

Cost and cost-effectiveness of third-generation indoor residual spraying (3GIRS) in sub-Saharan Africa

Results of data collection and analysis in the Next Generation IRS (NgenIRS) project

Joshua Yukich¹, Peder Digre², Sara Scates¹, Luc Boydens¹, Emmanuel Ubachukwu Obi Onyefunafoa¹, Nicky Moran¹, Mariandrea Chamorro³, Benjamin Johns³, Seydou Fomba⁴, Keziah L. Malm⁵, Lena Kolyada⁶, Baltazar Candrinho⁷, Rodaly Muthoni⁸, Jimmy Opigo⁹, Catherine Maiteki-Sebuguzi⁹, Damian Rutazaana⁹, Josephat Shillu¹⁰, Emmanuel Kooma¹¹, Nduka Iwuchukwu¹², Anna Winters¹³, Annie Martin¹³, Joseph Wagman¹⁴, Molly Robertson¹⁴

¹Tropical Health Consulting LLP, London, United Kingdom; ²PATH, Seattle, WA, United States; ³Abt Associates, Rockville, MD, United States; ⁴Programme National de Lutte contre le Paludisme, Bamako, Mali; ⁵National Malaria Control Program, Ministry of Health, Accra, Ghana; ⁶US President's Malaria Initiative (PMI) VectorLink Ghana Project, Abt Associates, Accra, Ghana; ⁷National Malaria Control Program, Ministry of Health, Maputo, Mozambique; ⁸PMI VectorLink Mozambique, Abt Associates, Maputo, Mozambique; ⁹National Malaria Control Division, Ministry of Health, Kampala, Uganda; ¹⁰PMI VectorLink Uganda Project, Abt Associates, Kampala, Uganda; ¹¹National Malaria Elimination Centre, Lusaka, Zambia; ¹²PMI VectorLink Zambia Project, Abt Associates, Lusaka, Zambia; ¹³Akros Inc., Lusaka, Zambia; ¹⁴PATH, Washington, DC, United States

Background

Indoor residual spraying (IRS) for malaria control is highly effective but may be limited by insecticide resistance. As such, third-generation indoor residual spraying (3GIRS) products with long-lasting formulations that are effective against pyrethroid-resistant mosquitoes have been introduced. However, there is limited evidence on their cost-effectiveness. This poster presents evidence of their cost and cost-effectiveness in the sub-Saharan African malaria control context as documented through the Next Generation IRS project (NgenIRS).

Results

Results of the cost and cost-effectiveness studies are synthesized and presented in the Table. The mean cost per person targeted was **5.33 US dollars (USD) (95% CI: 4.18–6.47)**. The meta-analysis of effect estimates indicates an **IRR of 0.67 (95% CI: 0.50–0.91)** (Figure 3).

The country-specific (Figure 1) and global (Figure 2) probabilistic sensitivity analyses show that 3GIRS is an effective intervention—despite significant heterogeneity—and may be an attractive intervention to policymakers depending on willingness to pay.

Discussion

The results suggest that according to World Health Organization standards, and despite significant variability in cost and effectiveness, **3GIRS is expected to be cost-effective or highly cost-effective in many contexts across sub-Saharan Africa when deployed in addition to current malaria-control interventions, including universal coverage with standard pyrethroid-only long-lasting insecticidal bednets.**

Several factors contribute to the total cost of an IRS program. While the cost of active ingredient (AI) is one of the most significant cost drivers in nearly all programs, the AI contributes typically 20% to 40% of the total cost of an IRS program in these settings. As such, changes in AI price can impact the total program cost substantially. Sensitivity analysis indicates that malaria burden and case fatality rate are important drivers of these findings.

Table. Results of cost and cost-effectiveness analyses.

	Program	Insecticide product	Target dose	Expected m ² per structure	Expected persons per structure	Cost per person targeted	IRR estimate (95% CI)	Cost per case averted	Cost per DALY averted
Ghana	AIRS/VectorLink (2017–2018)	Actellic®300CS	1 g/m ²	54.4	2.7	5.21 USD	0.60 (0.36–1.00)	3.20 USD	48.00 USD
	AGAMal (2017–2018)†	Actellic®300CS	1 g/m ²	40.0	1.1	5.42 USD	N/A	N/A	N/A
Mali	AIRS/VectorLink	Actellic®300CS	1 g/m ²	90.0	3.6	7.76 USD	0.68 (0.52–0.89)	6.76 USD	102.00 USD
Mozambique	AIRS/VectorLink	Actellic®300CS	1 g/m ²	132.0	3.9	4.68 USD	N/A	N/A	N/A
	NgenIRS CRT	Actellic®300CS	1 g/m ²	132.0	3.9	4.68 USD	0.78 (0.77–0.79)	34.44 USD	Pending
Uganda	Abt bilateral	Actellic®300CS	1 g/m ²	101.0	3.5	5.53 USD	0.53 (0.43–0.66)	41.25 USD	625.00 USD
Zambia	AIRS/VectorLink	Actellic®300CS	1 g/m ²	66.5	4.7	3.35 USD	0.88 (0.82–0.95)	78.85 USD	1,194.83 USD

AGAMal = AngloGold Ashanti (Ghana) Malaria Control Ltd.; AIRS = US President's Malaria Initiative Africa Indoor Residual Spraying Project; CI = confidence interval; CRT = cluster-randomized control trial; CS = capsule suspension; DALY = disability-adjusted life year; IRR = incidence rate ratio; N/A = not applicable; NgenIRS = Next Generation IRS project; USD = US dollar; WG = water-dispersible granules.
† AGAMal's expected m² and expected persons are per room rather than for full structure or all sleeping places.

Methods

Evidence of effectiveness and cost was collected in five sub-Saharan countries: Ghana, Mali, Mozambique, Uganda, and Zambia.

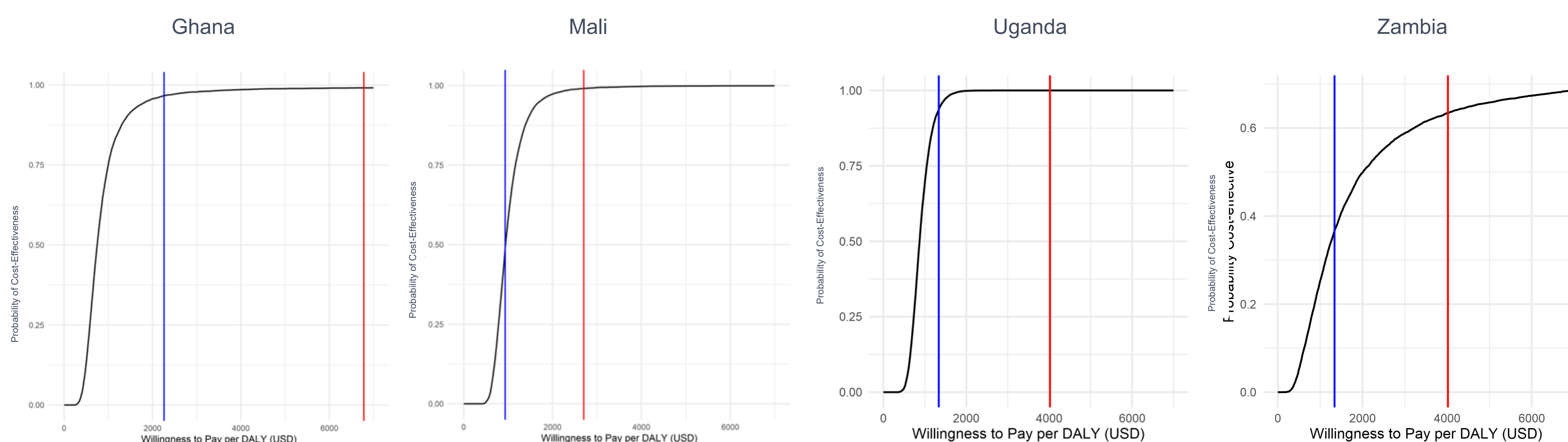
Costs: Cost data collection was targeted to collect the costs of operation for one year of IRS with a 3GIRS chemical using a bottom-up approach* to represent the cost for one year of 3GIRS with one spray round per year.

Effects: Effectiveness is presented in terms of an incidence rate ratio (IRR) comparing 3GIRS to a situation with the standard malaria-control interventions in place,† including pyrethroid-only-based long-lasting insecticidal bednets.

Meta-analysis: In order to derive unified information and uncertainty around cost, a meta-analytic approach estimated unit costs by calculating both the mean and standard deviation of the measured unit cost. We also estimated the parameters of a log-normal and gamma distribution that captured the uncertainty in unit costs. Effectiveness results were summarized as an IRR and 95% confidence intervals (CIs) (as well as standard errors); these were compiled across each setting and pooled using a DerSimonian-Laird random-effects model meta-analytic approach.

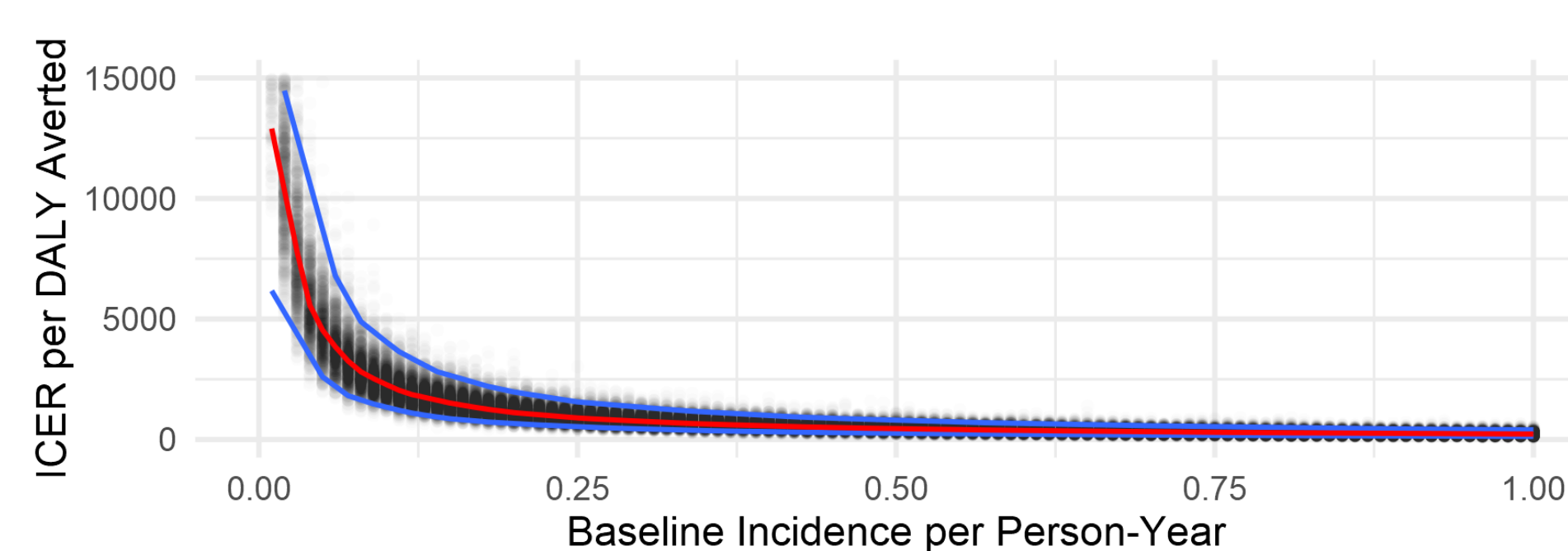
Sensitivity analysis: Probabilistic sensitivity analysis was conducted for each study setting, as well as across all study settings, and was based on the results of the meta-analysis.

Figure 1. Cost-effectiveness acceptability curves for DALYs averted using 3GIRS in Ghana, Mali, Uganda, and Zambia with standard WHO cost-effective (red) and highly cost-effective (blue) thresholds.



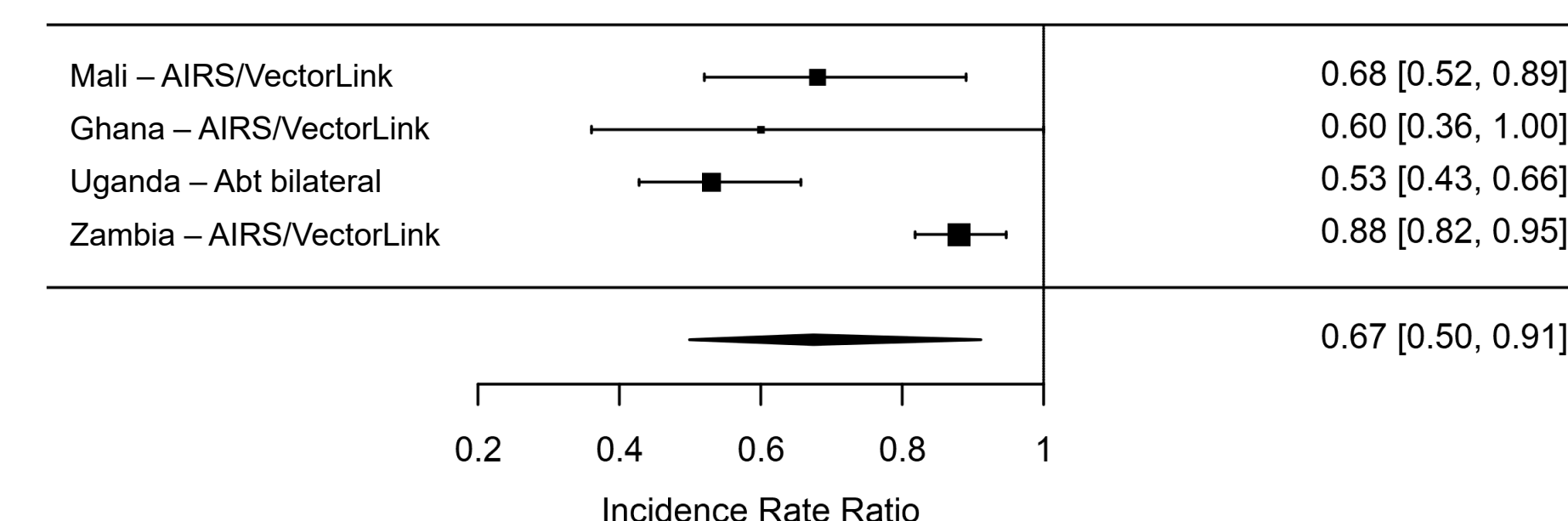
3GIRS = third-generation indoor residual spray; DALY = disability-adjusted life year; USD = US dollar; WHO = World Health Organization.

Figure 2. Global probabilistic sensitivity analysis results showing incremental cost-effectiveness ratio estimates (ICERs) for varied levels of baseline incidence.



Black circles represent individual simulation results; red lines indicate the median ICER; and blue lines represent 95% quantiles.
DALY = disability-adjusted life year; ICER = incremental cost-effectiveness ratio estimate.

Figure 3. Meta-analysis of effect estimates of IRS versus no IRS from observational studies in NgenIRS countries.



AIRS = US President's Malaria Initiative Africa Indoor Residual Spraying Project; IRS = indoor residual spraying; NgenIRS = Next Generation IRS project.

The Next Generation IRS (NgenIRS) project is a partnership, led by IVCC, that includes the US President's Malaria Initiative, Abt Associates, and PATH. NgenIRS works in close collaboration with leading insecticide manufacturers; national malaria control programs; the Global Fund to Fight AIDS, Tuberculosis and Malaria; and other stakeholders to save lives and protect health by reducing transmission of malaria through affordable indoor residual spraying of long-lasting, non-pyrethroid insecticides. It is funded by Unitaid. For more information, please visit www.ivcc.com/market-access/ngenirs or email David McGuire, Programme Director (david.mcguire@ivcc.com).



*All annuitization were assumed at a 3% discount rate. All costs were converted to 2017 US dollars (USD) by first converting them from the recorded currency to USD using an annual average exchange rate and then converting them to 2017 USD, where necessary, by adjusting for inflation using the US gross domestic product deflator.

†Deaths and disability-adjusted life years (DALYs) averted were calculated by using a simple set of assumptions about the proportion of cases seeking treatment, the case fatality rate among malaria cases, and the age distribution of malaria deaths.