Publication

A new WHO bottle bioassay method to assess the susceptibility of mosquito vectors to public health insecticides: results from a WHO-coordinated multi-centre study

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Author(s) Corbel, V.; Kont, M. D.; Ahumada, M. L.; Andreo, L.; Bayili, B.; Bayili, K.; Brooke, B.; Pinto Caballero, J. A.; Lambert, B.; Churcher, T. S.; Duchon, S.; Etang, J.; Flores, A. E.; Gunasekaran, K.; Juntarajumnong, W.; Kirby, M.; Davies, R.; Lees, R. S.; Lenhart, A.; Lima, J. B. P.; Martins, A. J.; Muller, P.; N'Guessan, R.; Ngufor, C.; Praulins, G.; Quinones, M.; Raghavendra, K.; Verma, V.; Rus, A. C.; Samuel, M.; Ying, K. S.; Sungvornyothin, S.; Uragayala, S.; Velayudhan, R.; Yadav, R. S.
Author(s) at UniBasel Müller, Pie ;
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BACKGROUND: The continued spread of insecticide resistance in mosquito vectors of malaria and arboviral diseases may lead to operational failure of insecticide-based interventions if resistance is not monitored and managed efficiently. This study aimed to develop and validate a new WHO glass bottle bioassay method as an alternative to the WHO standard insecticide tube test to monitor mosquito susceptibility to new public health insecticides with particular modes of action, physical properties or both. METHODS: A multi-centre study involving 21 laboratories worldwide generated data on the susceptibility of seven mosquito species (Aedes aegypti, Aedes albopictus, Anopheles gambiae sensu stricto [An. gambiae s.s.], Anopheles funestus, Anopheles stephensi, Anopheles minimus and Anopheles albimanus) to seven public health insecticides in five classes, including pyrethroids (metofluthrin, prallethrin and transfluthrin), neonicotinoids (clothianidin), pyrroles (chlorfenapyr), juvenile hormone mimics (pyriproxyfen) and butenolides (flupyradifurone), in glass bottle assays. The data were analysed using a Bayesian binomial model to determine the concentration-response curves for each insecticide-species combination and to assess the within-bioassay variability in the susceptibility endpoints, namely the concentration that kills 50% and 99% of the test population (LC(50) and LC(99), respectively) and the concentration that inhibits oviposition of the test population by 50% and 99% (OI(50) and OI(99)), to measure mortality and the sterilizing effect, respectively. RESULTS: Overall, about 200,000 mosquitoes were tested with the new bottle bioassay, and LC(50)/LC(99) or OI(50)/OI(99) values were determined for all insecticides. Variation was seen between laboratories in estimates for some mosquito species-insecticide combinations, while other test results were consistent. The variation was generally greater

with transfluthrin and flupyradifurone than with the other compounds tested, especially against Anopheles species. Overall, the mean within-bioassay variability in mortality and oviposition inhibition were < 10% for most mosquito species-insecticide combinations. CONCLUSION: Our findings, based on the largest susceptibility dataset ever produced on mosquitoes, showed that the new WHO bottle bioassay is adequate for evaluating mosquito susceptibility to new and promising public health insecticides currently deployed for vector control. The datasets presented in this study have been used recently by the WHO to establish 17 new insecticide discriminating concentrations (DCs) for either Aedes spp. or Anopheles spp. The bottle bioassay and DCs can now be widely used to monitor baseline insecticide susceptibility of wild populations of vectors of malaria and Aedes-borne diseases worldwide.
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