University of Basel

The Resistant Mosquito

Video Transcript

Insecticide susceptibility monitoring

NARRATOR: *Anopheles arabiensis*, *Anopheles gambiae*, and *Anopheles funestus*: these three mosquito species are the most important malaria vectors in Tanzania. Like many other countries, Tanzania relies on insecticide-based interventions to control malaria: insecticide-treated bed nets, indoor residual spraying and larvicides. To ensure that these interventions have the desired effect, the National Malaria Control Programme carries out regular mosquito surveillance throughout the country. The Ifakara Health Institute in Bagamoyo is an essential centre when it comes to research on malaria vector control and the question of insecticide resistance.

PRISCA: Hi, my name is Prisca Kweyamba. I work testing new vector control tools in Tanzania. And I am going to show you how malaria control programmes maintain the benefits of core malaria control tools, by monitoring the continued susceptibility of malaria vectors to insecticides.

NARRATOR: In a mosquito surveillance, researchers collect all kinds of data. Which species are present and in what abundance? How do these species behave and how susceptible are they to insecticides? The answers to these questions guide the choice of insecticides. The aim is not only to reduce the burden of disease but also to manage insecticide resistance.

It is a big job to assess insecticide resistance levels across a country as large as Tanzania. However, it is important to get a representative sample of the different vector species from all areas where insecticides are used for public health.

So, every year, a team travels around the country. The team collects larvae from a number of water bodies. Blood-fed females are captured from different locations. Sometimes, the researchers use light traps.

It is important to collect a representative sample of mosquitoes in a region and to include a variety of sites. This is to minimise the possibility that the mosquitoes all came from eggs laid by the same female. The mosquitoes are then kept in mobile insectaries. The larvae and offspring of the blood-fed females are raised to adults.

There are two main methods for testing whether wild mosquito populations are still susceptible to the insecticides: the WHO tube test and the CDC bottle bioassay. In the tests, the captured wild mosquitoes are exposed to insecticides. In the bottle bioassay, the insecticides coat the inside of the bottles. In the tube test, papers are impregnated with a so-called discriminating dose of the insecticide. This has been set at twice the amount that would kill all fully susceptible mosquitoes from the species being evaluated.

After exposure to this discriminating dose of insecticide for a set exposure period, normally one hour, the researchers count how many mosquitoes have been knocked down.

For most insecticides, mosquito mortality is assessed after 24 hours. Some newer insecticides with slower activity require an assessment after 72 hours. The tests are carefully controlled. This way, it becomes apparent if the number of mosquitoes dying changes over time. If there is a trend toward increased survival of the wild mosquitoes, the National Malaria Control Programme must decide whether to change the insecticide used. These studies are relatively easy to perform, and the insecticide-treated papers come from a central source to ensure quality.

In Tanzania, the insecticides used for indoor residual spraying, or IRS, protect around 6 million people. Since 2007, through careful monitoring, IRS has switched from pyrethroids to carbamates and then to organophosphates.

Currently, we are using a neonicotinoid and are carefully checking for any early signs of resistance. Some metabolic resistance can be overcome with synergists. In Tanzania, we use bed nets with both a synergist and an insecticide that kill metabolically resistant mosquitoes. The bed nets are distributed through clinics and schools to protect pregnant women and children who are most at risk from malaria.

A hole or two in an insecticide-treated bed net doesn't necessarily mean that its effect is dramatically diminished. However, it is important to include data about the condition of the nets. On the surveillance tours, researchers therefore assess the holes in nets. They hang them on a portable frame, count the holes and estimate their size according to an easy-to-use classification recommended by the WHO. The total of these estimates as well as susceptibility data is fed into a centralised government database. Based on evidence, decisions are then made on whether to continue with a particular insecticide or switch to an alternative.

It is important to make these decisions in a timely fashion, as it can take over a year to procure and distribute insecticide-treated bed nets or to organise IRS campaigns. With these programmes, Tanzania is working toward its goal of eliminating malaria by 2030.