Currently, the animals work in 21 medical centers in Dar es Salaam, Tanzania's capital, and double-check 75 percent of potential TB samples from medical centers in the Mozambique capital of Maputo.

Like the battle against land mines, the fight against TB—which claimed 480,000 lives in Africa in 2012, 58,000 of them in Mozambique, according to the World Health Organization—is badly in need of an innovative, rapid, and affordable detection technique. (Read "War on Disease—Challenges for Humanity.")

"We know that we need a new approach in the diagnosis of TB, so this could be one of the approaches," said Gaël Claquin, a TB/HIV specialist in Mozambique who is not directly involved in the APOPO project.

And so far, rats seem to be a promising solution: In the first 16 months of the Maputo program, the rats evaluated samples from roughly 12,500 patients. Of those, 1,700 had been found positive at the health clinics. The rats detected another 764 patients, an increase in detection rate of around 44 percent, according to APOPO.

Missed Cases

Like many developing countries, Mozambique relies on a TB detection technique that's more than a century old.

Trained lab technicians use microscopes to look at mucus, or sputum, samples of potentially infected patients to see if TB bacteria are present.

The accuracy of the technique depends on the performance of the lab technicians and the state of the equipment.

In Mozambique, more than half the cases are missed, said Claquin, a former national program officer for TB at the World Health Organization (WHO) Mozambique. It's these cases that Tariq and his eight rodent buddies are tasked with finding.

Lab technicians can make mistakes, said APOPO rat trainer Lila Denis

"People can die because of that. So we check [the sample] again to see if it is positive or negative."



Trainer Onesia Nhampara rewards Maria for identifying TB in a mucus sample at APOPO's lab in Maputo, Mozambique.

How It Works

After undergoing nine months of training in Morogoro, Tanzania, where APOPO is headquartered, the rats are put to work in the capital cities of Maputo or Dar es Salaam. In Maputo, Emilio Valverde, manager of the APOPO Mozambique TB Program, is in charge.

"What the rats are trained to do is associate the smell of TB with a reward, so it's what they call operative conditioning," Valverde said.

It is the same principle applied to detecting land mines, only the rats are trained to recognize the scent of specific molecules that reflect the presence of the tuberculosis germ—not the explosive vapor associated with land mines.

To keep the animals motivated, positive samples are mixed in with the unknown samples. When the rat alerts by scratching at a known sample, a buzzer is sounded and the rat is rewarded with a treat.

Any suspect samples are triple-checked, and if found to be positive, they're reported back to the clinics.

Each rat costs around \$6,700 to \$8,000 to train, but relatively little to maintain over their six-to-eight-year life span, said Valverde. In comparison, the new rapid diagnostic test GeneXpert costs \$17,000 per device and between almost \$10 and \$17 per test.

Rodent Drawbacks

Smelling out sickness is becoming more popular, explained Stewart Reid, with the Centre for Infectious Disease Research in Zambia.

While APOPO is the only organization he knows of using rats to sniff out TB, there has been preliminary research using honeybees or even electronic instruments—like an e-nose—to detect TB. Research has also indicated that dogs have an ability to detect cancer through smell.

Ivan Manhiça, with the Mozambique Ministry of Health, appreciates the rats' contribution to TB detection and clearly sees the advantages of their speed and affordability.

Still, there are drawbacks. The rats cannot differentiate between TB and a drug-resistant strain of the disease, said Claquin, the specialist from Mozambique.

According to Reid, making sure the rats' training is consistent and high quality is critical, as is completing key clinical trials necessary to obtain World Health Organization endorsement.

Increasing the size of the now relatively small project would also be difficult, said Jennifer Topping, of the United Nations Development Program in Mozambique.

At present the samples are collected weekly from clinics in Maputo and brought to the rats at Eduardo Mondlane University's College of Veterinary Medicine.

If the program is expanded, the rats would presumably be housed in regional labs and hospitals. Studies would need to be conducted to see how various people would feel about this unconventional technique, said Manhiça, of the health ministry. (Related: "Rats Show Regret After Wrong Choices, Scientists Say.")

"First we have to confirm, to have evidence enough, this technique works. Then we would have to discuss the logistics, because there are some regions, some districts where people eat rats."

Rat Questions Remain

What's more, only 25 percent of the samples the rats find suspicious are found to be positive for TB, according to APOPO's Valverde.

This does not mean they are negative, he said. But for now he cannot report them as positive because a rat alone is not yet an accepted diagnostic tool. (Test your knowledge of infectious diseases.)

Even so, Valverde does not shy away from the many questions that are sure to

arise if the project expands. He's excited about its potential and curious to know whether male and female rats perform differently, whether they might be able to detect latent TB or identify TB about to become active, and more.

As for Tariq and his companions, after a hard day's work, they're placed back in individual cages, where they proceed to wash their faces and get on with the ordinary task of being a rat.

Katya Cengel reported from Mozambique as a press fellow with the International Center for Journalists and the UN Foundation.