

The Resistant Mosquito

Video Transcript

Consequences and impact of vector control failure

Insecticide-treated nets, or ITNs for short, and indoor residual spraying, better known as IRS, are two examples of effective vector control tools. However, when mosquitoes develop resistance to insecticides, the impact of vector control can become compromised. Let's take a look at a few examples where new or additional vector control products were used in areas of pyrethroid resistance to increase population protection from malaria.

Is there additional benefit against pyrethroid-resistant mosquitoes if you add an additional ingredient to a bed net already treated with a pyrethroid insecticide? To find out, researchers have conducted two randomised control trials comparing standard pyrethroid-only nets to nets treated with both a pyrethroid and the synergist piperonyl butoxide, or PBO for short.

PBO is a synergist that acts by inhibiting certain metabolic enzymes that detoxify or sequester insecticides within the mosquito. A net treated with a pyrethroid and PBO would be expected to have an increased killing effect on mosquitoes that express metabolic resistance mechanisms.

Epidemiological data from a randomised control trial in Tanzania confirmed this effect. Among people who received PBO nets, malaria infection prevalence was lower after 9 and 21 months, compared to people who received standard pyrethroid-only nets. A second study in Uganda found similar results.

In areas of high pyrethroid resistance, there is another way to mitigate the potential decreased efficacy of pyrethroid-only nets, by introducing non-pyrethroid IRS as an additional intervention. The additional impact of non-pyrethroid IRS is most often observed when countries reorient their vector control programmes, shifting from one region of the country to another. This may be done for programmatic reasons to target higher burden areas. However, there is often a resurgence in malaria transmission in the area where IRS is removed, even if pyrethroid-only nets are in place.

A prime example of this is Mali. After the 2016 spray campaign, IRS activities using a long-lasting organophosphate were shifted from one district in the Segou Region to four districts in the Mopti Region. After the shift, in 2017, malaria case incidence rates went up 106% in the district where IRS was suspended, but down 42% in districts where IRS was introduced.



Decisions to deploy additional or alternative insecticidal products to manage resistance can sometimes require trade-offs. For example, the Mulanje Mission Hospital in Malawi needed to weigh budgetary and economic constraints when making operational decisions. The hospital's malaria programme was established in 2012 to reduce the high burden of malaria in its catchment area.

The programme manager, Mr. Katumbi, explained that a synthetic pyrethroid was the insecticide of choice in 2012, with a low cost of \$3 per sachet. Initially, the IRS programme covered four villages. Compared to villages that did not apply IRS, significantly fewer children under five died from malaria. Therefore, the funding support increased. Eventually 55 villages were covered. But in 2015 insecticide resistance was detected.

The programme decided to move to an organophosphate, the only other alternative in 2015. However, the new insecticide was around 10 times more expensive and coverage was reduced from 55 villages to 35 villages, excluding 17'000 people.

The programme did benefit from a market-shaping initiative funded by Unitaid, reducing the unit cost, and subsequently increasing coverage again, up to 52 villages in 2018. Mr. Katumbi explained that the programme will continue to rotate insecticides with different modes of action and monitor resistance as part of their Insecticide Resistance Management strategy, but costs will always be a concern.

Trials and case studies of implementation monitoring have influenced the strategies of malaria control programmes grappling with insecticide resistance. As a result, many have opted to distribute pyrethroid-PBO nets in upcoming mass distribution campaigns or to include non-pyrethroid IRS in their programming, to mitigate the effects of resistance.