

**Roll Back Malaria Vector Control Working Group (VCWG)**

**9<sup>th</sup> Annual Meeting, 19<sup>th</sup>-21<sup>st</sup> February 2014**

**International Federation of the Red Cross and Red Crescent Societies**

**17 Chemin des Crêts, Petit-Saconnex, Geneva, Switzerland**

**Co-chairs: Michael Macdonald and Jo Lines**

**Secretariat: Konstantina Boutsika**

**Rapporteur: Lucy Tusting**

**Day 1: Wednesday 19<sup>th</sup> February 2014**

**Session 1: Introductions and Objectives**

**IFRC Auditorium**

*Chair: Michael Macdonald*

Michael Macdonald opened the meeting and welcomed participants to the 9<sup>th</sup> Annual Meeting. To begin the meeting there was a remembrance for one of the great icons of medical entomology and malaria control, Professor Jean Mouchet, who died in January.

Jo Lines introduced the meeting aims and overall objectives of the Vector Control Working Group (VCWG), which are not only to facilitate partnership between technical experts in vector control but also to make technical expertise available to national malaria control programmes (NMCPs). The most productive Work Streams have worked as small committed groups, who see the VCWG as a way to increase the relevance of their own work and generate formal and peer-reviewed outputs and funding. Opportunities to improve output of the work streams include, (1) having active core groups within the work stream, (2) being organised in interacting with NMCPs and (3) facilitating formal debate on the major issues.

***Welcome remarks from the Roll Back Malaria Partnership – Dr. Fatoumata Nafo-Traoré, Roll Back Malaria (RBM) Partnership, Switzerland***

Dr. Nafo-Traoré thanked Jo Lines, Michael Macdonald and Konstantina Boutsika for their work coordinating the VCWG and welcomed participants. The revised terms of reference for the VCWG have been approved, reflecting a shift in emphasis in the work of the group from a purely scientific and academic approach to the provision of technical expertise to NMCPs. New considerations for the VCWG include the renewed call for universal coverage of interventions; the revised funding Global Fund funding model (which will necessitate giving more support to NMCPs) and continuing to ensure that countries collect reliable and consistent data. Issues raised by country program managers include assessing long-lasting insecticide treated net (LLIN) durability *in situ*. The RBM/UNDP Multisectoral Action Framework for Malaria was launched in September 2013 and many countries are interested in adopting this approach. As we move forward, it will be increasingly important to tailor interventions to the local circumstances.

***Update from the Global Malaria Programme (GMP) – John Reeder and Abraham Mnzava, WHO Global Malaria Programme (GMP), Switzerland***

*Current status of malaria control:* Dr. Reeder presented an overview of the global malaria burden. In 2012, 3.4 billion people remained at risk and there were 627,000 deaths. Between 2000 and 2012 there was a 29% decline in global malaria incidence. Total funding pledged for 2013 is US\$1.97bn, with further increases forecasted for 2014 to 2016 but no major expansion. LLIN and indoor residual spraying (IRS) delivery has been successful but only 42% of the population at risk currently sleeps under a net and only 4% (135m people) of the global population at risk was protected by IRS in 2012. There is evidence that IRS coverage may be falling. Insecticide resistance continues to be a major problem.

*Global Technical Strategy for Malaria:* The Global Technical Strategy (GTS) for Malaria, 2016 to 2025, will be a 10 year plan to support countries in their efforts to reduce the burden of disease and to work towards elimination. The GTS will set targets for 2025 and complement the updated RBM Global Malaria Action Plan, known as GMAP-2. The GTS is being developed by WHO/GMP, with oversight from the Malaria Policy Advisory Committee (MPAC), and will be presented to the World Health Assembly for endorsement in May 2014. Seven regional consultations on the GTS have been scheduled and a draft version will soon be available on the GMP website for wider input (see [www.who.int/malaria/areas/global\\_technical\\_strategy](http://www.who.int/malaria/areas/global_technical_strategy)).

*Malaria Policy Advisory Committee (MPAC):* MPAC continues to provide independent strategic advice and technical input to WHO for the development of policies. There are 15 members on the committee and meeting proceedings are published in the Malaria Journal. Feedback is welcome via [mpacgroup@who.int](mailto:mpacgroup@who.int). Evidence Review Groups (ERGs) are convened *ad hoc* to answer specific questions raised by the MPAC; Technical Expert Groups (TEGs) (including the Vector Control TEG, VCTEG) are standing committees that regularly report to MPAC.

*Global Malaria Programme Vector Control Unit:* Abraham Mnzava gave an update from the GMP Vector Control Unit, the mission of which is to maintain and promote evidence and consensus-based recommendations and guidelines, in addition to encouraging the development and testing of new vector control technologies and tools. The Vector Control Advisory Group (VCAG) was jointly established by GMP and the Department of Control of Neglected Tropical Diseases (NTD) and reports to GMP/MPAC and the Strategic and Technical Advisory Group for Neglected Tropical Diseases (NTD/STAG). VCAG exists to assess new tools, technologies and approaches for vector control and provides a pathway for new vector control tools to gain an initial recommendation; it differs however from the WHO Pesticide Evaluation Scheme (WHOPES) which provides product specifications. The second VCAG meeting was held in February 2014 and reviewed 9 dossiers from potential innovators. VCTEG was established by MPAC in Sept 2012 and has already reviewed evidence and made recommendations to MPAC on (1) maintaining universal LLIN coverage, (2) estimating LLIN longevity, (3) capacity building for public health entomology and (4) managing old LLINs and plastic packaging. A précis of each recommendation was presented. The next VCTEG meeting will be held the last week of February 2014 and will discuss: (1) prioritising vector control interventions when resources are constrained, (2) combining IRS and LLINs, (3) controlling early and outdoor transmission and (4) entomological surveillance. The contribution of the partners who have contributed to vector control work was acknowledged, including endemic countries, the Bill and

Melinda Gates Foundation (BMGF), United States Agency for International Development (USAID), UK Department for International Development (DfID), Swiss Agency for Development and Cooperation (SDC), the Global Fund for AIDS, Tuberculosis and Malaria and the VCWG.

***Update on budget and information exchange – Konstantina Boutsika, VCWG secretariat and Swiss TPH, Switzerland***

**Budget:** In 2013 the co-chairs requested US\$400,000 and received US\$20,000, which was allocated to the IRS Work Stream (for the West Africa Malaria Workshop) and the Entomological Monitoring and Integrated Vector Management Work Stream. The Continuous LLIN Distribution, Durability of LLINs and IRS Work Streams received funding from other sources. US\$600,000 has been requested based on the work plan for 2014-2015; however all RBM working groups have received US\$70,000 each, \$30,000 was being allocated for the annual meeting, leaving a balance of \$40,000 for the work streams.

**Communications:** The mailing list now has over 500 members. The updated VCWG website (in English and French) is also a useful resource and means for dissemination. The website received 8777 visits in 2013, less than in 2012, but this constitutes the largest number of visits to any RBM working group website. Most visits are from Europe (40%), the Americas (27%), Asia (15%) and Africa (13%). At the 9<sup>th</sup> Meeting, 192 participants are registered from 44 countries (compared with 162 participants from 35 countries in 2013). A breakdown of participation from different sectors was given.

***Lessons learnt and charting the way forward - Michael Macdonald***

Michael Macdonald again highlighted the decline in global malaria mortality in the past decade but emphasised that rates are now slowing and that funding levels may also be plateauing. Also of concern is the levelling in LLIN coverage and decline in IRS coverage as replacement, more expensive insecticides are needed to manage insecticide resistance. A new book by Professor James Webb from Colby College in the United States was mentioned ('The Long Struggle against Malaria in Tropical Africa'), which is due for publication in March 2014. The book reiterates the notion that 'after success and immunity wanes, the obligation to sustain remains'. While there has been broad global success in malaria control over recent years, there are areas of resurgence with increased malaria illness and deaths despite continued efforts of the NMCPs.

Priorities and opportunities for the VCWG include: 1) insecticide resistance, 2) sustaining universal coverage with LLINs, (3) new paradigms and outdoor transmission, (4) multisectoral approaches, (5) larvicide and (6) entomological monitoring and stratification. A major caveat was stressed; that malaria is a complex, specific and local disease. There is no magic bullet and no single solution that can be rolled out across the globe; quoting the American journalist H.L. Mencken, 'For every complex problem there is an answer that is clear, simple and wrong'. The strength of the VCWG is its diverse range of resources and expertise to help countries to build capacity to analyse local challenges and adapt norms to find local, optimum solutions.

***Insecticide resistance:*** The Global Plan for Insecticide Resistance Management (GPIRM, <http://www.who.int/malaria/publications/atoz/gpirm/en/>) is a valuable resource to help countries

deal with insecticide resistance, although uptake has been generally slow. The VCWG can support the implementation of five major components of GPIRM: (1) some countries are now establishing intersectoral committees to address insecticide resistance, especially in the Eastern Mediterranean Region where they are based on the existing Integrated Vector Management Committees, (2) the VCWG can help to encourage proper, timely entomological resistance monitoring as recommended by GPRIM. A new WHO guide for resistance monitoring is available which includes the complementary Centers for Disease Control (CDC) bottle assay. A prototype monitoring plan is also under development by the Global Fund and GMP, which will help countries establish national monitoring schemes for insecticide resistance, (3) GPIRM also advocates the development of new and innovative vector control tools and such work is being coordinated by the Innovative Vector Control Consortium (IVCC), VCAG and entrepreneurs elsewhere, (4) it is important to fill in knowledge gaps on mechanisms of insecticide resistance and on the impact of current levels of insecticide resistance on control. The VCWG can support groups such as the Pan African Mosquito Control Association (PAMCA) and African Network for Vector Resistance (ANVR), a consortium of universities and research institutions in Africa with the laboratory capacity to support national insecticide resistance monitoring efforts, (5) finally, it is crucial to ensure that key enabling mechanisms (advocacy as well as human and financial) are in place to detect and manage resistance.

*Sustaining universal LLIN coverage:* Issues of both distribution and LLIN durability must be addressed in order to achieve and maintain universal coverage. A new WHO guidance document on 'Prioritizing LLIN deployment when resources are constrained' is being drafted for 2014. Both the VCWG (specifically the Continuous LLIN Distribution and Durability of LLINs in the Field work streams) and the Alliance for Malaria Prevention (AMP) have an important role to play in implementing this. USAID and the NetWorks Project were acknowledged for their funding of much of this work.

*New paradigms and outdoor transmission:* Malaria control needs strategies aimed at reducing outdoor and residual transmission. The importance of breaking technical silos and making connections across disciplines for innovation was stressed; the role of the VCWG as a forum for diverse partners to come together for such discussions highlighted. Addressing outdoor transmission is especially important for containing artemisinin resistance in areas of the Mekong region, but also has relevance in Africa, Amazonia and the Western Pacific as well. Improved vector mapping and information management can help identify the areas where transmission is highest and encourage thinking more in terms of 'Most-At-Risk-Locations' rather than 'Most-At-Risk Populations', i.e. rather than focus on the broad category of migrant workers as a MARP, delineate and concentrate efforts on workplace transmission foci, where additional tools, such as IRS could be deployed.

*Multisectoral engagement:* The Multisectoral Action Framework for Malaria, launched in September 2013 (<http://www.rbm.who.int/docs/2013/Multisectoral-Action-Framework-for-Malaria.pdf>) to promote cross-sectoral collaboration, aligns closely with the principles of Integrated Vector Management (IVM). Efforts to implement a multisectoral approach to malaria are underway in the Lake Victoria region. The Lake Victoria Initiative (LVI) spearheaded by RBM and UN-HABITAT, builds upon a regional water and sanitation project of the Lake Victoria Basin Commission to supplement current vector control measures of LLINs and IRS through complementary larval source management in urban agriculture and peri-urban environments, incremental improvements to housing and public-private partnerships with the commercial agriculture sector for workplace and community programs,

including provision of LLINs and where indicated, IRS. Another example of multisectoral engagement was illustrated by the Sixth Meeting of the Conference of the Parties to the Stockholm Convention, held in Geneva in April-May 2013, recommending that funding be made available to support skilled staff and national capacity for entomological monitoring. This represents an opportunity for the VCWG to collaborate with the Stockholm Convention Secretariat, the United Nations Environment Programme (UNEP) and the associated Global Alliance for Alternatives to DDT. The VCWG can also collaborate more closely with the business community through GBCHealth, who have been instrumental in helping to facilitate IRS in West Africa, for example.

*Larviciding:* The LSM Operational Manual was published in 2013 (WHO, 2013. Larval Source Management: A Supplementary Measure for Malaria Control. An Operational Manual) and the WHO Interim Position Statement on larviciding in sub-Saharan Africa was published in 2012. The VCWG can help guide countries in their interpretation of WHO guidelines and their translation into operational use. Workshops could be a good means to providing technical expertise to countries, especially in ECOWAS where larviciding is being rapidly taken up. Quality control of the product is crucial.

*Entomological monitoring and capacity building:* Malaria control is at a critical juncture; maintaining recent gains and moving to elimination may not be possible in many settings unless there is greater investment in entomological monitoring and capacity building; local analysis and tailoring of interventions is essential to sustaining control. Expanding public health entomologist skills in epidemiology, information management and mapping is also key. All implementation partners and programmes must cater for capacity building and national ‘ownership’. Networks such as Malaria World, the Asian Collaborative Training Network for Malaria and the Pan African Mosquito Control Association (PAMCA) can contribute to the training and mentoring of this necessary cadre of the public health entomologist.

The election process for the VCWG chair was described. Notifications to solicit nominations will be sent by the Secretariat on March 3<sup>rd</sup> 2014. The deadline for confirmation from the nominees that they are willing to stand will be March 17<sup>th</sup> 2014. The election date will be March 31<sup>st</sup>, 2014 with voting from members of key supporting institutions. Jo Lines will stand down this year (2014) and Michael Macdonald next year (2015).

#### *Discussion*

- *Technical support:* The importance of providing technical support to malaria-endemic countries in Africa was again highlighted. The cost of technical assistance must be incorporated into Global Fund applications.
- *Managing insecticide resistance:* Adopting replacement compounds for IRS will be more expensive and this could be problematic; however RBM intends to convene discussions between product developers and countries to help address this.
- *Capacity building:* Countries must build a career structure for entomologists and make it viable for public health entomologists and vector control professionals experts to work in the field over the course of their entire careers.

**Session 2: Vector Control Landscape****IFRC Auditorium***Chair: Jo Lines***Alliance for Malaria Prevention (AMP) – Jason Peat, International Federation of the Red Cross and Red Crescent Societies (IFRC), Switzerland**

Jason Peat provided an update from the AMP, a multisectoral partnership within RBM that supports countries, in collaboration with the working groups, to achieve the Global Malaria Targets and the 2015 Millennium Development Goals by expanding the ownership and use of mosquito nets. A core working group of 19 members from 16 organisations works alongside five working groups on Behaviour Change Communication (BCC), Country Support, Emerging Issues, Monitoring & Evaluation and Operational Research. Highlights of 2013 include the distribution of over 91m LLINs in 10 countries and the development of position statements by the Emerging Issues Working Group on net durability and insecticide resistance. Support from CDC, USAID, the President's Malaria Initiative (PMI), Nothing But Nets, United Nations Foundation and the IFRC was acknowledged. The annual partners meeting was held earlier in the week, 17 and 18 February. Highlights of 2013 included evaluations of school and community distributions, recalculation of the Net Use Gap by including an indicator for Access, (i.e. not just how many people used a net the previous night, but how many who had access to a net used one) work on misuse of nets for things such as fishing, the UNITAID market-based analysis of net distribution and finally engagement the role of LLINs in elimination settings. This year, 2014 will see increased investment in capacity building and mentoring counterparts in the national programs. Weekly calls are held every Wednesday 15.00GMT International 1-213-787-0529, USA toll free 1-888-808-6929 access code 3904916. All are welcome to join.

**IVCC: Accelerating innovation in vector control for malaria and NTDs – Nick Hamon, Innovative Vector Control Consortium (IVCC), UK**

Public health needs innovative vector control tools, with rapid development times, low costs for end users and effective market delivery. Barriers to this innovation include the small and unpredictable market, high entry cost, low profit, regulatory hurdles and the slow path to market. IVCC is a Product Development Partnership that invests donor funds in research and development to overcome barriers to innovation in vector control. IVCC focuses not only on product development but also on delivery. Since 2005, 4.5m compounds have been screened and at least eight novel classes have been identified for further development, of which three will be selected and brought to market by 2022. Selecting products is a trade-off between many factors including toxicology and entomological efficacy, development costs and the potential of a compound in agriculture; IVCC will need to consider all of these in making decisions over the next few years.

**Harmonisation Working Group – Melanie Renshaw, African Leaders Malaria Alliance, Kenya**

All malaria-endemic countries are currently working on proposals for the new Global Fund funding model (NFM), with the first date for submission in May 2014. The Harmonization Working Group (HWG) is providing support to countries for the NFM, specifically in Situational Analysis, National Strategic Planning and Concept Note development (Box 1).

**Box 1. Harmonization Working Group provision of country support for the new funding model**
**1. Situational Analysis:**

- Analysis of past and present epidemiology of malaria, and recent progress in its control including risk mapping

**2. National Strategic Planning:**

- Strategic plan review and updating
- Operational plan costing
- Technical support
- Capacity development planning
- Programmatic and financial gap analysis

**3. Concept Notes:**

- Consultation and process management
- Country coordinating mechanism (CCM) governance support
- Concept note development

Support will be tailored on a country by country basis and will include support for in-country consultative workshops, internal consultants, external consultants and external partner joint mission support. HWG will also convene a series of meetings to support countries in the preparation of the NFM concept notes. Mock Technical Review Panels (TRPs) will allow country peer review of strategic plans and concept notes and allow a critical assessment selected priority interventions. The dates for these meetings are as follows:

- 10<sup>th</sup>-14<sup>th</sup> March 2014, Nairobi: Meeting to facilitate peer review of national strategic plans and 3 year operational plans.
- 7<sup>th</sup>-11<sup>th</sup> April 2014, Dakar: Francophone mock TRP for first wave countries (countries submitting in time for the May/June 2013 TRP).
- 14<sup>th</sup>-17<sup>th</sup> April 2014, Harare: Anglophone mock TRP for first wave countries.

The HWG will convene consultant NFM training workshops in conjunction with each meeting, organise webinars on key technical and NFM areas as required, brief second-wave countries in back to back workshops, provide remote expert review of near-final concept notes and provide updated implementation and technical guidance.

***Discussion***

- **Technical assistance:** Technical assistance requests to AMP, HWG and the VCWG need to be coordinated. Since there no longer exists core WHO funding in AFRO for technical experts, the HWG advises that countries budget for both internal and external technical assistance in their proposals. Countries must consider components of their programmes in addition to commodities, including monitoring and evaluation, capacity building, health system strengthening and technical assistance.
- **New product development:** There was discussion of the need to reduce product delivery times from initial identification to market. It was queried how funding is prioritised among new active ingredients and new paradigms. IVCC has now received unrestricted donor funding which can be directed towards new paradigms, but is limited in human capacity to

fully pursue all avenues while being able to maintain its focus on developing new active ingredients.

***Southern Africa Racing Against Malaria Rally (RAM-II), April 13<sup>th</sup>-25<sup>th</sup> 2014 - Shiva Murugasampillay, WHO, Switzerland (on behalf of Kaka Mudambo, RBM-Southern African Regional Network)***

An overview of RAM-II was given, which aims to help eliminate malaria by 2015 in low transmission/pre-elimination areas in Southern Africa, as a follow-on from the 2003 Racing Against Malaria (RAM) and the 2008 Zambezi River Expedition. The goal is to increase malaria control efforts especially on the remote border districts where intervention coverage may not be as high and to raise awareness of malaria control in the region. The rally will start in Dar-es-Salaam and finish in Namibia.

## **Session 2: Progress on Work Plan**

### **IFRC Auditorium**

*Chair: Christian Lengeler*

***Insecticide Resistance – Janet Hemingway, Liverpool School of Tropical Medicine, UK***

The agenda for the 5<sup>th</sup> Insecticide Resistance Work Stream meeting was presented. The meeting will review the developments of 2013, present work on resistance in Uganda and West Africa and discuss resistance monitoring and the priority areas of work for 2014.

***Continuous LLIN Distribution Systems – Kojo Lokko, Johns Hopkins University Center for Communication Programs (JHU CCP), USA***

The 2013 Work Plan included (1) the ‘Fragile Gains Paper’, an advocacy paper led by Lucy Paintain that draws attention to the likely impact of reduced coverage with ITNs on malaria in Sub-Saharan Africa; (2) a review of prioritising LLIN delivery when funding is insufficient (work carried out by WHO GMP); (3) work to track the effective dissemination and use of the Work Stream products developed in 2011/2012 and (4) a mid-year meeting of work stream core members at the 2013 American Society of Tropical Medicine and Hygiene annual meeting. Countries using continuous distribution tools include Uganda, Ghana and Nigeria amongst others. The 2014 meeting will focus on (1) the evidence on antenatal clinic (ANC) and extended programme of immunisation (EPI) delivery of LLINs, (2) the results from continuous LLIN distribution pilot work in the Eastern Region of Ghana through Schools, ANC and EPI, (3) the use of electronic vouchers and coupons, (4) the role of the private sector in continuous distribution, (5) prioritisation of LLIN delivery in conditions of scarcity and (6) data for stratification and mapping.

***Durability of LLINs in the Field – Albert Kilian, Tropical Health LLP, Spain***

The 2014 meeting will focus on (1) 2013 developments, (2) an update on ongoing durability studies, (3) the Tanzania ABCDR study, (4) measuring insecticide levels on LLINs in the field, (5) causes and mode of physical deterioration of LLINs and (6) discussion of priorities for 2014 and the draft work plan.

***Capacity Building for IRS – Manuel Lluberas, H.D. Hudson Manufacturing Company, USA***

Workshops were held at the MIM conference in Durban, October 2013, and in conjunction with GBCHealth in Accra, Ghana. Key points for discussion this year are (1) building capacity for public health entomologists, (2) promoting career paths at country level, (3) reinforcing program management components of IRS (specifically, personnel management, motor pool and logistics, and warehousing and waste management) and (4) cross-support with other programs.

***Larval Source Management – Steve Lindsay, Durham University, UK***

An Operational Manual on LSM (WHO, 2013. Larval Source Management: A supplementary measure for malaria vector control. An Operational Manual. Geneva, WHO. Available: <http://www.who.int/malaria/publications/atoz/9789241505604/en/>) was published in 2013 to help countries select interventions, plan and manage programmes and conduct LSM. Also published in 2013 was the Cochrane Review of LSM. The 2014 meeting will review progress in 2013, discuss the 2014 draft work plan, and review LSM case studies in India and Pakistan.

***Housing and Malaria – Steve Lindsay, Durham University, UK***

A new Work Stream will be convened following the launch of the Multisectoral Action Framework for Malaria which calls for action outside the health sector to contribute to malaria control. Social and economic development may have played a role in the decline in malaria over the past decade; metal roofed homes are rapidly replacing old thatched homes for example. Millions of new homes will be built in rural Africa by 2050 and African economies now have a 6% average GDP growth rate. These are opportunities for improving homes to protect against malaria. The first meeting will cover: (1) evidence supporting housing as a malaria intervention, (2) developing a framework for scaling-up housing interventions, (3) ongoing field work and (4) the draft 2014 work plan.

***Optimizing Evidence for Vector Control Interventions – John Gimnig, Centers for Disease Control and Prevention (CDC), USA***

The mandate of the Optimizing Evidence Work Stream is to coordinate evidence for combinations of field interventions and evaluate new paradigms. The 2014 meeting will (1) review recent evidence on LLIN-IRS interactions, (2) give updates on alternative bioactives (fungus and alternative chemicals), (3) review the re-designing of the vector control portfolio at the BMGF, (4) review the new VecNet portal, (5) review IVCC plans for new paradigms in vector control and (6) discuss the 2014 work plan (including work with IVCC).

***Entomological Monitoring and Integrated Vector Management (IVM) – Jacob Williams, Research Triangle Institute (RTI) International, USA***

The 2014 meeting will focus on (1) scaling up effective control (specifically covering (a) experiences on harmonised sub-regional requirements, (b) perspectives from industry, (c) an update on related activities by WHO and (d) a discussion of strategies to encourage action); (2) scaling up effective vector control (specifically (a) an update on the framework for integrated vector control and (b) opportunities to leverage investments in other vector borne diseases for malaria vector control); and (3) scaling up effective vector control in the context of the ‘Vector Borne Diseases’ theme for World Health Day 2014.

### ***Discussion – Summary of the first day***

- *Importance of broader mosquito control:*
  - Efforts to distribute LLINs, IRS and other vector control methods should be integrated so resources are not wasted. For example IRS staff are redundant for part of the year and when not spraying could work on LLINs, Larval Source Management, housing improvements and other aspects of vector control.
  - *Culex* and especially *Aedes* vectors of dengue and chikungunya should be considered alongside *Anopheles* control: though it is not the mandate of RBM to work with other vector-borne disease, it is important to attempt to coordinate control efforts.
  - Scaling-up vector control interventions must be tailored to wider existing malaria control infrastructure (including surveillance, diagnosis and treatment).
- *Learning from the past:* a group could be assembled to review the factors common to successful historical elimination programmes.
- *Engaging with the private sector:*
  - Africa is rapidly developing and consumers themselves can be an additional source of financial support for vector control.
  - Malaria is disease with many social and economic determinants; technological solutions must take this into account.
  - GBCHealth facilitates alliances between the private sector and public health, for which there are considerable benefits in addition to just improving employees' health.
- *New paradigms:*
  - Evaluating new paradigms may be challenging given the low incidence of malaria and presence of other control measures in many locations. While there are challenges to conducting large field trials the structure for doing so does exist.
  - VCAG was formed to establish protocols to evaluate new paradigms and to provide feedback on trials at every stage, from early concept to final field evaluation.  
[http://www.who.int/neglected\\_diseases/vector\\_ecology/Operational\\_procedures\\_for\\_VCAG.pdf](http://www.who.int/neglected_diseases/vector_ecology/Operational_procedures_for_VCAG.pdf) As defined on the VCAG webpage, a new “paradigm” as opposed to a new “product” is if one or more of the following conditions are met:
    - An intervention or combination of interventions that protects humans against a different group of vectors or in different transmission settings (or contexts), different human populations or via a different mechanism from existing methods, e.g. an odour-baited trap or a genetically-modified insect.
    - An intervention where one or more of its characteristics is sufficiently changed that entomological effect alone is not sufficient to imply epidemiological effect, e.g. a resistance-breaking bednet.
    - When a product is not adequately described by an existing target product profile (TPP) and validation will result in the development of a new TPP, and hence a new product class.
  - New approaches to conducting studies could shorten time to reach the end user.
  - IVCC is holding a session to solicit ideas on new paradigms at the VCWG this year.

- *Multisectoral approaches:* Capacity to collect and analyse entomological, ecological and environmental information will help steer national development plans towards better town planning, agricultural practices, house design and other factors that will reduce the risk of vector borne diseases and complement ongoing malaria control efforts.

***Update on the activities of the Outdoor Malaria Transmission Work Stream – Michael Macdonald on behalf of Marc Coosemans***

Both human and vector ecology necessitates addressing outdoor transmission. For human ecology there are needs by forest workers, homesteaders, soldiers and rubber tappers who are outside and exposed during transmission times. For vector ecology, Bayoh and colleagues (2010) amongst others have documented the shift from *An. gambiae* to *An. arabiensis* in areas of east Africa where there is high use of indoor control methods through LLINs and IRS. This Work Stream initially focused on challenges in the Mekong, including in March 2013 when the 6<sup>th</sup> work stream meeting was held at Mahidol University in Bangkok with an aim to review the control efforts and research activities related to outdoor transmission and to establish a secretariat to facilitate communication and coordination. Establishment of a viable secretariat has not yet been successful. Nevertheless, there are numerous individual partner initiatives to address outdoor or residual transmission, including PMI/Mekong, the WHO/BMGF operational research on artemisinin resistance containment held in Bangkok December 2013, the IVCC ESAC-3 ‘New Paradigms’ initiative and research on personal protection by the Armed Forces Pest Management Board. Recent publications on outdoor transmission include Durnez and Coosemans, 2013. Residual Transmission of Malaria: An Old Issue for New Approaches. In *Anopheles mosquitoes - New insights into malaria vectors*, Manguin (Ed)) and a large-scale evaluation of a mosquito repellent in Cambodia (MalaResT), preliminary results for which are now available. The need to find a solution to outdoor transmission is there, the partners are there and the science is there; it is important to revive this work stream as a forum to facilitate communication and sharing of best practices for this important area of work.

**6<sup>th</sup> Durability of LLINs in the Field Work Stream Meeting**  
**15.30-18.00, Wednesday 19<sup>th</sup> February 2014**  
**Auditorium, IFRC, Geneva**

**Chairs: Albert Kilian and Steve Smith**

**Rapporteur: Lucy Tusting**

***Overview of developments in 2013 – Albert Kilian, Tropical Health LLP, Spain***

Over the past five years the Work Stream has focused its work on (1) behavioural aspects of LLIN durability including care and repair, (2) research on durability, (3) methods of laboratory textile testing of LLINs in order to predict field performance and (4) methods to measure LLIN survival in the field.

**1. Behavioural aspects of durability:**

- a. Recent publications (e.g. Wills et al., 2013. Malaria Journal, **12**: 242, working in Ethiopia) confirm very low repair rates.
- b. An ongoing study in Nigeria (Nasarawa State) suggests that changing repair behaviour can be challenging but after one year of follow up there was a significant increase in the proportion of households repairing holes in nets. A second year of data collection will allow net condition (integrity) to be assessed.
- c. Quantitative research shows that people are able to determine the need for replacement and express a demand for replacements (Loll et al., 2013, Malaria Journal, **12**: 337).

**2. Research on durability:**

- a. Ongoing work, yet to be published, indicates that the locations of the holes are important for mosquito entry, and that there are differences among species in finding and entering through these holes.
- b. Work on mosquito entry related to both hole size and insecticide level is planned in Tanzania.

**3. Textile testing of unused LLINs in order to predict field performance:**

- a. WHO (GMP-WHOPES) is testing recommended LLIN brands using currently existing textile tests. An initial meeting was held in August 2012 to discuss preliminary data with the final results expected in early 2014.
- b. The Bill & Melinda Gates Foundation has funded the Results For Development (R4D) and Non-woven Innovation & Research Institute (NIRI) and TropHealth Studies [http://www.trophealth.com/?page\\_id=2](http://www.trophealth.com/?page_id=2)

**4. Field data net survival:**

- a. A number of 2013 studies have reported on aspects of net survival in the field:
  - Mutuku et al., 2013. Malaria Journal, **12**: 46 (Kenya): a cross-sectional survey of existing nets routinely used was conducted. Physical condition and use were assessed and nets considered ineffective with a hole surface >500cm<sup>2</sup>.

The proportion of effective nets decreased until the third year and then stabilised at 30%.

- Mejía et al., 2013. *Malaria Journal*, **12**: 158 (Kenya): a study was conducted within a Millennium Village to assess Olyset survival 4.5 years after distribution. A mean survival of 5.5yrs was estimated, with a more likely survival time of 4.5yrs when missing households are accounted for.
- Haji et al., 2013. *Parasites & Vectors*, **6**: 82 (Zanzibar): three year old Olyset nets were analysed and 68% found damaged (however a low-cut off was used).
- Wills et al., 2013. *Malaria Journal*, **12**: 242 (Ethiopia): a multiple cross-sectional survey was conducted to assess PermaNet 2.0 after 3-32 months of use. No attrition was reported; 30% LLINs were ‘torn’ after 26-32 months.
- Odhiambo et al., 2013. *Journal of Tropical Medicine*, **2013**: 563957 (Kenya): Netprotect was evaluated in two villages. Attrition after 3 years was 21% with 90% nets still effective in cone assays.

a. Methodology for survival estimate:

- A draft document with a review of existing evidence was prepared and presented at the 1<sup>st</sup> Vector Control Technical Experts Group (VCTEG) meeting in July 2013 and the Malaria Policy Advisory Committee (MPAC) meeting in September 2013. An official Guidance Note has now been published (WHO, 2013. WHO Guidance Note for Estimating the Longevity of Long-Lasting Insecticidal Nets in Malaria Control. Geneva, WHO. Available: [http://www.who.int/malaria/publications/atoz/who\\_guidance\\_longevity\\_llns.pdf](http://www.who.int/malaria/publications/atoz/who_guidance_longevity_llns.pdf)).
- It was decided that insecticidal effectiveness will not be included in the recommended measure of median LLIN survival until a field test is available that does not necessitate removing or destroying the net, and until a better understanding of the minimal effectiveness is available (i.e. the insecticide level at which no extra clinical protection is achieved).
- A median survival analysis tool in a MS Excel spread sheet format will be made available online, which will allow survival outcomes to also be plotted.

b. Preliminary data from ongoing studies were presented:

- An ongoing retrospective durability study in three regions of Nigeria: preliminary results indicate that the way in which nets are used has a large bearing on survival.
- Two cross-sectional surveys 12-36 months after a LLIN campaign in the Eastern Region of Ghana which indicates that median survival of the 75D polyester nets used is around 5 years.
- A prospective LLIN study in Uganda of seven brands, showing on general a 3.5-4 year median survival with very little differentiation between brands.

In summary:

- There are too few publications with sufficient data to make a judgement on survival.
- Unpublished data suggests that median net survival in some sites is closer to 4-5 years (or more) than 3 years.

- There is a need to disseminate new guidelines and build capacity for the application of these guidelines.

#### *Discussion*

The following points were raised by participants:

- The overall goals of durability research are to produce an ideal LLIN product specification and to make recommendations on the ideal frequency of LLIN redistribution. There are insufficient data on these at present to make firm recommendations.
- The 'net survival tool' is useful and simple, however it must be remembered that the assessment of net quality is subjective.
- Much data on net durability has been, or is being, collected through prospective studies. These results may not be generalizable, since study participants may take better care of their nets. To account for this bias, it is important to consider both integrity and attrition when analysing prospective studies. This bias should not be problematic in retrospective studies.

#### ***Current studies of LLIN durability – Steve Smith, Centers for Disease Control (CDC), USA***

Much work is ongoing to collect data and analyse LLIN survival, as recommended by the 2013 WHO Guidance Note, with at least 21 ongoing field studies in 19 countries. Preliminary results from Malawi, Kenya and other PMI sites were presented at MIM Durban in October 2013; one brand of net was found to perform considerably less well because of the knitting pattern and the manufacturer has now resolved this. At least four laboratory studies are also ongoing, coordinated by WHO, CDC, RD4 and Leeds University among others. Issues for discussion include how best to collect and disseminate information about ongoing research and whether the Durability Work Stream can provide technical expertise to assist the planning and design of studies.

#### *Discussion*

Results of studies ongoing with the old design of Olyset® net need to be treated with caution given the new knitting pattern. There was also discussion of the number of nets required to maintain 100% coverage.

#### ***Tanzania ABCDR study – Lena Lorenz, London School of Hygiene & Tropical Medicine, UK***

The overall aim of ABCDR is to investigate LLIN durability in Tanzania by measuring the Attrition, Bioefficacy, Chemical residue, physical Degradation of LLINs and insecticide Resistance. The study comprises a prospective and retrospective study. The prospective study began in October 2013 when community sensitisation, household enrolment, a baseline questionnaire and net distribution (collection of old nets and distribution of sufficient new nets) were conducted. There are 8 participating districts, within which 10 villages and 45 households in each are enrolled. Approximately 9000 nets (Olyset® with the new knitting pattern, PermaNet® 2.0 and Netprotect®) were distributed at baseline. The retrospective study is an analysis of Olyset® nets distributed by the National Malaria Control Program (NMCP) campaign for children under five years old in 2009-10 and a universal campaign for all age groups in 2010-11. Preliminary results from the baseline survey and next steps for the study were presented.

#### *Discussion*

Net durability in low-endemic settings should be considered.

***Measuring insecticide levels in the field - Karl Malamud-Roam, Rutgers, The State University of New Jersey, USA***

This research originated to solve the problem of conducting chemical assays of permethrin-treated clothing without destruction, and the absence of a reliable, non-destructive method for routinely measuring the concentration of pesticides on LLINs in the field. Analytical extraction and quantification is destructive and expensive. Other measurements might include: electro-magnetic spectra (x-ray fluorescence, x-ray in lab and field, IR absorption, UV fluorescence or indicator dye) or non-destructive chemical assays such as minor extraction and colorimetry or ELISA. Pesticide estimation might use the following proxies: bioassays, wash count, use/deployment time and wear, abrasion or fabric weight loss. The pros and cons of currently available methods were discussed alongside the challenges in using chemical assays, including difficulties in standardising the extract, variability of pesticide on nets and reagent stability. Criteria for a reliable test include sensitivity, being effective for all fabrics, acceptable to users, inexpensive and durable in the field.

***Causes and mode of deterioration - Steve Russell, University of Leeds, UK***

Current projects aim to understand the actual cause and modes of physical deterioration of LLINs in field settings, and to lay a foundation for improved LLIN textile testing methods that can be used in LLIN procurement and to encourage innovation in net technology. In this study 526 used LLINs (12-36 months use) were collected from sites in Uganda, Nigeria, Kenya, India and Mozambique and a direct analysis conducted to determine damage mechanisms resulting from use in the field. A total of 41,294 damage sites were inspected along with the entire LLIN structure (e.g. seams). Of all damage sites, 57.2% were pulls, 41.3% were holes and 1.5% were other defects. Photographs were presented to illustrate each damage mechanism. Seven primary and three secondary mechanisms leading to holes were described. Damage mechanism profiles by hole frequency were presented by country. Mechanical damage is the most widespread and consistent source of holes. Improving snag resistance will likely improve durability. LLINs are also particularly susceptible to holes that are caused by cutting, thermal (fire) and rodent damage. Damage mechanisms affect subsequent hole size; tearing and seam failure produce the largest holes. Preliminary analysis indicates a relationship between laboratory tests for "hook strength" and the corresponding number of snags and tears per net observed in the field. The next phase in this research is to develop a suite of new LLIN textile testing methods and specifications to reflect actual modes of damage found in the field and to improve the linkage between lab test performance and long-term field durability.

***Discussion***

It was queried whether some net brands are more attractive to rodents or if it was more a matter of net cleanliness (i.e. no food residue) and storage. Given the large extent of rodent damage, messages can already be given out alongside net distribution to raise awareness of protecting from this damage. Understanding the origin of holes will help plan distribution and design future nets. The trade-off between net strength and price was highlighted.

***2014 Work Plan and discussion – All***

- Developing assays for pesticides on nets is not only relevant for duration of effectiveness but also for considerations of disposal of netting fabric beyond their effective lifetime.

- Given the close relationship between laboratory tests for “hook strength” and the corresponding number of field snags and tears, WHOPES should perhaps adopt this as a criterion.
- Current data is not sufficient to make recommendations on which brand of net is best; the user aspect and the environment where the net is deployed is important.
- It was queried whether used nets could be recycled and made into pit latrine covers, for example. Polyethylene material can be recycled, but the feasibility and practicality of collection of nets from the field for recycling currently lacks guidance; it is also unknown if there is any residual pyrethroid present that may affect the saleability of the end product.
- Issues were raised over the development of ultra long-lasting nets, e.g. a decade, including: price, uncertainty over how long nets are needed, possible problems inherent in using the same insecticide on a net for an extended period and how to demonstrate that a net will last for a decade given the long testing time needed for WHOPES approval.

A draft 2014 Work Plan will be circulated for input.

**Day 2: Thursday 20<sup>th</sup> February 2014**

**5<sup>th</sup> Insecticide Resistance Work Stream Meeting  
9.00-12.00, Thursday 20<sup>th</sup> February 2014  
Auditorium, IFRC, Geneva**

**Chairs: Janet Hemingway & Maureen Coetzee  
Rapporteur: Lucy Tusting**

**Welcome and overview of 2013 developments - Maureen Coetzee, Witwatersrand University, South Africa**

Maureen Coetzee opened the meeting and gave an overview of developments in the past year. Brief highlights include the publication of the WHO guidelines on insecticide testing in 2013 which are now available online (WHO, 2013. Test procedures for insecticide resistance monitoring in malaria vector mosquitoes. Geneva, WHO. Available:

<http://www.who.int/malaria/publications/atoz/9789241505154/en/>), the launch of the Pan African Mosquito Control Association (PAMCA) at MIM Durban in October 2013 and the further development of the online insecticide resistance data base Insecticide Resistance (IR) Mapper.

**Vector resistance studies in Uganda in relation to insecticide use in public health and agriculture – Tarekegn Abeku and Michelle Helinski, Malaria Consortium, UK**

The objectives of the pyrethroid resistance management project were: (1) to evaluate the role of IRS using carbamates or organophosphates in pyrethroid resistance management, in order to prolong the usefulness of LLINs, (2) to understand the role of insecticides used in public health and agriculture in the spread of vector resistance, (3) to understand the impact of resistance on the effectiveness of interventions and (4) to help the Uganda Ministry of Health develop resistance management strategies. IRS was introduced in northern Uganda in 2006 first using DDT and pyrethroids and later when resistance was detected in 2009, switching to bendiocarb in 2010. The study was conducted in 45 sites in 3 groups of districts which had been exposed to different levels of IRS and LLIN coverage. The study comprised entomological surveys (pyrethrum spray catches twice at 12 houses in each site and WHO susceptibility tests), household and prevalence surveys, health facility-based morbidity studies, and data on the intensity of insecticide use in public health and agriculture. The use of agricultural pesticides differed by region, with organophosphates most commonly used overall. Indoor resting density was lowest in the group that had received IRS and highest in the group that had not received IRS or LLINs. No evidence of resistance to bendiocarb was found in any of the IRS districts. Resistance or suspected resistance to deltamethrin and permethrin was found in all districts where testing was possible. Malaria prevalence was highest in the group that had not received any major LLIN or IRS campaign, suggesting that nets appear to be providing protection despite widespread pyrethroid resistance.

**Insecticide resistance in West Africa – Hilary Ranson, Liverpool School of Tropical Medicine, UK**

AvecNet (<http://www.avecnet.eu/>) research on cross resistance in Cote d'Ivoire and measurement of the strength and impact of resistance in Burkina Faso was presented. In Tiassale, Cote d'Ivoire, *Anopheles gambiae* is resistant to all classes of insecticide available for IRS. There are high frequencies of the kdr mutation, insensitive acetylcholinesterase, CYP6M2 and multiple CYP6P enzymes. All of these resistance mechanisms are found elsewhere; kdr is widespread and insensitive ace-1 is spreading in West Africa. In Burkina Faso, pyrethroid resistance is well established. Three years of WHO monitoring data show little change in resistance levels in Valle de Kou. However once resistance is established, diagnostic assays may mask drastic change in resistance levels. This study therefore investigated how best to quantify the level of resistance in the population. Different assays were evaluated. The LT50 determination showed a ten-fold increase in time to mortality in one year (July 2011 to July 2012), however very long exposure times were required for the test making it less operationally useful in this setting. In an attempt to identify an alternative indicator of resistance, mortality rates were measured in a Kisumu laboratory strain and the Valle de Kou field strain after exposure to new and used LLINs. In order to determine a threshold level for an operationally significant level of resistance, CDC bottle bioassays were conducted with deltamethrin; however datasets were highly variable. Future research should assess whether diagnostic dose assays alone are sufficient to set insecticide policy, whether it is possible to define an operationally significant level of resistance from a bioassay and how best to select source mosquitoes. Further work must also link bioassay and molecular data to resistance impact.

**Cochrane review of impact of insecticide resistance – Janet Hemingway, Liverpool School of Tropical Medicine, UK**

The review assessed the impact of pyrethroid resistance on LLIN effectiveness and has now been accepted, with publication due in March 2014. It was a difficult process since methodologies are not standardized; future studies must ensure compliance with guidelines. Outcomes included were blood feeding, mosquito mortality, induced exophily, deterrence, not passing through the net, knockdown and time to knockdown. Resistance levels were stratified into high, moderate and low. Overall, there was considerable variability in the data and the assays used, and therefore insufficient evidence to evaluate whether pyrethroid resistance has had any impact on the effectiveness of LLINs.

**Discussion**

- *Monitoring resistance:*

- Measuring resistance is a priority for countries. The technical expertise may not exist on the ground to do so and standardized methods are still required.
- A solution to the variability in resistance measurement would be to have a WHO collaborating centre which takes responsibility for testing.
- As patterns of resistance change it is becoming clear that the picture is complex and evolving and that resistance can spread very quickly; the greatest risk at present is in West Africa with hotspots elsewhere. Few populations have kdr alone and it is therefore necessary to both detect other mechanisms while taking into consideration the strength of resistance that can be conferred by kdr.

- The data already exist to inform strategy in-country; it is not clear however who should provide leadership especially given that decisions potentially will impact on lives saved.
- *Resistance management:*
  - It will be crucial to apply new insecticides only in combination with other insecticides to avoid resistance emerging. IVCC is working towards three new active ingredients, which will have no cross-resistance and will be implemented with a careful resistance management strategy.
  - There is a need for clear guidance for NMCPs faced with resistance to all four classes of insecticides used for adult mosquito control.
  - Technical skills must be developed in-country and there is a need for nationally-owned policies that incorporate the agricultural sector. Both WHO and the FAO should raise awareness of this amongst policy makers, perhaps also involving organisations such as CropLife.
  - While GPIRM sets general principles for resistance management, guidelines for country-level implementation are needed as it is difficult to make general recommendations across all settings. Resistance management plans have been assembled for (1) Bioko and Equatorial Guinea in collaboration with Marathon Oil, published in the Proceedings of the National Academy of Sciences and on the IVCC website, and (2) Zambia, which will be available later in 2014 and good templates exist for some other countries. Guidelines for various scenarios would also help. This is being addressed by the WHO GMP and the VCTEG.
  - Insecticide resistance does not always translate into control failure; countries are in great need of guidelines on which strategies to adopt and when.
  - IVM can play a role in resistance management and has been recommended for years yet has not been adopted by countries.
- *Impact of resistance on LLINs:*
  - In areas of high pyrethroid resistance, the impact of resistance on net efficacy could be assessed using a randomised controlled trial with treated and untreated nets in each arm; the ethics would be debatable but could be justified by arguing equivalence between the two interventions in the presence of resistance.
  - The difficulties experienced in conducting the Cochrane Review of the impact of resistance are similar to those experienced for the Larval Source Management and LLIN reviews. Many studies are poorly designed and evaluated and therefore cannot be included in Cochrane reviews; this is a waste of resources. The CONSORT guidelines for reporting clinical trials should be replicated for entomological data.
- *Role of the Work Stream:*
  - The VCWG lacks funds but could consider having a partner who is a legally registered entity submit an Expression of Interest for a regional application to the Global Fund for funding to support the work of networks such as PAMCA; the deadline for submission of the Expression of Interest is 1 May.
  - The Global Plan for Insecticide Resistance Management (GPIRM) does not describe specific country-level plans to manage resistance, but outlines a general strategy and theory. A subgroup of VCTEG or the IR Work Stream could help guide its implementation at the field level.

- The Work Stream can also:
  - o Serve as a means of communication between research and VCTEG, and between research and NMCPs.
  - o Assess whether we have sufficiently robust assays to monitor resistance.
  - o Help countries adopt IVM as a resistance management strategy.
  - o Document strategies being used in-country, to allow the effectiveness of different methods to be gauged in the coming years.

#### ***Work Stream priorities for 2014***

1. Develop a document on best practices illustrating how 2-3 countries have implemented GPIRM.
2. Support WHO to convene country advisory groups to advise countries in developing resistance management strategies. Core members of the work stream should be identified to help examine country data and provide immediate advice; an email will be circulated after the meeting to assemble a list. Regional nuances must be accounted for so expertise should be matched. This is urgent given the upcoming Global Fund deadline.
3. Develop short advocacy or position statement on the current status of LLINs and IRS in the context of resistance and to ensure that countries are aware of GPIRM.

**5<sup>th</sup> Capacity Building for IRS Work Stream Meeting**  
**9.00-14.00, Thursday 20<sup>th</sup> February 2014**  
**Salle V, IFRC, Geneva**

**Chairs: Manuel Lluberas and Shiva Murugasampillay**  
**Rapporteur: Lucy Tusting**

***Introductions – Shiva Murugasampillay, World Health Organization, Switzerland***

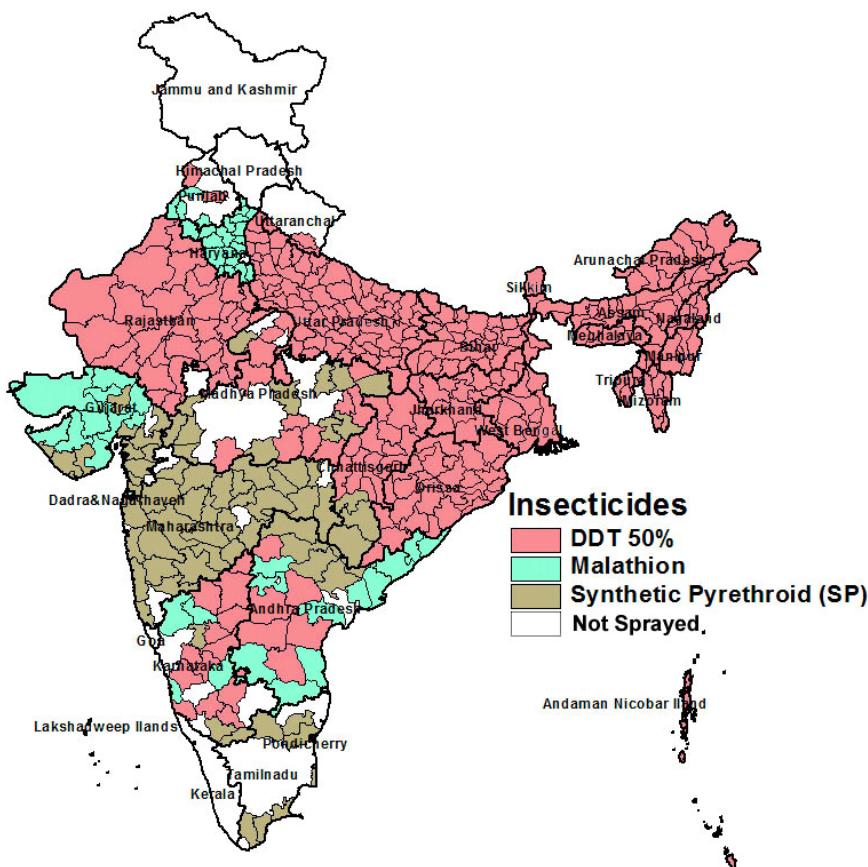
Shiva Murugasampillay opened the meeting and outlined its aim, to discuss current and emerging issues around the scaling-up and maintenance of IRS for malaria control and elimination. The major WHO publications on IRS policy and use were reviewed: (1) *Indoor Residual Spraying: Use of Indoor Residual Spraying for Scaling-Up Malaria Control and Elimination*, (2) *WHO Technical Consultation on Indoor Residual Spraying and Long-Lasting Insecticidal Net Interventions* and (3) *Indoor Residual Spraying: An Operational Manual for Indoor Residual Spraying (IRS) for Malaria Transmission Control and Elimination*. Different types of country needs for IRS support were outlined, ranging from countries who are at the early stage of piloting IRS (e.g. Malawi, Nigeria), to countries that have now started and are moving to phased expansion (e.g. Ghana, The Gambia) and countries that have been implementing IRS for longer and are scaling up coverage (e.g. Mozambique, Zambia, Yemen), or are working to improve quality (e.g. India, Ethiopia, Pakistan). Data from the 2013 World Malaria Report indicates that 81 countries recommend IRS as part of the malaria control programme, but that overall IRS coverage fell from 5% of the global population at risk in 2011 to 4% in 2012. Depending on how one calculates, the costs of IRS remain relatively high (per person per year of protection) compared to LLINs and these may increase as a result of needing to introduce more expensive insecticides in response to insecticide resistance. The targeted use of IRS with non-pyrethroid insecticides may become increasingly important for managing insecticide resistance.

Sub groups of the Work Stream include IRS Evidence and Reporting (Raj Maharaj and Immo Kleinschmidt), IRS Procurement and Supply Management (Rabindra Abeyasinghe and Gerhard Hesse), IRS Training and Country Capacity Building (Manuel Lluberas and Steve Knowles), IRS Supervision, Reviews and Evaluation (John Govere and John Rwakimari) and IRS Advocacy and Financing (Steve Knowles). Achievements in 2013 included the IRS symposium at MIM Durban; the fostering of private-public partnerships, for example the Accra workshop in collaboration with GBCHealth, AngloGold Ashanti, Syngenta and others; and increased collaboration with countries in the Middle East and Asia including Sudan, Yemen, Iran, Pakistan, Afghanistan and India. Work in 2014 should aim to more actively involve core work stream members, countries and partners and discuss how best to bring new IRS products to market.

***IRS for malaria control and elimination in India – Rajander Sharma, Ministry of Health, India***

IRS is used in India to control malaria (primary vector *Anopheles culicifacies* and secondary vectors *An. fluviatilis*, *An. minimus*, *An. sundaicus*, *An. stephensi* and *An. dirus*) and visceral leishmaniasis (VL) (*Phlebotomus argentipes*). VL is endemic in the eastern states of India, namely Bihar, Jharkhand, Uttar Pradesh and West Bengal. 48 districts are endemic with sporadic cases reported elsewhere. An estimated 165.4 million people are at risk, primarily in poorer, rural areas. The target population for IRS is 40.7m for DDT, 10.3m for malathion and 35.3m for pyrethroids (Figure 1). Resistance to malathion, DDT and pyrethroids had been detected in a number of districts by 2010. A strong

program of capacity building is in place; this includes national level workshops and state level training programs run in Orissa (malaria) and Bihar (VL). Monitoring and evaluation is conducted by collecting both entomological data (susceptibility status, bio-efficacy measured by cone bioassays and human biting rates) and clinical data (annual parasite index, slide positivity rate). Data on the likely impact of IRS on malaria and VL was presented alongside operational details of the program.



**Figure 1.** Districts of India targeted for IRS in 2014.

**Tools for monitoring and evaluation and quality control of IRS in Pakistan – Muhammad Mukhtar, Directorate of Malaria Control, Pakistan**

24 species of *Anopheles* transmit malaria in Pakistan, the primary vector being *An. culicifacies* and the secondary vector being *An. stephensi*. There are eight sentinel sites for entomological surveillance. IRS has been a major component of the malaria control program since the 1960s. Pakistan has a Quality Assurance Protocol which outlines the epidemiology of malaria in Pakistan; the role of quality assurance in IRS and the development of quality assurance systems; the roles and responsibility of various stakeholders for the implementation and management of IRS; standard operating procedures; and information on handling of insecticides. Tools for IRS in Pakistan include the preparation of a work plan, reporting and recording tools such as daily spray reports, gap analysis, M&E plans, checklists for storing facilities and pre-spray activities, technical assistance, training plans and curricula, a training module for the maintenance of sprayers, safety measures for IRS and reporting mechanisms for IRS.

***IRS in Swaziland – Teclar Maphosa, National Malaria Control Program, Swaziland***

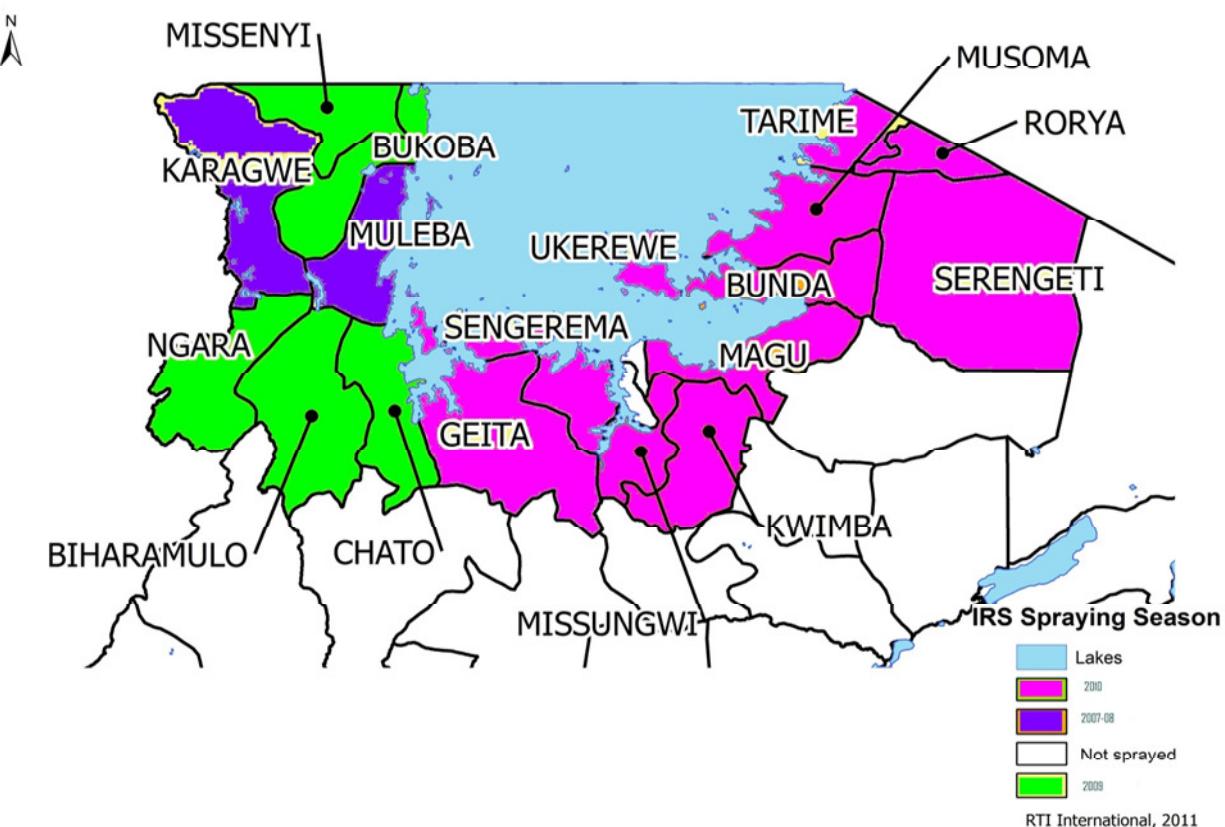
Swaziland is characterized by seasonal malaria transmission (November to May) and is at the pre-elimination stage, with 2015 the target date for elimination. The total population at risk in 2012-2013 was 285,972, approximately 30% of the overall population. Between June 2012 and July 2013 there were 379 confirmed cases, of which 26% were autochthonous. The primary vector is *An. arabiensis*. The elimination program has four main components: (1) Good Case Management, (2) Integrated Vector Management (joint IRS and LLIN distribution to the population at risk), (3) Surveillance and Epidemic Preparedness and Response and (4) Information, Education, and Communication (mass media campaigns for the whole population and travelers and community outreach to endemic areas). Malaria vector control is centralised, with no community teams. A vector control sub-committee at national level under the Swaziland Malaria Elimination Advisory Group (SMEAG) provides input on policies, gives technical guidance on implementation and monitors progress towards implementation. The target for IRS is 85% coverage of the population of households at risk. DDT is used for traditional structures and ICON® for modern structures. There are three spray teams each with 18 members, comprising 12 seasonal spray operators, 5 foremen and a team leader. 93% and 90% coverage was achieved in 2011 and 2012 respectively in targeted areas, 101,030 structures were sprayed in the 2011/2012 season and 73,217 structures were sprayed in the 2012/2013 season. The community is involved by working with Rural Health Motivators (RHMs), community leaders and school teachers.

***Community based Indoor Residual Spraying in Tanzania: Findings and recommendations from pilot testing - Joshua Mutagahya Rubona, Research Triangle Institute (RTI) International, USA***

With PMI support, IRS was initiated in Muleba and Karagwe districts in 2007 and 2008 respectively. It was expanded to all seven districts of Kagera in 2009, to six districts in Mwanza and five districts in Mara regions in 2010, covering 18 districts in the Lake Zone by the end of 2010 (Figure 2). Different modes of implementation have been used, ranging from highly centralized to partially decentralized and community-based IRS. From 2007 to 2009, IRS was organized at highly centralized camps with large camps accommodating >100 people, staff provided with food and sleeping places, large spray areas serving ≥20,000 sprayable structures and large storage facilities to accommodate bulky insecticides, Personal Protective Equipment and other commodities. The disadvantages of this system were the difficulties in organizing the large number of people and related logistics, the expense of the accommodation, food, water supply and transportation and difficulties in managing transportation. IRS became part decentralized in 2010-2012 with a shift from large camps to medium size IRS sites, which served 5,000-10,000 sprayable structures, with an average of 40 spray operators per site and no accommodation or food costs.

Since 2012, RTI, in collaboration with regional and district authorities, has been working to further decentralize IRS, with the aim of organizing and implementing IRS at village level, referred to as community based IRS (CBIRS). The specific objectives of CBIRS are to (1) reduce costs, (2) increase the level of community participation and ownership, (3) reduce the organizational complexity of IRS, (4) achieve an acceptable level of IRS quality and (5) comply with environmental protection requirements. In CBIRS, IRS is organized and implemented at the village level, with recruitment of spray operators by village governments, recruitment of village IEC mobilisers, a switch from using vehicles to bicycles for transportation and water for spray sub-sites supplied by the village. The scheme was piloted in November and December 2013 in collaboration with regional and district

authorities. Preliminary results indicate that CBIRS increases community participation and ownership, reduces the organizational complexity, achieves an acceptable quality and complies with environmental protection requirements.



**Figure 2.** Scale-up of IRS in the Lake Zone of Tanzania, 2007-2010.

#### ***Public-private partnerships for IRS – Sancia Dalley, GBCHealth, USA***

GBCHealth developed as a result of efforts by forward-thinking international leaders, originally Nelson Mandela in 1997, who recognized the power of business to help HIV/AIDS in the developing world. By 2001, the ambassador Richard Holbrooke had grown the network to over 100 companies with support from Soros, Turner and Gates. The mandate of GBCHealth was expanded to include tuberculosis and malaria in 2007. In 2014, the organisational vision is being redefined to further accelerate corporate investments and competencies in support of the Millennium Development Goals 4, 5 and 6. GBCHealth aims to unlock the power of business in the following ways: (1) convene and connect businesses, governments, multilaterals and civil society, (2) drive the creation of high-impact partnerships (business-to-business and business-to-government), (3) provide recognition and visibility to companies, (4) champion best practices in business engagement on health, (5) represent business in key global health settings and (6) provide guidance to companies on their workplace and corporate social investment initiatives.

Malaria remains a core focus, a good example being the corporate-led IRS programs typical of the Oil & Gas and Mining Sectors, for whom malaria control yields a clear return on investment. In Simandou, Guinea, at an iron ore project, a joint venture between Rio Tinto, Chinalco and the IFC reduced annual malaria cases in the controlled zone from 120 to 2 within two years. GBCHealth also works to facilitate knowledge exchange on IRS. Four conferences and workshops have been hosted

in Africa between 2009-2013, collectively reaching more than 450 participants primarily from the private sector, national malaria control programs and implementing agencies. Key outcomes included increased collaboration between business and implementers e.g. RTI, Chevron, Exxon, BHP Billiton. Priority areas for future work are regions where the greatest impact can be made, specifically Nigeria, DRC, Ghana, Angola, which have a high disease burden, strong corporate presence and on-ground partners/implementers.

***Building capacity for IRS in Africa – Allison Belemvire and Kristen George, President's Malaria Initiative (PMI), USA***

An update on the PMI IRS program and capacity building was given. In 2012, PMI sprayed more than 7 million houses, protecting more than 30 million residents. Approximately 34,000 personnel were trained to conduct IRS operations; this figure excludes ancillary personnel such as drivers, mobilisers or pump technicians. The coverage rate continued to be high; all 16 countries achieved a coverage of 92% or more, and 11 countries achieved coverage of 95% or more. The data for 2013 are still being finalized, however initial data indicate that PMI sprayed ~5.5 million structures, protecting ~21.8 million residents. In 2014, the proposed total IRS budget is ~US\$90 million, similar to 2013. This will assist IRS programs in 15 countries in the areas of technical assistance, environmental compliance and entomological monitoring. The major PMI focus continues to be on Tanzania, Uganda, Zambia, and Ethiopia. The emergence of pyrethroid resistance has led to a shift in the predominant class of insecticide used from pyrethroids to organophosphates. PMI closely monitors insecticide resistance levels. For example pyrethroids were the main insecticide used in Ghana as the PMI program was scaled-up from 5 to 9 districts, however emerging insecticide resistance necessitated a switch to Actellic® CS in 2011. The higher cost of Actellic® CS forced a reduction in program size from 9 to 4 districts. Capacity building is also a major focus of PMI, for example in Ethiopia, community-based IRS has been piloted in 6 districts using the existing government health extension worker structure.

***New Tools for IRS – Manual Lluberas, H. D. Hudson Manufacturing Company, USA***

New tools for IRS from H. D. Hudson include the IRS Commodity Calculator (patent pending) which uses country-specific parameters to generate a three-page detailed summary with (1) number of houses to be sprayed, (2) total surface area to be sprayed, (3) size of spray teams and personal protection equipment needed, (4) storage and handling requirements, (5) transport and logistics needs, (6) a four-year budget and (7) activity plan based on end date. All calculations and estimates are easily modified by the user to fit program needs and parameters. Other new developments from H.D. Hudson include WHOPEs-approved field kits for the Hudson X-Pert® Sprayer. Existing tools include the WHOPEs-approved Constant Flow Valve™ which ensures even spray. H.D. Hudson is also developing remote sensing tools to guide IRS operations, using 65cm resolution satellite imagery from a 50x50km grid to identify and categorize IRS homes and identify and categorize mosquito sources with 95-97% accuracy.

***Benefits of flow control valves in hand compression pumps for IRS - Iñigo Garmendia, Goizper Group, Spain***

The 2006 WHOPEs Vector Control Equipment specifications state that a flow rate control device shall be fitted and its type declared. The device shall maintain a uniform output at the nozzle ±5% of the specified discharge rate. Low pressure control flow valves (CFVs) differ from traditional spraying equipment with pressure gauges in that they provide an even tank pressure and flow rate. There are

a number of benefits to using low pressure CFVs including (1) a reduction of insecticide deposit variations on walls, (2) a 25% reduction in the volume of water required to spray 250 m<sup>2</sup> (7.5 litres instead of 10l), (3) a 50% reduction in insecticide loss due to rebound and atomization, by ensuring optimum droplet size and (4) a seven-fold reduction in the exposure of workers to insecticides and (5) 50% less nozzle tip abrasion.

#### ***Discussion – all***

- *IRS tools and equipment:*
  - New tool kits for field teams designed to extend the operational life of a compression sprayers are now available. These are designed for team leaders and spray operators and contain the most commonly-replaced components of a sprayer, to allow field replacement without the need to return to a central warehouse or workshop.
  - Spray teams should consider the benefits derived from the use of flow valves (as recommended by WHO/PES) during spray operations. However, team leaders and program managers must remember that most of these units were designed for use with emulsifications. While they could help in generating better spray patterns and reducing excessive spraying, their use with suspensions (wettable powders) may result in clogging of valves. In these instances, spray concentration adjustments must be made, but these are frequently beyond the capacity of spray operators. Therefore, the formulation adjustments and the potential for field re-adjustments if they fail, coupled with the added expense associated with these units, must be weighed against the potential benefit associated with their use relative to the impact on the quality of the spray if last-minute field adjustments are required.
  - A new, web-based tool (IRS Commodity Calculator) that will facilitate the planning of IRS operations and estimation of IRS program requirements will be made available this year.
- *Program structure and funding:*
  - There is a good case for investing in IRS. The program established by the private sector in Ghana, for example, has generated approximately 4000 jobs directly or indirectly linked to the vector control program. Examples from Ghana, the Copper Belt in Zambia, South Africa and elsewhere demonstrate that a properly structured and funded IRS campaign is beneficial both to those funding the program and to the surrounding populations.
  - In Ghana, the IRS program started as a corporate campaign and was later extended to a national program. It will soon cover 35 districts. This corporate structure provides security and stability that has been instrumental in securing external financial funding for the national campaign.
  - NMCP managers must explore how to coordinate effort between operations, i.e. how best to use the infrastructure set up by an IRS campaign to assist in the distribution and evaluation of LLINs and to identify larval sources around family compounds. This could be done simply by adding a few lines to IRS operator worksheets.
- *Capacity building:*

- Viable career paths in public health entomology are needed to make mosquito control operations, including IRS, sustainable and adoptable. Without this, the accomplishments of the past few years will fade away soon after external funding expires or is no longer available.
- Attention must be focused on building positions for field technicians and team leaders and supervisors at a national level, as advanced degrees in entomology are available in most countries or in regional groups.
- Information can be exchanged between mosquito control professionals outside Africa and malaria vector control workers within Africa. This is especially valuable where outdoor transmission is problematic and IRS and LLINs will not be of significant value.
- *Role of the VCWG:*
  - The VCWG has become an academic exercise. While it is necessary to have proper documentation and reliable data to justify the interventions used, a good portion of the programs that have produced tangible effects and eliminated or reduced malaria rates in the areas where they operate do not meet the criteria for a Cochrane Review.
  - Discussions during the meeting revolved around study design, statistical analyses and other academic aspects with little consideration of program design and implementation. Some participants of the IRS work stream voiced concern that the operational constraints and timelines of their respective programs preclude them from submitting their findings and observations for publication in peer-reviewed journals and/or findings are not considered publishable because of improper study design. This does not mean that these programs are not successful.
  - It was suggested that the era for pilot projects on malaria vector control is over. There is sufficient evidence to begin adapting and implementing programs that have produced significant results in other parts of the African continent, and the VCWG should focus its attention on this.
- *World Health Day 2014:* A display at the World Health Day celebrations with examples of vector control operations around Africa would be beneficial.

**Priority areas of work for 2014:**

1. Identify the more active core members.
2. Involve more closely the core countries and partners including Tanzania and Zanzibar, Uganda, Nigeria, Ghana, South Africa and Swaziland; and RBM-SARN, Hudson, Arysta-Syngenta, Goizper, MRC-Durban, RTI, Abt, Anglo Gold Ashanti, GBHealth, Bayer, IVCC and PMI.
3. RBM led negotiations on financing new IRS products from market to delivery and quality control (Kenya and Ghana).
4. Outline the role of IRS in elimination and prevention of re-introduction and develop thresholds and guidance to transform IRS from a blanket to a more targeted approach (India and Swaziland).
5. Develop Microsoft Excel tools for improving planning, quality, monitoring and reporting.
6. Explore new technologies including the use of mobile phones for public messaging and remote sensing and GIS for targeting IRS.

7. Evaluate how IRS can be combined with LSM and LLINs (India and Swaziland).
8. Aligning the labelling of compression pumps with the labelling of insecticide sachets.
9. Encourage decentralization of IRS programmes to the village level with support for supervision to ensure timing, coverage and quality (Tanzania and Ethiopia).
10. Develop private-public partnerships on malaria and maternal and child health (Nigeria, Angola, DRC and Ghana).
11. Expand the AngloGold Ashanti model in Ghana, the Rio Tinto model in Guinea, the Anglo Ashanti Gold Mine model in Tanzania and the Ilovo sugar model in Malawi.
12. Develop a new PMI IRS paradigm with greater efforts to build national program capacity structures and systems for sustainability.

## 9<sup>th</sup> Continuous LLIN Distribution Systems Work Stream Meeting

**13.00-15.00, Thursday 20<sup>th</sup> February 2014**  
**Auditorium, IFRC, Geneva**

**Co-chairs: Jayne Webster & Kojo Lokko**

**Rapporteur: Lucy Tusting**

Kojo Lokko opened the meeting, drawing attention to the Continuous Distribution (CD) eToolkit, available online, which includes the NetCALC tool, CD guides, country cases studies, training materials, Social and Behaviour Change Communication (SBCC) materials and Monitoring and Evaluation (M&E) tools. These tools can be accessed on the Roll Back Malaria website as well as: <http://www.k4health.org/toolkits/continuous-distribution-malaria>.

***Evidence on ANC delivery of LLINs: what data is available and what data is needed? – Jayne Webster, London School of Hygiene & Tropical Medicine, UK***

Delivery of LLINs through antenatal clinics (ANC) is currently policy in 34 malaria endemic countries in Africa; however effectiveness has only been assessed in a few geographic locations and at a small scale. To evaluate the effectiveness of this delivery strategy it is necessary to have data on ANC attendance and LLIN availability, LLIN delivery, uptake and use. However the Demographic and Health Surveys (DHS) and the Malaria Indicator Surveys (MIS) currently only include indicators for the first of these, ANC attendance. Data on ANC delivery was presented for Segou district, Mali and Nyando district, Kenya. The required data could be collected by adding two simple questions to the DHS and MIS: (1) ‘Where did you obtain this net?’ (with response categories including ANC) and (2) ‘When you saw someone for antenatal care were you given a mosquito net?’ (to quantify the proportion of pregnant women attending ANC who were given an LLIN). The Vector Control Technical Experts Group (VCTEG) have recently recommended the use of these indicators. A formal request should be made to the Monitoring and Evaluation Reference Group (MERG) by both the VCTEG and the VCWG that these two questions be added to the DHS and the MIS. In addition, DHIS2 (an electronic health management information system used in many African countries) already has an indicator on LLIN receipt at ANC, and the denominator could be added to this.

***UNICEF experience with ANC supply systems – Valentina Buj, UNICEF, USA***

The work of UNICEF in ANC delivery of LLINs in Huila province, Angola and in Sierra Leone was outlined. UNICEF faces numerous challenges to distributing LLINs, including long lead times and procurement, campaigns using LLINs designated for routine channels such as ANC, difficulties in quantifying the demand for LLINs through ANC and other continuous distribution systems, the logistics of distribution, transportation (i.e. the less mass-transport that can be used, the more the cost increases), difficult terrain, mechanisms for distribution (e.g. fixed point vs house to house), how to integrate different interventions, installing LLINs in the home, communicating public health messages, warehousing and storage. Strategies used to increase success include strong leadership at the central level, good logistics, using multiple strategies, using a variety of transport means and avoiding stockouts.

### *Discussion*

- *Evidence on ANC delivery of LLINs:* A summary for MERG with the options for the DHS has been produced. If there is reluctance to add questions to the DHS since it is already long, a tick box for receipt of a net could be added to the existing question on which ANC services a woman has received.
- *ANC delivery of LLINs:* LLINs should be given at the first ANC visit to prevent malaria in pregnancy; this is UNICEF policy. Supervision is important to ensure that women are offered nets at the clinic.
- The use of routine nets as a buffer in distribution campaigns undermines requests to donors for funding for nets.

### ***MEDA: Ghana and Tanzania – Thomas Dixon, Mennonite Economic Development Associates (MEDA), Canada***

E-Coupon logistics focus on delivery (mapping where nets are sold to determine where and when retailer replenishment must occur), discount (providing individual consumers a tailored, flexible transparent subsidy) and demand (creating demand through price subsidy and behaviour change communication (BCC); providing information by area. E-Coupons are generated by SMS, using a short code, as in the Tanzania National Voucher Scheme, which operates through clinics, and the Ghana Pilot scheme, which operates through clinics, schools, employers and self-issuance. E-Coupons can be redeemed at retail shops by the retailer sending an SMS incorporating the beneficiary's coupon number and another short code. In Tanzania, by December 2013, the e-Coupon was operational in 1,928 clinics and 1,989 retailers in all regions; 1,191,041 vouchers had been redeemed. In Ghana, by January 2014, primary school and employer e-Coupons became operational and over 4,000 e-Coupons had been issued with an approximately 50% redemption rate. An online mapping tool is now available which displays e-Coupon issuance and redemption in Tanzania.

### ***PSI: Movercado/Mozambique experience – Angus Spiers, Population Services International (PSI), USA***

A video on the Movercado model was shown, illustrating the 'Movercado Eco-System', which uses a largely cash-free mobile money system in Mozambique to provide LLINs. (<http://www.youtube.com/watch?v=6pODbb7alcg>). Vouchers can be redeemed at branded shops and key messages are delivered via text message. A private sector distribution network supplies shops and pharmacies. The system allows tracking of redemptions and of the success of interactions, all geographically linked through Google maps. Movercado integrates the delivery of LLINs with communication through text messaging giving advice on health interventions and the attendance at health facilities for mothers and their babies. PSI is now looking to scale up Movercado elsewhere.

### ***Role of the private sector: potential and reality – Albert Kilian, Tropical Health LLP, Spain***

High LLIN coverage has been achieved in some places including The Gambia, Mali and the Mekong region. The contribution of the commercial LLIN market to scale-up is currently small but has potential. The Markets for Health Framework, developed by the World Bank Institute and University of California San Francisco, outlines the market forces at play in LLIN distribution campaigns and unstructured markets, both of which have disadvantages. After campaigns, need grows which can be turned into demand, and it is recommended that demand-driven 'pull systems' should increasingly dominate continuous distribution strategy. In order to do so, it is necessary to understand both the

market and the role of the product in public health. Practical means to achieving this include creating a platform for public-private dialogue, marketing campaigns, controlling counterfeits, varying subsidy levels, allowing local tendering and investing in local production where feasible. Even the poorest homes can access LLINs through the commercial sector (see 2010-11 DHS, Senegal). Threats to market development include leakage at the warehouse/transport stage and counterfeits. The private sector can contribute to sustaining universal coverage if (1) LLINs are seen as consumer goods, (2) countries and donors commit to give continuous distributions the opportunity to develop and engage the private sector (3) and thorough country-specific market analysis is conducted.

### *Discussion*

- *E-Voucher scheme:*
  - A large number of LLINs are recommended by WHO/PES and it was suggested that this may complicate the introduction of e-Coupon schemes. However, there is room for suppliers in these systems. Experience from Ghana indicates that the voucher scheme was the best means to engaging the private sector. For those without mobile phones, e-Coupons can be issued on paper.
  - There are ethical issues involved in targeting messages that may contain sensitive information (e.g. a husband may not know his wife is pregnant) or collecting data on redemption unless participants without consent. PSI has a data governance council to regulate this.
- *Engaging the private sector*
  - Uganda and Tanzania could be good candidates for engaging the private sector in LLIN distribution.
  - Disposable incomes in Africa are increasing, representing an opportunity for the private sector to participate more in LLIN distribution.

### ***Results from NetWorks Ghana eastern region continuous distribution – Albert Kilian on behalf of Joshua Ofori, Johns Hopkins University Center for Communications Programs (JHU CCP), Ghana***

The study aimed to assess whether continuous distribution of LLIN through schools successfully increased LLIN coverage. Activities began in November 2010 with two hang-up campaigns, with baseline surveys, school distribution, health facility distribution. Data on LLIN ownership indicates that continuous distribution contributed substantially to overall LLIN coverage. 46% LLINs were delivered through schools, 20% through ANC and 14% extended program of immunisation (EPI). The data indicate that continuous distribution effectively targeted those who had not received a campaign net. Campaign delivery is pro-poor and continuous distribution is less equitable, though as assessed using the concentration index, it is not far from equitable. The continuous distribution LLINs appear to have reached households that did not receive LLINs in the mass campaigns.

### ***Prioritization and LLIN delivery – Jo Lines, London School of Hygiene & Tropical Medicine, UK***

WHO policy remains universal coverage across all age groups however constrained resources may necessitate prioritisation. Net coverage can be targeted (1) geographically or (2) to the most vulnerable group, and with three levels of coverage: (1) no nets, (2) under-5s and pregnant women and (3) all ages. On behalf of the Vector Control Technical Experts Group (VCTEG), modelling groups at Imperial College and the Swiss Tropical and Public Health Institute (Swiss TPH) were asked to model the distribution of LLINs for maximum impact in conditions of insufficient LLINs to achieve

universal coverage. Swiss TPH concluded that all under-5s should be covered in all areas and all ages covered in high transmission areas. Imperial College concluded that it is not optimal to target geographically unless the high prevalence area has a parasite prevalence in excess of four times that in the low prevalence areas. The recommendation is to define 'very low risk locations' where zero coverage is assigned. In all other locations, LLINs should be assigned to vulnerable groups. Any remaining LLINs should be assigned to highest risk areas. Risk must be defined pragmatically within each country.

#### *Discussion*

The value of targeting hotspots was discussed; this is likely to be only applicable in areas of lower transmission.

#### **Draft 2014 Work Plan**

The Work Stream could (1) recommend that the VCWG and VCTEG make a formal request to the MERG for consideration of the inclusion of both questions on the DHS and MIS, (2) support documentation for programmes on potential analysis using these survey questions for evidence-based strategy development and programme improvement and (3) develop documentation and possibly provide technical support on how to use the DHIS2 to improve programmes.

A draft Work Plan will be circulated by email.

**6<sup>th</sup> Entomological Monitoring and Integrated Vector Management (IVM) Work Stream meeting**  
**15.30-17.15, Thursday 20<sup>th</sup> January 2014**  
**Auditorium, ICRC, Geneva**

**Chairs: Jacob Williams and Raman Velayudhan**  
**Rapporteur: Lucy Tusting**

Jacob Williams outlined the aim of the meeting, which was to examine (1) improving country access to products, (2) using multi-vector interventions and (3) World Health Day 2014 and its theme ‘Vector Borne Diseases’. The meeting also aimed to identify the bottlenecks to accessing vector control products that are within the power of endemic countries to remove.

### **1. Improving country access to products**

***Experiences on harmonized sub-regional requirements (OCEAC) – Josiane Etang, Organisation de Coordination pour la lute contre les Endémies en Afrique Centrale (OCEAC), Cameroon***

OCEAC is the Organisation for the Coordination of Endemic Disease Control in Central Africa, founded in 1963 and operational in Cameroon, Central African Republic, Congo, Equatorial Guinea, Gabon and Chad. OCEAC aims to coordinate research, training and expertise to target malaria and other major infectious diseases. An example of a new regionally-coordinated program is the Drug Policy Harmonization Programme, launched February 2014 in Libreville, Gabon. Access to vector control products can be improved through close coordination with manufacturers and timely registration of new products.

***Improving market entry of vector control products – Gerhard Hesse, Bayer S.A.S. Environmental Science, France***

An outline of National and Regional Regulatory Authorities in the European Union (Biocidal Product Regulation (BPR)), Africa (Interstate Committee for Drought Control in the Sahel (CILLS), Southern African Development Community (SADC)) and Middle East and Asia (Gulf Cooperation Council (GCC)) was given. Standalone National Regulatory Authorities necessitate a dossier submission, potentially with repetition of efficacy studies if the situation is unique. In the best case scenario for vector control products, there would be (1) a WHO evaluation and recommendation (e.g. WHO Pesticide Evaluation Scheme (WHOPES)), (2) regionally harmonised acceptance of dossier and results based on WHOPES and (3) in unique eco-epidemiological situations, a local scheme for efficacy with acceptance of a general data package, based on WHOPES, BPR and Environmental Protection Agency (EPA) for example.

***Update on related activities by WHO – Raman Velayudhan, World Health Organization, Switzerland***

WHOPES continues to evaluate and recommend vector control products for use in public health. In collaboration with the Food and Agriculture Organization of the United Nations (FAO), specifications are developed for all pesticides. Countries are encouraged to use standard WHO evaluation procedures to assess vector control interventions. Quality control is a major issue today and countries are requested to take this into account when buying and using products. The Vector

Control Advisory Group is now fully operational and nine items comprising five new paradigms were evaluated at the latest meeting. Future submissions are welcome for consideration at the meeting in November 2014. WHOPES continues to support capacity development in countries on sound management of pesticides.

#### *Discussion*

OCEAC procedures could be used as a template for other countries and regions such as the Economic Community of West African States (ECOWAS). Some regulatory procedures such as CILLS or SADC are efficient and easy for industry but others less so. Communication between regulatory authorities could improve procedures and speed. Having one registration for a region is efficient and this system could be expanded. In agriculture, there is a history of collaboration between countries. The IVCC has held a series of meetings to ensure good laboratory practice to meet OCEAC and other requirements. Countries can take responsibility for product quality control while delegating the process of registration to regional networks. In southern Africa, regulatory documentation has recently been coordinated such that registration can be attained simultaneously for multiple countries.

## **2. Using multi-vector interventions**

#### ***Project update: Framework for Integrated Vector Control – Steve Lindsay, Durham University, UK***

Definitions of Integrated Vector Management (IVM) vary; IVM pertains both to the use of multiple tools (often outside the health sector) for one disease; and to the use of one tool for multiple diseases. The overall goal is of this project is to develop a handbook for vector control managers at the national (and province) level, ideally available as an online tool. As the first stage, a systematic review has been conducted to review all interventions against all vector-borne disease, for example LLINs against leishmaniasis. The study is also evaluating where vector-borne diseases are co-endemic by mapping the distributions of different diseases including *Plasmodium vivax*, *P. falciparum*, onchocerciasis, dengue and leishmaniasis. For example, there is a belt across central Africa and areas of South America and Asia where LLINs can be used to control both leishmaniasis and malaria. Modelling is also being used to assess the potential impact of using one tool against two diseases transmitted by one vector (e.g. *Anopheles gambiae*, malaria and lymphatic filariasis) and preliminary results suggest a multiplicative effect. The handbook will cover which tools to select, how to implement them and how then to monitor and evaluate. Funding from the Bill and Melinda Gates Foundation was acknowledged.

#### *Discussion*

- *Evidence for vector control policy:*

- The importance of building an evidence base to determine which tools should be used and where was stressed. Given the large number of combinations of interventions, assimilating sufficient evidence for each combination may be problematic, however in attempting to do so it will become apparent where data are missing and where research is needed. For example, the recent Cochrane Review of larvivorous fish found insufficient evidence to support their use in larval control.

- Standards for evidence may be too high; Cochrane reviews are useful but a mid-level or historical evidence could be acceptable. However policy makers look for the highest quality evidence.
- In systematic reviews of vector control interventions, entomological data is problematic given non-standardised methods of collection and poor reporting.
- Despite the lack of evidence for some interventions, there may still be opportunities for integrating surveillance and other infrastructure in order to gather at least some evidence for effectiveness. Systems of sentinel sites for long-term monitoring of clinical and entomological outcomes, in the context of existing interventions and the occasional introduction of new paradigms, would be informative. The US Centers for Disease Control and Prevention (CDC) is working to establish ten sentinel vector sites globally.
- By building maps of different diseases it will be possible to quantify the burden of diseases globally. Other diseases become increasingly obvious as malaria declines; for Africa, mosquito abatement is the long-term aim.
- The WHO Regional Office for Africa (AFRO) published an IVM guide for Africa in 2002.

### **3. World Health Day 2014 - theme ‘Vector Borne Diseases’**

***Brief on World Health Day and the role of RBM partners in advocacy – Raman Velayudhan, World Health Organization, Switzerland***

World Health Day is celebrated on 7<sup>th</sup> April each year to mark the anniversary of the founding of WHO in 1948, with an annual theme. This year, for the first time in two decades, the theme is ‘Vector Borne Disease’. The goal of the campaign is to raise awareness of vector-borne disease and to encourage those at risk to protect themselves. Specifically targeted will be families in endemic countries, travellers and residents of countries with emerging vector-borne disease. Key messages are that (1) mosquitoes, flies, ticks, bugs and freshwater snails can spread diseases that cause serious illness and death, (2) diseases such as malaria, dengue, leishmaniasis and yellow fever are preventable, (3) over half of the world’s population is at risk and (4) personal protection is simple by sleeping under a bednet for example. A webpage is live at [www.who.int/campaigns/world-health-day/2014/en/index.html](http://www.who.int/campaigns/world-health-day/2014/en/index.html). Other materials such as posters and factsheets are being produced with events in Geneva, in-country and in airports. RBM partners can raise awareness of the campaign by sharing the link, printing campaign posters and sharing information through social media.

***Discussion***

Increasingly, a greater proportion of larval habitats will be man-made and it is important for people to be aware of this.

***Draft 2014 Work Plan:***

1. Document procedures in exemplary regulatory bodies and circulate draft for input. In doing so the Work Stream should coordinate with CropLife which is carrying out a similar project.
2. Develop decision making tools for IVM and field test them in select countries.

**1<sup>st</sup> Housing and Malaria Work Stream Meeting**  
**17.15-18.30, Thursday 20<sup>th</sup> January 2014**  
**Auditorium, ICRC, Geneva**

**Chair: Steve Lindsay**  
**Rapporteur: Lucy Tusting**

Michael Macdonald opened the meeting and gave a rationale for introducing housing to the VCWG.

***Electrostatic netting and eave tubes – Bart Knols, In2Care BV, The Netherlands***

Ongoing EU-funded research on electrostatic netting and eave tubes was presented. Insecticides can be bound to electrostatic netting, achieving good transfer of active ingredients to mosquitoes, up to 90% mortality after 24 hours and requiring lower insecticide concentrations than those used on insecticide-treated nets (ITNs). In Africa, houses are increasingly being built with metal roofs and brick walls replacing thatch and mud walls, and with closed eaves. A new intervention, comprising a PVC tube containing insecticide-treated netting inserted into closed eaves, has been observed to achieve high mosquito mortality. This intervention increases airflow into the home and reduces the quantity of insecticide required per house. The tubes can also be covered with wire netting to prevent rodent damage. Being at eave level, the tubes are unlikely to come into contact with humans, increasing possible bioavailability since more toxic actives can be used. An alternative to this intervention is to remove odd bricks and insert impregnated netting in their place.

***Discussion***

It was queried whether high humidity reduces the electrostatic effect; however efficacy was not observed to decline over a period of two months in field conditions with 60-80% humidity. The upfront cost of the intervention is the house modification but ongoing maintenance costs are low. Over a period of three years, cost per person per year is comparable with LLINs.

***The evidence supporting housing as a malaria intervention – Mariana Stephens, Habitat for Humanity, USA***

The vision of Habitat for Humanity (HFH) is a world where everyone has a decent place to live. HFH is increasingly approaching housing as a process, acknowledging that most people build incrementally. HFH has Housing Quality Standards to define the acceptable quality of a new or rehabilitated house, which were developed based on the United Nations Millennium Development Goals, International Residential Building Codes, UN-HABITAT and Sphere guidelines. These guidelines focus on five house features: design, durability, secure tenure, water and sanitation. The 2011 Shelter Report on Housing and Health, which had a chapter dedicated to malaria, concluded that interventions that combine health and housing are essential for long-term improvements in global health ([http://www.habitat.org/gov/take\\_action/shelter\\_report\\_2011.aspx](http://www.habitat.org/gov/take_action/shelter_report_2011.aspx)). More recently, a white paper has been drafted that reviews studies on 'mosquito proofing' housing around the globe and assesses whether improving housing can be an effective strategy today (Anderson L, Simpson D and Stephens M, 2014. Effective Malaria Control Through Durable Housing Improvements: Can we learn new strategies from past experience? Global Programs Department White Paper No. 1. Habitat For

Humanity, Atlanta). The Multisectoral Action Framework for Malaria considers housing improvements a viable multisectoral malaria intervention. Early studies helped spread the practice of screening houses in the United States and, more recently, studies in Malawi (Wolff et al 2001, BMJ), Bioko (Bradley et al 2013, PLoS One), Kenya (Atieli et al 2009, Malaria Journal), Ethiopia (Massebo & Lindtjorn 2013, Malaria Journal) and The Gambia (Lindsay et al 2003, TMIH; Kirby et al 2009, Lancet) have demonstrated the potential for improving homes to protect against malaria.

Future research issues include: (1) identifying the contexts (urban vs rural) where housing improvements can reduce malaria transmission, (2) whether housing improvements are cost-effective on a large scale, (3) questions of sustainability and maintaining access to materials and building expertise over time and (4) whether housing improvements can be included as long-term malaria solutions in control programs. Future work could aim to (1) incrementally improve housing as part of anti-malaria programs, (2) include malaria-prevention strategies in home-building and home-improving projects partnering with housing micro-finance institutions and (3) consider housing as part of IVM. The Center for Innovation in Shelter and Finance (CISF) exists to facilitate collaboration between public, private, and third sector actors in the market to develop sustainable and innovative housing solutions. Its vision is to serve as a place of knowledge, expertise, advice, and innovation, enabling poor families to acquire adequate housing. In conclusion, HFH advocates that malaria control programs should consider targeted housing improvements as a sustainable additional intervention to reduce transmission and that we can aim to 'Build Malaria Out'.

#### *Discussion*

People living in endemic regions of Africa do not see malaria as a problem and this must be considered when encouraging the improvement of homes to protect against malaria. Good housing can reduce standing water around the home and HFH can work with the entire community to achieve this. Housing does not relate simply to malaria but presents opportunities for dengue, respiratory disease and diarrhoea control. Not only must we consider the 'healthy home', but also housing as a basic human right.

#### ***Developing a framework for scaling-up housing interventions – Caroline Jones, KEMRI, Kenya***

The process of scaling-up interventions involves the following key actors: the innovation, the resource team, and the key players for innovation and adoption. The attributes of the intervention should be optimised (by involving the users in design), key stakeholders should be identified and engaged, a driving team for synthesis and advocacy should be created, and a scale-up strategy developed. Stakeholder analysis should be conducted to identify stakeholders at local, national and international level. Individuals can be drawn from each level to form stakeholder groups to liaise with the driving team. A trial of a new intervention should continually engage both the community and stakeholders.

#### *Discussion*

The success of malaria control is closely tied to the social environment. Using interventions such as housing, which are not specific health interventions, will not only complement the main interventions but also make malaria control more relevant to broader development agendas. It was suggested that housing may be more difficult to sell to donors as indicators and metrics may be more difficult to collect, however HFH has developed metrics that have been successful in attracting donor funding. Moreover, housing can help reduce reliance on donors.

***A preliminary evaluation of insecticide-impregnated ceiling nets in Western Kenya – John Lucas, Sumitomo, UK***

A preliminary evaluation of insecticide-impregnated ceiling nets in Western Kenya was presented. Olyset® nets (2% permethrin) were cut and sewn into sheets and inserted into two houses in western Kenya. One control home was installed with untreated netting. Netting was secured by stapling it into walls below eaves. Overall, 10.5 x 5m netting was used for each home. Nets were installed in May 2010, left for nine months and then uninstalled. Fewer mosquitoes were collected in the screened homes with a possible residual effect after screening was removed and possible displacement of mosquitoes from the screened to unscreened homes. Findings have been published (Kawada et al., 2012. Jpn J Infect Dis, **65** : 243-246).

***Eave nets, windows and doors in western Kenya – Ole Skovmand, Intelligent Insect Control, France***

Work is ongoing to design house screening suited to western Kenya. Eave nets take 45 minutes and three people to install per house. The amount of net required corresponds to two to three bednets, depending on house size. Windows are easy to screen however doors are problematic; hanging nets over doors are viewed as ugly and nets begin to disintegrate, while insecticide-impregnated lamels are effective for a period of weeks or months but equally unpopular among residents, although the effect on cockroaches, flies and pests is appreciated. Suggestions for a better door screen are invited.

***Discussion and draft 2014 Work Plan***

The following draft work plan for 2014 was proposed: (1) engage with parties outside health sectors and (2) develop a position statement on housing. Additional suggestions were invited.

- It was decided that a position statement on housing was not necessary at this stage.
- The strength of RBM is its capacity to bring together partners from different sectors. The Lake Victoria Initiative is collaborating with UN-HABITAT and RBM and is a good example of cross-sectoral collaboration in housing and malaria. It will be productive to continue to engage with different partners until a core group of people interested in housing and malaria is identified.
- The typical cost of a new home was queried; costs vary by region and can be gauged by talking to local universities and architecture students. Building new homes can also generate income and the process thereby becomes a product itself.

### Day 3: Friday 21<sup>st</sup> February 2014

**6<sup>th</sup> Optimizing Evidence for Vector Control Interventions Work Stream Meeting**  
**9.00-12.00, Friday 21<sup>st</sup> February 2014**  
**Auditorium, IFRC, Geneva**

**Chairs: Christian Lengeler and John Gimnig**  
**Rapporteur: Lucy Tusting**

John Gimnig opened the meeting and reiterated the role of the Work Stream, which is to provide a forum for donors, the Innovative Vector Control Consortium (IVCC), Vector Control Advisory Group (VCAG) and Vector Control Technical Experts Group (VCTEG) in developing new paradigms. An overview of the agenda was given.

***LLIN-IRS interactions – an update of recent evidence – chaired by Immo Kleinschmidt, London School of Hygiene & Tropical Medicine, UK***

***Impact of insecticide resistance in Anopheles arabiensis on effectiveness of malaria vector control in Sudan – Hmooda Kafy, National Malaria Control Programme, Sudan***

The objective of the trial was to assess the impact of insecticide resistance on the effectiveness of malaria vector control in Sudan and to determine the effects of different combinations of vector control intervention combinations. The specific objectives were (1) to determine the impact of long-lasting insecticide-treated nets (LLINs) and LLINs plus indoor residual spraying (IRS) on malaria control and (2) to determine the insecticide resistance status and underlying genetic mechanisms in the primary malaria vector *An. arabiensis* in four districts of Sudan. In each arm clusters were randomised to receive either LLINs alone or LLINs with IRS. The study was designed so that the 70 clusters in each of the two study arms were balanced in terms of insecticide resistance levels and between the four study areas. Clinical data were collected through active case detection in cohorts of 200 children in each study cluster using community health workers and cross-sectional surveys. Overall, LLIN use averaged approximately 80% from 2011 to 2013. In 2012 there was no evidence of a difference in parasite prevalence (Odds Ratio (OR) 1.45, 95% confidence interval (CI) 0.61 to 3.45) or incidence (Rate Ratio (RR) 1.11, 95% CI 0.68 to 1.80) in clusters with LLINs alone compared to clusters with LLINs and IRS. The study has two more years to run. 2013 findings have not yet been analysed.

***Combined use of LLIN and IRS compared to LLIN alone for malaria control: results of a cluster randomised trial in Tanzania – Natasha Protopopoff, London School of Hygiene & Tropical Medicine, UK***

The study aimed to assess the effectiveness of LLINs and IRS for controlling malaria versus LLINs alone. The study was conducted in Kagera, Muleba district, an area of moderate transmission with two annual peaks after the long and short rains. The primary vector is *An. gambiae s.l.* The study was a two arm cluster randomised controlled trial with 25 clusters per arm. In each of two baseline and three post-intervention cross-sectional household surveys 80 homes with a total of 80 children and 20 adults were selected per cluster. The primary outcomes were parasite prevalence and

entomological inoculation rate (EIR). Clinical and entomological data were collected alongside data on socio-economic and demographic variables and intervention coverage. In the baseline year, both arms received both IRS and LLINs and in the second year, one arm received LLINs and IRS and one arm received LLINs alone. IRS coverage averaged 90% with ITN use ranging from 36-53%. Prevalence was significantly lower in the IRS+LLIN arm compared to the LLIN only arm (OR 0.43, 95% CI 0.19 to 0.97, p=0.043) as was EIR (RR 0.01 (adjusted for baseline anopheles density), 95% CI 0.00 to 0.01, p<0.001). Findings indicate that in this area of Tanzania with moderate net use and high pyrethroid resistance, it is beneficial to apply IRS with bendiocarb in addition to LLINs. A second randomised controlled trial is planned in Muleba with four arms (1) high coverage with standard Olyset® LLINs, (2) high coverage with Olyset® Plus, (3) high coverage of Olyset® and IRS with pirimiphos methyl capsule suspension (CS) and (4) high coverage of Olyset® Plus LLIN and IRS with pirimiphos methyl CS.

***Does indoor residual spreading provide additional protection over current best practice alone – a cluster randomised control trial in The Gambia – Steve Lindsay, Durham University, UK***

The trial was conducted in Basse, Upper River Region, The Gambia. 35 clusters were randomised to receive LLINs alone and 35 clusters were randomised to receive DDT-IRS plus LLINs. The primary outcome was incidence of clinical malaria measured through passive case detection. A clinical cohort of 7,858 children aged 6 months to 14 years was enrolled. Cross sectional surveys were also conducted before and after the rains with entomological surveillance carried out over two rainy seasons. The study was conducted over two years (2010 to 2011). Both LLINs and IRS were deemed to be operating successfully. IRS coverage was 86% in 2010 and 83% in 2011. DDT was analysed by an independent WHO-certified laboratory and found to be satisfactory. The concentration sprayed was measured by high-performance liquid chromatography with a target dose of 2.0 g/m<sup>2</sup> and mean actually spray dose of 1.7g/m<sup>2</sup>. High mortality was observed in WHO cone tests. At baseline, LLIN coverage was 46% and increased through distribution to 93% at the end of the rains in 2010 and 96% in 2011. Cone tests on LLINs had good mortality. Baseline parasite prevalence was 1.6%. In both years, there was no evidence that IRS had a protective effect, with no difference in attack rates, malaria incidence per child per month, moderate and severe anaemia and parasite prevalence between arms. These findings were corroborated by the entomology data; no difference in mosquito density (light traps and exit traps) and sporozoite rates was observed. The data indicate that the susceptibility of the vectors to DDT and permethrin used in the study area was high. However increasing resistance was detected in the second year (2011) in a few foci. In an area of seasonal, low transmission, with good LLIN coverage, there was no benefit of adding IRS.

***Benin – Immo Kleinschmidt, based on published results by Corbel et al***

A four arm cluster randomised control trial was conducted in Benin, with clusters randomised to receive the following interventions: (1) targeted LLIN to pregnant women and children aged <6 years (the control), (2) universal coverage with LLINs, (3) targeted LLIN plus full coverage of carbamate-IRS applied every 8 months and (4) universal coverage plus carbamate-treated plastic sheeting. Overall there were 28 clusters with 7 per arm and the primary outcome was incidence of clinical malaria in children followed for 18 months. There was no evidence of a difference in malaria incidence between any study arms. In conclusion, there is no benefit in combining IRS with targeted LLIN coverage, compared to targeted LLIN coverage alone and no benefit of universal LLIN coverage

versus targeted LLIN coverage in this area of Benin. However the study may have been under-powered with only seven clusters per arm.

#### *Discussion*

A précis of the characteristics of the four trials was presented and hypotheses for the observed findings discussed. In the Tanzania trial, an analysis including only net users (i.e. accounting for generally low net use) still found a protective effect. It was suggested that passive case detection may not have been reliable in The Gambia; however any biases would have been comparable across groups, and other outcomes (parasite prevalence from cross-sectional surveys and entomological outcomes) corroborate the incidence data. One limitation of the Benin trial may have been that only one round of IRS was conducted each year, and bendiocarb has a short residual effect. The low baseline levels of transmission in the Sudan and Gambia necessitates caution in interpreting results; vector control interventions may have reached their maximum potential efficacy and other interventions may be needed in such settings. In The Gambia trial, there was a large increase in malaria in the second year, possibly due to high rainfall despite high LLIN coverage and good case detection and management. Overall the results suggest that in areas of good LLIN coverage with little pyrethroid resistance and low transmission, there is no evidence of a benefit in adding IRS. In areas of higher transmission and with high levels of pyrethroid resistance there may be added protection due to the combination. Possibly, where one intervention is compromised then it is worth adding a second. The Vector Control Technical Experts Group (VCTEG) will examine new evidence in February 2014.

#### ***Updates on alternative bioactives – Matthew Thomas, Penn State University, USA***

EU-funded research on eave tubes was presented. Eave tubes are a potential new intervention which provides a high entry point for vectors at which they are targeted with bendiocarb-treated electrostatic gauze and pieces of LLIN. Experimental hut trials are ongoing in Ifakara, Tanzania. Biological actives such as fungi (*Beauveria* spp.) could potentially be added to the eave tubes. Transient exposure (5 seconds) to *Beauveria* gives 100% laboratory mortality within 5-6 days which though slow is more effective than controls or permethrin. Models indicate that eave tubes with fungus could have a significant impact on EIR in Ifakara even in the absence of instant kill. Virulent *Beauveria* can impact on the survival and transmission potential of adult mosquitoes by reducing fitness several days before death. Insecticide resistant mosquitoes are completely susceptible to *B. bassiana*. The active could also be produced locally; a photograph of a facility in Benin was shown and used to treat homes at around 10 cents per house. Registration for the product is simple (dossiers already exist) and ethical permissions are in place. The next stage is to conduct a field trial if funding can be secured. Other research has focused on whether Smart Patches can be added to LLINs to improve their efficacy. A series of 'optimization' studies have been conducted with a single bednet with 50 mosquitoes within a controlled environment chamber. Smart Patches could provide greater product choice and improve the efficacy of compromised nets.

#### *Discussion*

It is hoped that a large cluster randomised controlled trial can be conducted to test these interventions. The longevity of eave tubes was queried; persistence of the fungus in the field has been observed for 3-6 months. The five second exposure was chosen as a conservative figure but in

reality could be longer. Better mortality is achieved with focal points (i.e. eave tubes) instead of entirely screened eaves.

***Redesigning the Vector Control portfolio at the Bill and Melinda Gates Foundation – Janice Culpepper, Bill and Melinda Gates Foundation (BMGF), USA***

The Bill and Melinda Gates Foundation (BMGF) recently laid out its strategy for vector control for the next 25 years with the overall aim of malaria elimination. The three overarching goals are to (1) accelerate the trajectory to zero transmission by applying interventions and strategies based on the five principles of the Analytical Framework, (2) prepare for the next generation of interventions, strategies and delivery modes and (3) sustain progress by preventing resurgence in countries that are nearing elimination and helping them to achieve and sustain their current elimination goals. Under the three goals, the five principles of the Analytical Framework are that (1) malaria eradication is the elimination of parasites from the human population, (2) complete cure at the individual level is necessary for elimination, (3) targeting asymptomatic infection is key, (4) the principles of evolutionary medicine should be the formulation of science, product development and operational development and (5) think global and act local. These are supported by six initiatives: (1) ‘eliminate’, (2) ‘infection detection’, (3) ‘achieve radical cure’, (4) ‘prevent transmission’, (5) ‘focus on the last mile’ and (6) ‘mobilise’ (i.e. advocate for political support and funding). The new strategy requires new vector control tools that can deliver complete transmission prevention, and work is ongoing with partners to ‘fill the gap’. Specifically, new active ingredients (AIs) are being investigated to combat resistance and the research portfolio is being broadened to target outdoor biting.

***Discussion***

The trade-offs between the short term cost and long-term savings of elimination need consideration and are being investigated by BMGF. It is important to invest in people and systems in addition to products.

***VecNet update – Tom Burkot, James Cook University, Australia***

VecNet evolved from the MalERA consultation and its mission is to use spatially explicit data to understand and model the impacts of interventions on malaria transmission for control and eradication ([www.vecnet.org](http://www.vecnet.org)). A demonstration of the VecNet site was given. Various tools are available including the VecNet Digital Library, which contains data, tagged citations, articles and reports that members can search and curate. The Transmission Simulator gives access to complex models. Parameters including weather data, vector species, malaria epidemiology and interventions can be entered and different malaria control scenarios simulated. The Risk Mapper, under development by the Malaria Atlas Project, is a tool for malaria control programmes for comparing the impact of LLINs and IRS over time. Other tools include the Product Impact Evaluator and Computational Intervention Portfolio Evaluator. The site is currently in beta testing and will be made more user friendly and widely available in 2014.

***Revival of IVCC plans for new paradigms in vector control – Tom McLean, Innovative Vector Control Consortium (IVCC), UK***

IVCC is a product development partnership that invests in research and development to overcome barriers to innovation in vector control. The portfolio includes new active ingredients, new formulations, re-purposed AIs and new paradigms. The presentation focused on new paradigms.

Over the past year, an IVCC Framework for validation of new intervention paradigms and product categories has been developed, alongside a framework for rapid assessment and adoption of new vector control tools and a case study of the design of a programme for validation of the spatial repellent paradigm. An Expert Scientific Advisory Committee has also been formed (ESAC 3). The mandate of IVCC is not to make policy, but to create the evidence to validate Target Product Profiles (TPPs), while ensuring that procedures align closely with those of VCAG. Key objectives are to achieve or develop: (1) protection from disease transmission by outdoor biting mosquitoes, (2) protection during targeted elimination campaigns and (3) protective products distributed through private sector and consumer channels. The specific strategy of IVCC is to (1) develop TPPs, to enable multiple manufacturers to design products in a particular class, (2) partner with multiple companies that have the capability to develop and deliver the products matching the TPPs and (3) prepare for the introduction of new paradigms. Within scope could also be odour baited traps, repellents, swarms and possibly others, whereas out of scope are new designs of bednets and IRS that fit the current TPP, genetically or biologically modified mosquitoes (which lie outside the IVCC skills base) and early stage research. To be debated is housing stock improvement. The process for portfolio management will be: (1) basic research and concept development, (2) proof of concept, (3) epidemiological validation and (4) policy endorsement and adoption.

#### ***Discussion – 2014 Work Plan and interactions with IVCC***

The main activity in previous years has been to organise the annual meeting at VCWG which is valuable in bringing partners together. In 2013, the only organised session was a session on LLINs and IRS combinations at MIM Durban. This level of activity is in line with financial and personnel resources (very limited).

The following areas of work in 2014 were proposed:

- The Work Stream regularly interacts with IVCC, and since resources are limited the Work Stream could continue to act as a forum and a link between IVCC and researchers.
- Statisticians and epidemiologists could be brought in to advise on study design. Other working groups in RBM have run training workshops to improve understanding of the issues involved in trial design; this Work Stream could convene these alongside already planned meetings.
- Since the same gaps in research seem to recur, specific questions for research should be listed and circulated, drawing on expertise within the group.

It was also noted that:

- Large annual meetings such as the American Society for Tropical Medicine and Hygiene (ASTMH) are an opportunity to hold additional Work Stream meetings.
- The Special Programme for Research and Training in Tropical Diseases, TDR, may be a good partner for capacity building.

**5<sup>th</sup> Larval Source Management Work Stream Meeting**  
**13.00-15.00, Friday 21<sup>st</sup> February 2014**  
**Auditorium, IFRC, Geneva**

**Chair: Steve Lindsay**  
**Rapporteur: Lucy Tusting**

Steve Lindsay opened the meeting and welcomed participants.

***Review of progress in 2013 – Lucy Tusting, London School of Hygiene & Tropical Medicine, UK***

Lucy Tusting briefed participants on the main developments in larval source management (LSM) in the past year. The Cochrane Review of LSM was published in September 2013 (Tusting LS, Thwing J, Sinclair D, Fillinger U, Gimnig J, Bonner KE, Bottomley C, Lindsay SW., 2013. Mosquito larval source management for controlling malaria. Cochrane Database Syst Rev, 8). In 13 included studies, LSM was associated with substantial reductions in malaria incidence and prevalence in appropriate settings. The review concluded that In Africa and Asia, LSM is an option in both urban and rural areas alongside LLINs and IRS, where sufficient larval habitats can be targeted. Further research was recommended to evaluate whether LSM is appropriate or feasible in rural Africa where larval habitats are more extensive. The LSM manual, which had input from many Work Stream members, was launched in July 2013 (WHO, 2013. Larval Source Management: A Supplementary Measure for Malaria Vector Control. An Operational Manual. Available: <http://www.who.int/malaria/publications/>). At the MIM conference in Durban in October 2013, RBM sponsored a symposium on LSM. The United Nations Development Program (UNDP)/RBM ‘Multisectoral Action Framework for Malaria Control’ was published in September 2013 and advocates that LSM can be integrated into sectors outside health including agriculture, water and sanitation management and planning and construction.

***Draft 2014 Work Plan***

Steve Lindsay outlined a draft 2014 work plan: (1) update the environmental management handbook, (2) develop manuals for LSM in SE Asia and S America, (3) finalize a list of WHO/PES-recommended larvicides, (4) increase advocacy to funders/donors and (5) support national malaria control programs (NMCPs) doing LSM.

***Discussion***

- ***LSM manuals:*** It was decided that updating the environmental management handbook was not necessary at this stage. However a manual on mosquito control in urban tropical environments could be valuable, with the inclusion of dengue and chikungunya vectors and a focus on reducing nuisance biting in the context of broader mosquito control. It would be important to check this would not duplicate existing guides; the WHO Southeast Asia Regional Office (WHO-SEARO) for example has produced documents on dengue control.
- ***Supporting NMCPs:*** the importance of building local capacity for LSM (including for surveillance) was highlighted with the caveat that it is not yet clear how best to do so. One solution would be to have regional training centres for LSM, LLINs, IRS and insecticide resistance management in southern, eastern and western Africa. Additionally, the Work Stream could provide consultant expertise to LSM programmes by first outlining what is

needed for capacity strengthening at the country level and then identifying those best placed to provide support. Nigeria for example has budgeted for LSM and would like a consultant.

***Increasing advocacy to funders and donors – Shiva Murugasampillay, World Health Organization, Switzerland***

Advocacy is active support for a cause and in the context of LSM requires consensus among all parties, from field workers through to policy makers. The RAM-II project is a good example of advocacy for eliminating the malaria parasite in the Southern African Development Region. The potential of LSM was demonstrated in the past by the elimination of *An. gambiae* in Brazil and Israel and *An. arabiensis* in Egypt. Today, LSM is underway in many countries and leadership already exists. WHO policy on LSM has also evolved over recent years and, for the first time, information on LSM was collected for the 2013 World Malaria Report. In advocating for LSM it is important to consider the requirements of funders. For example, the new Global Funding Model board will look to WHO for guidance so it is important to present harmonised recommendations across all groups including the Vector Control Advisory Group (VCAG) and Vector Control Technical Expert Group (VCTEG). Others such as the World Bank and African Development Bank may be more independent in their thinking however united opinion on LSM should remain the endpoint. Other organisations to consider include the African Union, African Leaders against Malaria, European Mosquito Control Association and ECOWAS. In conclusion, advocacy for LSM could communicate that (1) LSM has potential as a tertiary and supplementary vector control intervention, (2) LSM is applicable wherever larval habitats can be adequately targeted and (3) LSM can evolve into general nuisance mosquito control.

***Discussion***

It is important also to consider the Malaria Advocacy Working Group, which is next meeting the week beginning 24<sup>th</sup> February 2014 in Geneva.

***Supporting NMCPs doing LSM – Silas Majambere, Liverpool School of Tropical Medicine, UK***

There is an urgent need to support NMCPs because many countries are currently implementing LSM in Africa including Angola, Zambia, Ghana, Tanzania, Nigeria, Burkina Faso, Malawi, Guinea Bissau, Equatorial Guinea, Benin, Mauritius, Mauritania and Gabon. However most have not followed the recommendations of the LSM Operational Manual, particularly in planning, choosing larvicides and monitoring and evaluation (M&E). The challenge is that some countries do not have a strong entomological monitoring system (and this is a cross-cutting emergency), although this can be quickly set up, and there is often no LSM officer at NMCP level. Countries could be supported by (1) listing those countries where LSM is being carried out or planned, (2) forming a body of experts who can give WHO-backed technical assistance and (3) linking up with a local research institute for M&E wherever possible (e.g. the Tanzanian NMCP and Ifakara Health Institute). Technical assistance could specifically help in training LSM officers and teams in (1) deciding where and when to larvicide, (2) writing local standard operating procedures and (3) testing and choosing larvicides; and in training field staff on (1) mapping and knowing habitats and (2) technical application of larvicides. In conclusion, the areas in which consensus is needed are: (1) whether or not NMCPs are the best sector to do LSM, (2) how a multisectoral approach can be achieved and (3) whether LSM should be community based or vertically managed.

### *Discussion*

- The role of NMCPs in conducting LSM was discussed. It was suggested that NMCPs may not be the best sector to carry out LSM since other diseases and vectors can also be targeted. However it may not be possible to generalise across countries in this respect. Where there is a strong community input then the NMCP may take a lead role in conducting LSM and there may be an opportunity for NMCPs to provide leadership for LSM in coordinating different sectors. In 2004-2005 in Zambia, the NMCP helped install a three year environmental health course for technicians outside the NMCP to carry out LSM; this could be a good model for other countries.
- The importance of ensuring that resources for LLINs and IRS are not shifted to LSM in situations where LSM cannot be effective was stressed.
- Political support for LSM is crucial. Experience in Burkina Faso indicates that it is possible to make a large impact in urban settings however it is imperative that local politicians and communities see it as a priority.
- A system of sending experts to countries could be useful if not a duplication of WHO services; and if it could be funded. It is important to remember that countries may not specifically lack knowledge or technical skills, but NMCPs may simply be understaffed.

### ***Urban Malaria Control Scheme in India – Rajander Sharma, Ministry of Health, India***

Vector-borne disease has historically been a major public health problem in India with a high prevalence of malaria, visceral leishmaniasis, dengue, chikungunya, lymphatic filariasis and Japanese Encephalitis. The Indian National Malaria Control Programme was launched in 1958 and as urban malaria became more problematic (for example malaria increased in Mumbai in the 1970s and 1980s alongside increased construction activities and labour migration from endemic areas), the Urban Malaria Control Scheme was sanctioned in 1971. Initially, 23 towns were selected for implementation and the scheme has subsequently been extended to 131 towns in 19 states, covering a population of 116 million. *Anopheles stephensi* is the primary vector. Interventions include channelization of rivers, larviciding and civic bye-laws to reduce larval habitats in construction sites and around buildings. Data on malaria cases and deaths in 19 states conducting LSM was presented for 2005 to 2013. Fifty-year trends in malaria incidence were also presented for Mumbai, Delhi and Mangalore. Ongoing challenges to the program include urbanisation and population growth, the increase in *An. culicifacies* in peri-urban areas, the intermittent drinking water supply (which encourages water storage), development projects without health impact assessments, inadequate health infrastructure, immigration and poor disease surveillance.

### ***Larval Source Management for the control of vector borne disease in Pakistan – Muhammad Mukhtar, Directorate of Malaria Control, Pakistan***

Malaria and dengue are the major vector-borne diseases in Pakistan. Dengue has increased from 4 endemic districts, 699 confirmed cases and 7 deaths in 1994-2003, to 119 endemic districts, 63,234 confirmed cases and 554 deaths in 2005-2011. The national vector-borne disease control program follows an annual cycle of planning (January to May), larviciding (May to June, which is the dry season) and IRS (July to August) in preparation for the peak transmission season (August to December). Malaria vector larval habitats are typically fish ponds, water tanks and water courses which are fixed and easy to target. The main vectors are *An. culicifacies* and *An. stephensi*. Dengue vectors mainly breed in peri-domestic man-made containers which are an ideal target for LSM. LSM

is carried out through larviciding, specifically comprising Breeding Site Assessment Surveys (BSAS) and mapping, evaluation of resistance to larvicides and repeat application (temephos and fenthion) at 7-10 days and 3-4 cycles per month. Habitat manipulation and modification are also done, for example water reservoirs are cleared of vegetation at their peripheries, their concrete edges are repaired and the flow rate is maintained, achieving good control of larvae (Ensink JH, Mukhtar M, van der Hoek W, 2007. Simple intervention to reduce mosquito breeding in waste stabilisation ponds. *Trans R Soc Trop Med Hyg*, **101**:1143-1146). Malaria and dengue control in the Punjab is based on IVM and 'The Punjab Prevention and Control of Dengue Regulations, 2011'. This legislation bans old tire businesses from storing tires in outdoor areas, bans all containers that are potential larval habitats and discourages domestic water storage. In conclusion, while larviciding remains the priority intervention in Pakistan, particularly for malaria control, environmental management and IVM have also demonstrated their potential for sustainably controlling vector-borne disease.

#### *Discussion*

- The examples of LSM in India and Pakistan illustrate that there may be two scenarios where LSM can work: (1) 'opportunistic' LSM, where there are many uniform larval habitats (as in the Tennessee Valley Authority or Sri Lankan gem mine pits) and (2) 'intensive' LSM, which requires intensive discipline, management and organisation. It was clarified that although some examples of LSM in Pakistan may be described as opportunistic, the intervention has also been successful in areas not characterised by numerous uniform habitats.
- Given the man-made nature of urban larval habitats in Asia there is an opportunity to improve the design of buildings and towns to reduce breeding.

#### *Discussion*

##### *New Global Fund Model:*

- LSM clearly has a major role to play in malaria control and we must consider whether this is a suitable juncture for countries to request funds from the Global Fund. The RBM Harmonization Working Group is currently advising countries on their Global Fund applications and will insert a paragraph into their guidance making it clear that in planned programs (1) larvicide products used should be WHO PES approved and (2) a very strong monitoring and evaluation component is required. Since a poorly proposed LSM component could jeopardise entire applications, countries need to be advised to proceed with caution. NMCPs must also provide evidence for the specific settings in which LSM can work. The publication of the Cochrane Review will provide some reassurance to the Global Fund board.
- Many opportunistic possibilities for LSM may exist and be easily missed. In order to encourage countries to find these, it may be helpful to collate stories of opportunistic success.
- Funding has been sought from RBM for the LSM Work Stream to convene ECOWAS workshops and to give technical assistance for LSM in 10 countries.

Steve Lindsay closed the meeting and thanked participants.

### Session 3: The way forward for 2014

#### Auditorium

*Chairs: Michael Macdonald and Jo Lines*

#### **Larval Source Management – Steve Lindsay, Durham University, UK**

*The following proposed areas of work were discussed:*

1. Updating the environmental management handbook.
2. Developing manuals for LSM in Southeast Asia and South America.
3. Finalising a list of WHO/PES recommended larvicides.
4. Advocacy to funders and donors.
5. Supporting NMCPs doing LSM.

#### *Draft 2014 Work Plan:*

1. Consider developing a manual on urban mosquito control in the tropics.
2. Finalise the WHO/PES-approved/recommended list of larvicides on the website.
3. Continue to advocate for LSM.
4. Help provide technical assistance to countries through RBM.

#### **Housing and Malaria – Steve Lindsay, Durham University, UK**

*The following topics were discussed:*

1. The evidence supporting housing as a malaria intervention.
2. Developing a framework for scaling-up housing interventions.
3. Ongoing pilot work in house screening in Kenya and Tanzania.

#### *Next steps:*

1. Engage with interested parties within health and in other sectors.
2. Possibly convene a workshop on housing and malaria.

#### *Discussion*

It was suggested that the lead for housing should not be taken by the VCWG but UN-HABITAT or Habitat for Humanity, and that it is important to advocate that these organisations improve homes to protect against malaria. However experience from agriculture (e.g. WHO and the Food and Agriculture Organization of the United Nations) indicates that partnership and motivation is needed from both sides. In addition, given that those working in vector control do not yet have consensus on which housing improvements protect, the housing sector cannot be expected to make such decisions alone.

#### **Insecticide Resistance – Maureen Coetzee, Witwatersrand University, South Africa**

*The following topics were discussed:*

1. Insecticide resistance data from Uganda, Cote d'Ivoire and Burkina Faso, which demonstrate that the WHO diagnostic dose is one part of collecting resistance data and those additional procedures are needed to fully document resistance.
2. The Cochrane Review of the impact of resistance on the efficacy of LLINs, which did not identify any studies with clinical outcomes and identified 56 studies with entomological outcomes for inclusion. The review concluded that the data were too variable to draw

statistically valid conclusions and underlines the need for standardized methodologies to be used in these kinds of trials.

*Priorities for 2014:*

1. Advocacy for implementing IRM policies:
  - a. Create a core group of experts who can be contacted when necessary to advise countries on interpretation of data and the way forward. Use the sub-regional networks and ANVR focal points to drive this.
  - b. Within two months, circulate the Zambia and Equatorial Guinea insecticide resistance management plans.
2. Monitor how countries manage insecticide resistance keep track of resistance data.
3. Recommend to VTEG that resistance intensity tests are standardized and revive WHO collaborating centres to assist with specialized tests. Draw up guidelines on how to monitor operationally significant resistance.

*Discussion*

- *Template insecticide resistance management plans:* The insecticide resistance plans for Zambia and Equatorial Guinea, soon to be made publicly available, will be useful resources. The Work Stream could consider replicating these for other countries with existing plans, to maximise the information available for NMCP managers.
- *Study quality:* Given the poor quality of data available on the impact of insecticide resistance on LLIN efficacy, made evident by the Cochrane Review, the Work Stream could advise on study quality.
- *Monitoring resistance:*
  - Some countries will lack the capacity to collect the data required in the GPIRM and WHO collaborating centres could assist.
  - The recommendation to VCTEG on standardising resistance intensity tests must be clear and detailed.
- *Advocacy:* There was a call for optimism; despite resistance we are in a better situation than at the end of the Global Malaria Eradication Programme, with a promising drug pipeline and organizations such as IVCC working on the next generation of actives and interventions. The review by Cohen and colleagues (Cohen et al., 2012. Malaria Journal 11: 122) highlights that a major reason for programme failure is often a cessation of effort, and it is important to maintain motivation and advocate to politicians and donors that the situation is optimistic.

***Continuous LLIN Distribution Systems – Jayne Webster, London School of Hygiene & Tropical Medicine, UK***

*The following topics were discussed:*

1. Delivery of LLINs through ANC and EPI.
2. Continuous LLIN distribution pilot work in Ghana and the Eastern Region through Schools, ANC and EPI.
3. The use of electronic vouchers and coupons.
4. The potential role of the private sector and Movercado in continuous distribution.
5. Prioritisation of LLIN delivery in conditions of scarcity.
6. Data for stratification and better mapping.

*Draft 2014 Work Plan:*

*Strengthen the collection and use of data (on LLIN source and ANC delivery):*

1. Request the addition of two questions to the DHS and MIS.
2. Develop and implement a guide for analysis and use of these data for strategic planning.
3. Review which countries include the collection of data on LLINs delivered through ANC.
4. Develop and implement a guide for analysis and use of these data for strategic planning.

*Evidence on Continuous Distribution channels:*

5. Document evidence on continuous distribution from a number of countries.
6. Consider costing studies on continuous distribution from projects in a number of countries.

*Planning for continuous distribution*

7. Develop 'Guidelines for school based distribution of LLINs'.

*Discussion*

It was highlighted that data on LLIN distribution and coverage could be improved and that those working in EPI could inform this. When prioritising LLIN distribution in times of scarcity, it is important to continue to monitor whilst targeting interventions. The support of the NetWorks project and CDC for the Work Stream was acknowledged.

***Durability of LLINs in the Field – Stephen Smith, Centers for Disease Control and Prevention, USA***

*The following topics were discussed:*

1. 2013 developments, including newly published methods for estimating the functional survival of LLINs from field data, which do not include measurement of insecticide activity loss until a practical, nondestructive field method is available.
2. Ongoing laboratory durability studies, the preliminary findings of which indicate that LLIN damage and attrition are largely the function of the local environment and that most LLINs perform similarly.
3. Ongoing field studies including the Tanzania ABCDR study.
4. Nondestructive testing for pyrethroids on fabrics in the field.
5. Causes and mode of deterioration.
6. Discussion of priorities for 2014 and a draft work plan.

Outstanding issues include the practical definition of a 'failed' net (i.e. the level of acceptable damage and insecticide loss) and the economics and implications for insecticide resistance of improving durability.

*Next steps:*

1. Improve communication: balance presentations with discussion in future meetings and hold regular teleconferences.
2. Co-chairs will coordinate with members to develop the 2014 Work Plan.
3. Explore potential for developing collaborative ties with the Global Fund.

*Discussion*

Those interested in the non-destructive testing of insecticides on nets should contact Karl Malamud-Roam ([kmr@aesop.rutgers.edu](mailto:kmr@aesop.rutgers.edu)). The issue of ultra long-lasting insecticide treated nets was

discussed; it is difficult at this stage to make recommendations on the ideal net life but it should be remembered that untreated nets still give some protection. It was suggested that IRS teams can be drawn upon to assess the condition of LLINs when visiting homes, although this will not collect attrition data which allows calculation of the median net survival time.

***Capacity Building for IRS – Shiva Murugasampillay, World Health Organization, Switzerland***

*The following topics were discussed:*

1. Progress in 2013, specifically (1) the IRS symposium at MIM Durban, (2) developing private-public partnerships through GBCHealth with Anglo Gold Ashanti, Syngenta and other partners and (3) reaching out more to the Middle East and Asia including Yemen, Iran, Pakistan, Afghanistan and India.
2. Building capacity for public health entomologists, for example in conjunction with PMI.
3. Promoting career paths at country level.
4. Reinforcing program management components.
5. Cross-support with other programs.

*Priority work areas for 2014:*

1. Identify the more active core members
2. Involve more closely the core countries and partners including Tanzania and Zanzibar, Uganda, Nigeria, Ghana, South Africa and Swaziland; and RBM-SARN, Hudson, Arysta-Syngenta, Goizper, MRC-Durban, RTI, Anglo Gold Ashanti, GBCHealth, Bayer, IVCC and PMI.
3. RBM led negotiations on financing new IRS products from market to delivery and quality control (Kenya and Ghana).
4. Outline the role of IRS in elimination and prevention of re-introduction and develop thresholds and guidance to transform IRS from a blanket to a more targeted approach (India and Swaziland).
5. Develop Microsoft Excel tools for improving planning, quality, monitoring and reporting.
6. Explore new technologies including the use of mobile phones for public messaging and remote sensing for targeting IRS.
7. Evaluate how IRS can be combined with LSM and LLINs (India and Swaziland).
8. Aligning the labelling of compression pumps with the labelling of insecticide sachets.
9. Encourage decentralization of IRS programmes to the village level with support for supervision to ensure timing, coverage and quality (Tanzania and Ethiopia).
10. Develop private-public partnerships on malaria and maternal and child health (Nigeria, Angola, DRC and Ghana).
11. Expand the AngloGold Ashanti model in Ghana, the Rio Tinto model in Guinea, the AGM model in Tanzania & Ilovo model in Malawi.
12. Develop a new US-PMI-IRS paradigm with a new contract of building national program capacity structures and systems and sustainability.

*Discussion*

Many programmes have requested IRS products packaged as water-soluble sachets. Industry should submit data to WHOPES so that it can incorporate this into its criteria.

***Optimizing Evidence for Vector Control Interventions– Christian Lengeler, Swiss TPH, Switzerland***

*The following topics were discussed:*

1. Recent evidence on LLIN-IRS interactions.
2. Alternative bioactives (fungus and alternative chemicals).
3. Re-designing of the vector control portfolio at the BMGF.
4. The new VecNet portal.
5. IVCC plans for new paradigms in vector control.
6. 2014 work plan.

*Draft 2014 Work Plan:*

1. The Work Stream has a limited budget and no workforce, however the annual meeting, with roughly 100 participants, is useful for sharing ideas and data and for networking.
2. It may be possible to organise ad hoc sessions linked to existing meetings, as was done with the workshop on LLIN-IRS combinations at the MIM conference in Durban, October 2013.
3. Consider holding a workshop on the design of field trials for vector control interventions, probably alongside an existing conference.
4. Consider becoming involved in epidemiological stratification at the country level and outline how vector control interventions could be meaningfully combined, whilst being cautious of the policy implications.

***Entomological Monitoring and IVM – Jacob Williams, Research Triangle Institute (RTI) International, USA***

The meeting focused on scaling up effective vector control and specifically:

1. Facilitating country access to products.
2. Using multi-vector interventions.
3. World Health Day, 7<sup>th</sup> April 2014 with the theme ‘Vector Borne Disease’.

*Next steps:*

*Facilitating country access to products:*

1. Collaborate with OCEAC to document experiences from regional harmonization efforts.
2. Document national focal points and status of country pesticide regulation frameworks.
3. Collaborate with industry partners to develop a basic dossier based on approved specifications.

*Using multi-vector interventions:*

4. Proactively advocate for joint evaluation of the impact of malaria vector control on LF.
5. Support the development of the new manual and help find funding for the field testing of this manual in 2015-2016.
6. Highlight and clarify the role of IVM in insecticide resistance management.
7. Document IVM programs and M&E of IVM.

*World Health Day:*

8. Increase awareness of the campaign by sharing the link to the website, printing campaign posters, promote messages through social media.

***Outdoor Malaria Transmission – Michael Macdonald on behalf of Marc Coosemans***

***Discussion***

In 2013 it was agreed that the Outdoor Transmission Work Stream would focus more on sub-Saharan Africa yet it appears that it still focuses on the Mekong. However other locations are becoming more involved such as Ifakara, Tanzania. Those already working in outdoor transmission should be encouraged to help lead the work stream.

***Summary – Michael Macdonald and Jo Lines***

Michael Macdonald thanked all participants and reiterated the usefulness of the meeting for networking. Swiss TPH was thanked for providing financial and technical guidance, IFRC for providing the venue, Jason Peat and Melanie Caruso for their role in the meeting organisation, IVCC for their sponsorship of individuals, PMI and RBM. Konstantina Boutsika was also thanked for her overall efforts in organisation.

Jo Lines reflected on the progress made since he first became co-chair, when WHO had no plan for insecticide resistance management, LLIN distribution systems were in their infancy, no larval source management policy existed, LLIN durability had not been considered in depth and no system existed for considering and bringing forth new vector control technologies. The architecture of WHO/RBM has also greatly improved in the same period, a change creditable to Rob Newman. In closing, Jo Lines thanked all participants, Michael Macdonald and Konstantina Boutsika for their support and emphasised that being co-chair has been a great honour.

Konstantina Boutsika thanked all participants and highlighted that the 9<sup>th</sup> VCWG meeting had around 200 participants; substantially more than the 72 who met when she first became secretariat in 2010.