

**Roll Back Malaria Vector Control Working Group (RBM VCWG)
11th Annual Meeting, 3rd-5th February 2016
Moevenpick Hotel, Rue de Pré Bois, Geneva**

**1st Indoor Residual Spraying (IRS) and Insecticide Resistance
Management (IRM) Work Stream Meeting
09.00-12.00, Thursday 4th February 2016
Moevenpick Hotel, Rue de Pré Bois, Geneva**

**Chairs: Mark Hoppé & Dereje Dengela
Rapporteur: Lucy Tusting**

Introduction – Mark Hoppé, Syngenta, Switzerland and Dereje Dengela, Abt Associates, USA

This work stream combines the previous *Insecticide Resistance* and *Capacity Building for Indoor Residual Spraying (IRS)* work streams. Its aims are to: (i) address major challenges and promote best practice IRS delivery in the context of insecticide resistance management (IRM), with the aim of maximising the long term utility of this vector control tool, and (ii) to promote and support the practical implementation of the Global Plan for Insecticide Resistance Management (GPIRM).

Feedback from IRM workshops - Janet Hemingway, Liverpool School of Tropical Medicine, UK

Feedback on two workshops on IRM was given. A meeting in January was co-organised by Janet Hemingway and Mike Reddy of the Bill and Melinda Gates Foundation (BMGF). Major topics in IRM were identified and fourteen experts identified and asked to invite further participants, alongside major funders including BMGF, USAID and the US National Institutes of Health. The aim was to map out major outstanding questions, with an operational focus. The planned output is four papers in *The Lancet Global Health*. A multicountry trial is ongoing but complete data are only available for Sudan; a draft manuscript is being expedited. Interpretation of these data is complicated by the increase in pyrethroid resistance that has occurred over this time period. A switch from pyrethroids to pirimiphos-methyl for IRS in Ghana was associated with a reduction in parasite prevalence, and a similar picture is emerging in other locations. It is critical to examine the economic implications of resistance and to balance the trade-off between coverage and effectiveness. There is much to learn from the agricultural sector and antimicrobial resistance field. A second workshop was convened by ISGlobal, funded by the Biotechnology and Biomedical Sciences Research Council (BBSRC) in the UK which brought together experts working on resistance in different areas (e.g. fungicides, herbicides). A BBSRC funding call will be announced later in 2016. A meeting report will soon be available.

Review of the interdisciplinary insecticide resistance workshop held at Penn State - Matthew Thomas, Penn State University, USA

An overview of the interdisciplinary workshop 'Insights from Agriculture for Insecticide Resistance Management', held in September 2015 was given. The workshop brought together a combined mix of researchers who think about resistance evolution from diverse perspectives: public health, agriculture (insects and weeds), theoreticians, empiricists, lab, field, industry and policy. The findings were structured around five pillars of the current GPIRM plan (i) IRM strategies, (ii) monitoring, (iii) new tools, (iv) knowledge, (v) enabling mechanisms:

- (i) **IRM strategies:** The greater the exposure to an insecticide the greater the selection pressure for resistance. The most far-reaching approach to address this issue in agriculture has been the development of Integrated Pest Management (IPM) strategies that aim to minimize the reliance on insecticides. The pending resistance crisis for disease vectors creates an urgent need to develop and implement integrated, multi-tactic integrated vector management (IVM) strategies that parallel IPM in agriculture. Numerous studies in agriculture show that IRM strategies that utilize diverse insecticide products over time and space can slow resistance evolution (e.g. rotations, mixtures, mosaics). However, which strategy works best depends strongly on the specifics of the insect genetics, population dynamics and behavior. There is no general rule. There are few theoretical examinations of these strategies for disease vectors and next to no empirical tests. In the absence of this information there is no convincing evidence base for recommending one strategy over another.
- (ii) **Monitoring:** The point of monitoring should be to understand what products or actives can be used, rather than what cannot be used due to loss of susceptibility in the target insects. If assays or markers correlate poorly with operationally relevant outcomes, they provide little insight. Demonstrating the impact of resistance and subsequent value of IRM strategies requires appropriate methods for characterizing resistance. IRM needs better assays.
- (iii) **New tools:** Current target product profiles (TPPs) emphasize persistent products with long decay half-lives. This feature could maximize selection for resistance. Defining outcome-based TPPs (where the outcomes are reducing transmission and slowing selection for resistance) could encourage development of a broader range of vector control products.
- (iv) **Knowledge:** Numerous studies in agriculture demonstrate evolution of insecticide resistance with direct links to crop loss. However, the relationship between vector resistance and disease epidemiology can be complex (probably more so than in agriculture). Development of effective IRM strategies requires better understanding of these relationships.
- (v) **Enabling mechanisms:** We need to consider susceptibility as a ‘public good’ and transition to value-based rather than cost-based products and approaches. Achieving this requires a change in national and international policy and development of appropriate regulation.

In conclusion, the key insights from agriculture are that: (i) the best approach to resistance management is IPM (so we need IVM), (ii) if monitoring is to be useful, it needs to tell us something about functional significance of resistance (current resistance monitoring tells us little); (iii) agriculture manages resistance in part through a product pipeline so we need a better pipeline to support development of new products (with ‘outcome-based’ TPPs); (iv) we need a better understanding of functional significance of resistance and of the impact of potential IRM strategies (the evidence base for current prescriptions is weak) and (v) we need to accept susceptibility as a public good and consider ‘value’ and not simply ‘cost’.

The NgenIRS programme - Tom McLean, Innovative Vector Control Consortium, Liverpool, UK

An introduction to the ‘Next generation IRS Project’ was given. While long-lasting insecticide treated nets (LLINs), IRS and artemisinin combination therapies have helped to avert 663 million cases of malaria in Africa, 2000-2015 (Bhatt *et al.* 2015, Nature), resistance to all four classes of insecticide available for malaria control is increasingly prevalent across Africa and elsewhere. While the entomological impact is understood, the operational impact harder to assess. Longitudinal data showing a reduction in parasite prevalence in children following a switch from pyrethroid to actellic CS IRS in Bunkpurugu-Yunyoo district, Northern Ghana, an area of high pyrethroid resistance, was shown. While IRS coverage in Africa has fallen overall in Africa since 2010, NgenIRS will address the underlying causes of market shortcomings. The overall goals are (i) to increase the use of third generation IRS products and (ii) a growing market for third generation IRS products without intervention of a co-payment. More information is available at www.ngenirs.org.

Discussion

- It is important to remember that we are not only dealing with pyrethroids but the other three insecticide classes also.
- Strong advocacy for maintaining high coverage of IRS should be integral to the NgenIRS programme. The programme will have a communications officer dedicate to this.
- While modelling is used extensively in other areas (drugs, vaccines), it is often dismissed within vector control. Advocacy of the utility of modelling could be improved.

Tools for improving the effectiveness of IRS in Pakistan - Muhammad Mukhtar, Directorate of Malaria Control, Pakistan

A total of 95 million people remained at risk of malaria in Pakistan in 2014, with the greatest incidence along the north western border with Afghanistan. Since the Global Malaria Eradication Programme era of the 1960s, IRS has been a key element of the National Vector Control Strategy. Yet despite high (>80%) coverage of IRS in many areas, there was no significant decline in malaria transmission in these locations during 1985-2006. In 2007 the IRS strategy was revised, focusing on system strengthening & capacity building, better timing of application, promotion of only WHO-recommended products, and the introduction of an epidemic response IRS strategy in 2015 supported by the Global Fund, in addition to the general national IRS strategy. Data on IRS coverage in 2014-2015 were presented. Quality Assurance Protocols and Tools for IRS were developed in 2013-2014, which were approved at the state level in 2015. Work is also underway to strengthen vector surveillance and monitoring and evaluation, to support the National IRM Plan (2015); to improve capacity for IRS at all levels, to promote inter-sectoral coordination and to fix responsibilities among ministries, departments and institutes. Remaining challenges to implementing IRS include the political influence over the selection of target areas, funding shortfalls and delays, authority conflicts and technical and human capacity.

Summary of pre-meeting feedback – Mark Hoppé

Pre-meeting feedback was sought on questions relating to implementation of the GPIRM, implementation of IRM within IRS campaigns, limitations to achieving full effectiveness and coverage within IRS campaigns. Consistent themes in the responses were: (i) how to move from insecticide resistance mitigation to management and (ii) how to facilitate or simplify the implementation of best practice IRM. Impediments to implementing IRM include its logistic complexity, questions over costs versus benefits of IRS and IRM and the limited list of effective insecticides to choose from. IRM and

IRS need to be managed in the context of IVM and the impact of agricultural use of insecticides explored. Looking forward, the work stream needs to decide how to deliver the greatest impact.

Discussion – All

- New products and active ingredients are emerging and it is important to consider how to preserve their efficacy when introducing them to the market.
- Feedback from NMCPs on the guidance needed for implementing of GPIRM.
- The previous IRS work stream focused on four areas: (i) research and evidence, (ii) procurement and supply management, (iii) training and supervision and (iv) advocacy for IRS and vector control. This work stream could carry forward some of these.
- It was agreed that IR monitoring is critical. It is possible that IR monitoring could be done with existing resources if done differently. We also need to link with the agricultural sector to understand how resistance is emerging in other areas. However, data alone are useless unless acted upon.
- Looking at the system holistically is important; reductions in malaria parasitaemia achieved by vector control may reduce the selection pressure for artemisinin resistance.
- Many suggestions made in the VCWG discussions are already being worked on by other members of the VCWG. Collating a database of all work ongoing, available resources and acronyms used may be a valuable output for the VCWG. Indeed, a major aim of the VCWG is to bring together a network of VC experts and to disseminate information to this network.
- CropLife has previously collated information from different vector control forums; updating this would be useful. The President's Malaria Initiative has a wealth of resources online, including data on how programme decisions have been made based on IR data.
- Malaria control programmes could be made more cost-effective by combining different streams (e.g. durability monitoring, spray teams) and therefore reducing staff and travel costs.
- IRS quality was discussed; it is important to improve quality assurance and to involve the community in this process.

Priority areas for the work stream:

1. Effectively communicating the GPIRM.
 - *Next step:* Identify existing initiatives.
2. Producing a living directory of resources (organisations, programmes and individuals involved with IRM/IRS).
 - *Next steps:* Identify all interested parties and produce a directory of IRM/IRS partners.
3. IRM training.
 - *Next steps:* Identify target audience and explore opportunities.
4. IRS capacity building: undertake an audit of key factors limiting the implementation of IRS programme, the analysis of which will identify potential actions for the work stream.
 - *Next steps:* Identify key players, solicit feedback with a structured questionnaire/interview, and identify opportunities to support capacity building.

Day 3: Friday 5th February

Session 3: Feedback from the work stream meetings

Chairperson: Jacob Williams

1st IRS IRM priorities work stream meeting - Mark Hoppé, Syngenta, Switzerland

The IRS IRM work stream combines the previous insecticide resistance and capacity building for IRS work streams. Two overarching priority themes were identified in the meeting: (i) advocacy for the issue of insecticide resistance management and (ii) the need to conduct insecticide resistance management within the context of integrated vector management.

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Discussion – All

- *Training materials:*
 - The Abt Associates/President's Malaria Initiative (PMI)/Africa IRS (AIRS) reports and information are a useful resource for capacity building.
 - WHOPES have begun to develop standard operating procedures for IRS methods which will soon be available online.
- *Coordination of IRS in country:*
 - There remains a lack of coordination between those implementing IRS in-country e.g. Abt/PMI and NMCPs. There is considerable scope to standardise methods and programme structure.
 - UNITAID provides a forum for communication to an extent but there may be a need for country IRS steering committees to bring together all stakeholders and agree on common strategies.
 - A recent paper describes how stakeholders within vector control have been brought together in Cambodia through a consortium that meets every two months (Canavati *et al.* 2016 *Malar J*).
- BMGF is interested in IRM and recently convened a meeting of experts to put together a series of papers for the *Lancet Global Health* to set an agenda for IRM.