University of Basel

The Resistant Mosquito

Video Transcript

Theoretical approaches in Insecticide Resistance Management

Insecticide resistance management is the implementation of a strategy to limit the spread of resistance in a vector population, while successfully controlling all individuals in that population.

The primary strategy of any insecticide resistance management programme is to minimise the selection of a resistant population. There are two approaches to this.

First, "redundant kill". In this case, vector control is undertaken in such a way that even "resistant" mosquitoes are killed, or prevented from having offspring. This may be because they are exposed to a high dose of insecticide to which they are unable to resist, or because they are exposed to several insecticides or control methods. The assumption is that if they manage to survive exposure to one insecticide, the other will kill or possibly sterilise them. The "resistant" genes cannot then be passed on to new generations.

The second approach is to prevent susceptible mosquitoes from being exposed to a selective dose of insecticide. Mosquitoes can be exposed to insecticides, and resistant populations can be selected, in situations other than vector control, such as in agriculture or gardening, where pesticides are used. This exposure should be reduced as much as possible. They may also be exposed to low doses of insecticide on very old insecticide-treated nets or IRS deposits, which provide only partial control, and thus high levels of selection.

There are three main approaches to providing "redundant kill":

The first approach is insecticide mixtures. Mixtures involve exposing mosquitoes simultaneously to two insecticides with different modes of action – either on an insecticide-treated net or on a surface treated with an indoor residual spray, or IRS. This method is more effective if the mosquitoes are sensitive to both insecticides in the mixture. It is also important that the residual activity of the two mixture partners is the same, so that mosquitoes are always exposed to an effective dose of both mixture partners.

The second approach is rotations. Rotations involve using a single insecticide at time t and switching to another insecticide with a different mode of action at time t+n. It is important to undertake insecticide susceptibility monitoring to identify an insecticide from a mode of action class to which the target

mosquitoes are susceptible for the next rotation. It is possible to rotate mixtures and thus combine two approaches to resistance management.

The third approach is mosaics. Mosaics involve using a given insecticide in one area and another insecticide with a different mode of action in another area of that region. The scale of the mosaic can be very small, where different houses in the same town or village receive different insecticide applications. Or even within the same house, where two different insecticide-based interventions are used, for example long-lasting insecticidal nets, or LLINs, and indoor residual spraying, or IRS. On a larger scale, different cities, villages, or subregions are treated with insecticides from different mode of action classes. Insecticides used in the mosaic must be rotated over time.

Synergists are products that inhibit the action of enzymes involved in the detoxification of insecticides. Their use is not a resistance management approach per se, but can be considered as "resistance mitigation". However, it does allow successful control of vectors carrying certain metabolic resistance mechanisms.

The control of onchocerciasis, or river blindness, under the West African Onchocerciasis Control Program, or OCP, has been a historically successful example of managing insecticide resistance in Simulium black fly. This success is due in part to the ecology of black fly larvae, which have a well-known and well-defined habitat. It can be easily and effectively targeted in a well-organised and coordinated insecticide rotation programme.

While rotations, mixtures, and mosaics are the primary approaches to resistance management, every effort should also be made to minimise exposure of mosquitoes to selection in non-vector control settings.

It is also important to regularly identify the mosquito species present and their insecticide susceptibility status in order to use the most appropriate insecticide mixtures or rotations.