# Vector Control Working Group

14th Annual Meeting, 30th January – 1st February 2019

Moevenpick Hotel, Rue de Pre Bois 20, 1215 Geneva

Co-chairs: Keziah Malm & Justin McBeath

Secretariat: Konstantina Boutsika

Rapporteur: Robert Jones

# Day 1: Wednesday 30th January 2019

## Session 1: Introductions and Updates
## Chairperson: Justin McBeath

*Welcome, introductions and meeting objectives - Justin McBeath, Bayer*

Konstantina Boutsika, Swiss Tropical and Public Health Institute, welcomed attendees to the 14th VCWG Meeting and introduced the new co-chairs of VCWG, Keziah Malm (NMCP Ghana) and Justin McBeath (Bayer, UK). The co-chairs thanked the partners and the Secretariat, and the previous co-chairs. The growth of VCWG was highlighted: this year's meeting has 272 participants, and the extended membership has more than 1,500 people. There was a balanced representation at the meeting this year with about a third each from affected countries, from industry and from research and academia. The diversity of the group is part of its richness. Newcomers to this meeting were acknowledged and welcomed.

The objectives of the RBM Vector Control Working Group meeting were stated.

1. Dialogue around best-practice sharing
2. Information dissemination
3. Aligning constituencies on challenges faced in malaria vector control
4. Networking

The meeting proceeded with plenary sessions and parallel work stream meetings and, as a new approach this year, three key-note sessions.

*Update from the RBM Partnership - Melanie Renshaw, African Leaders Malaria Alliance*

Working groups (WG) are accountable to the board through the CEO, and have to be accredited by the Board. Governance has to ensure adequate participation of malaria-affected countries, and demonstrate self-financing and self-convening capacity. RBM working groups include the Case Management Working Group (CMWG), Monitoring and Reference Evaluation Reference Group (MERG), Malaria in Pregnancy Working Group (MiPWG), Social and Behaviour Change Communication Working Group (SBCCWG), Vector Control Working Group (VCWG), and the new Multi-Sectoral Working Group (MSWG). They will be looking for areas where they can work together. The partnership's strategic priorities for 2018-2020 are to keep malaria high on the political and development agendas, promote and support regional approaches to the fight against malaria, and promote and advocate for sustainable malaria financing. Opportunities for engagement include participation in the Country/Regional Support Partner Committees (CRSPC). CRSPC Sub-regional meetings provide an opportunity to engage with countries, other working groups and partners, and dissemination of working group products. VCWG supports the Global Fund (GF) replenishment advocacy at every opportunity. It is the year of GF replenishment: $14 billion is needed to maintain support at the same rate that countries are supported today, so all positive messages that can be shared will be extremely helpful.

*Update from the WHO Global Malaria Program - Jan Kolaczinski, Global Malaria Programme*

The guidelines for malaria vector control aim to clearly articulate the evidence base on which guidance is based, facilitate the uptake of WHO guidance, and serve as the main communication channel for new or revised WHO policy recommendations on malaria vector control. Other publications include the malaria surveillance, monitoring and evaluation reference manual, and the global report on insecticide resistance in malaria vectors. The Global Vector Control Response (GVCR) was adopted in May 2017 at the World Health Assembly, and regional progress has included the finalisation of a regional action plan in the Americas, development of a regional framework in Africa, and completion of a sub-regional vector control assessment in the Greater Mekong Subregion (GMS). Work in 2019 will include monthly data updates to the Malaria Threats Map Application, expanding guidance for elimination settings, assessing the potential threat of *Anopheles stephensi* spreading to new areas, and a handbook on practical entomology in malaria.

- It was commented that insecticide treated nets (ITNs) were quite slow to reach big investments in the 1990s. It is difficult to make policy recommendation for different settings based on trials in 1-2 places. How this is done does not seem to be part of the Vector Control Advisory Group's (VCAG) role. It was responded that it is very difficult to give global guidance that fits for everybody, but there is a clear recognition that something needs to happen at a country level to inform prioritisation in that context.

*Update on the WHO evaluation process for vector control tools - Marion Law, WHO Prequalification – Vector Control*

The evaluation pathway for vector control products is one pathway with two different routes, which come together at the end in a prequalification (PQ) decision. Those interested in pursuing a prequalification for their vector control product must submit their 'Request for Determination of Pathway'. If the product class already has a WHO policy recommendation it will go straight to PQ, where safety, quality and efficacy will be reviewed. If there is no WHO policy, it will go through the VCAG pathway. PQ will evaluate the safety, quality and efficacy, but the public health value will also be evaluated and a policy recommendation will be developed. In the last year, 98 requests for determination of pathway were received, of which 56 have gone through the PQ pathway, and 16 manufacture site inspections have been conducted. Priorities for 2019 include continuing the assessment of applications and post-market activities. The Joint Meeting on Pesticide Specifications (JMPS) and Collaborative International Pesticides Analytical Council (CIPAC) procedures will also be a priority for 2019.

- It was asked how 'validity through the lifecycle' could be monitored. It was responded that PQ is responsible for the product from concept through its lifetime, and when it is on the market the job to oversee it can become even bigger. This oversight is targeted, sometimes as a reaction to a complaint or if additional data are needed.

*Vector Control Advisory Group update – Anna Bowman, Vector Control Advisory Group*

VCAG is an advisory body that advises WHO on new tools, technologies and approaches for the control of vectors of malaria and other VBDs. It assists in the development of policy recommendations on these new tools, assesses the public health value of new interventions, and provides guidance on developing the evidence base required for such assessments. There are currently 17 new vector

control interventions under VCAG review, of which 11 are in step 3 (planning or implementing randomised controlled trials (RCTs)). The range of intervention types include ITNs, spatial repellents, attractive targeted sugar baits, peri-domestic residual sprays and combined repel and lure devices, vector traps for disease management, genetic manipulation of vectors for disease control, sterile insect technique combined with microbial infection, microbial control of human pathogens in adult vectors, systemic insecticides and housing modification. The terms of reference have been updated, and the option for off-cycle reviews has been developed. In addition, standard operating procedures have been developed to clarify processes. Ideas for the improvement of VCAG were invited.

- It was asked how long it takes to get from step 1 to step 3 of the VCAG review. It was responded that this depends on the product, and the stage at which the applicant enters.
- It was asked if there is an online resource for looking at what needs to be done to conduct epidemiological studies. It was responded that there is a VCAG guide on their website.

*Keynote presentation*

*Market Access Initiatives: New Nets Project and NgenIRS - Christen Fornadel, Innovative Vector Control Consortium (IVCC)*

IVCC works to overcome barriers and increase access to novel vector-control tools, working in three areas: helping to develop these tools, enabling their use in the field, and delivering those tools through access and market–shaping initiatives. The Next Generation IRS (NgenIRS) project aimed to increase use of third-generation IRS (3GIRS) products in insecticide resistance management (IRM) programmes. From 2016-2018, the co-payment support for insecticides provided by the NgenIRS project increased the number of people protected by almost 57%, reaching almost 62 million, which is estimated to have averted 2.6-5.2 million malaria cases.

The New Nets Project was funded to catalyse the introduction of dual active ingredient long-lasting insecticidal nets (LLINs) in a market where there is weak evidence of efficacy, demand is limited by policy and price, and there is a hesitant pipeline. An RCT will begin in 2019 in Benin, which is intended to be complementary to a Tanzania RCT that has already started. It will collect entomological and epidemiological field data, as well as data on net efficacy, use, chemical content, and integrity. There will also be four cost-effectiveness pilot studies in Burkina Faso, Mali, Rwanda and Mozambique. These will compare standard LLINs, second generation LLINs and piperonyl butoxide (PBO) LLINs and collect data on vector bionomics, malaria epidemiology and human behavioural determinants of risk. IVCC are also investigating whether Phase II experimental hut trial outcomes can serve as surrogates for epidemiological and transmission outcomes.

- It was asked what the likely response of the WHO would be to entomological correlates, as opposed to the current requirement for epidemiological trials. It was responded that the idea is to provide a comprehensive dataset that would be convincing enough to WHO.
- It was added that the lack of evidence of correlation was presented to VCAG, and that they would have a discussion on this issue when data were generated.
- It was commented that when there are several products, different settings, different vector species, and different resistance statuses, the number of combinations of decisions are too many to do trials with epidemiological outcomes, and it cannot be done without using entomological outcomes. It was responded that the data collected in these studies can be fed into modelling for decision making.

# Individual Work Stream Meetings
# 4th LLIN Priorities Work Stream meeting
# 10:30-13:30, Wednesday 31st January 2019
# Co-leaders: Hannah Koenker & Ikupa Akim

*Introduction – Hannah Koenker, Johns Hopkins University*

Hannah Koenker opened the meeting, and reviewed the LLIN priorities work stream work plan 2018/2019.

*Presentation: Comparative durability and lifetime cost of three insecticide-treated net (ITN) products in Tanzania, Sarah Moore - Ifakara Health Institute and Swiss Tropical and Public Health Institute*

Findings of the ABCDR prospective longitudinal household-randomised double-blinded ITN cohort survey in Tanzania were presented. The study aimed to examine the three-year life of bed nets (attrition, physical integrity, functional survival, biological efficacy and insecticide content) under real-life conditions, and the economic impacts of their lifespan. 10,598 new LLINs (3,529 Olyset, 3,519 PermaNet 2.0, 3,550 NetProtect) were distributed. All three net types were found to be identical in feeding inhibition, but PermaNet 2.0 and NetProtect were superior when mortality was taken as the endpoint. It was concluded that the difference in functional survival, and the associated annual economic cost between brands, was due to damage and net loss through discarding of damaged nets. Older nets were found to be still highly efficacious after three years, with a lower functional survival of Olyset being due to more rapid accumulation of holes. Functional survival analysis indicated 2.0 years for Olyset, 2.5 years for PermaNet 2.0, and 2.6 years for NetProtect, with equivalent annual costs of $1.5 for Olyset and $1.2 PermaNet 2.0 and NetProtect. User perception of net damage is an important determinant of functional survival, thus encouraging net care and continued use even of older nets is important.

*Presentation: The Tanzania School Net Programme: Eight Years of Experience - Josh Yukich, Tulane University*

In 2011 Tanzania convened nationwide stakeholder meetings to develop a national plan for keep-up of LLIN coverage. It was agreed that two distributions would be used, the on-going voucher scheme targeting pregnant women and infants, and distribution of nets to households via school children. The school net distribution pilot programme was designed to be independent of the Tanzania National Voucher Scheme, and was implemented in three regions - Mtwara, Ruvuma, and Lindi. Nets were deployed each school year from 2013. The programme expanded geographically after its third cycle and now in its sixth year, is the main mechanism of net distribution in 14 of 26 regions, with 9,535 distribution points included by 2017. Measurements showed that cost per net was much lower than anticipated ($4.19 weighted mean), with savings (compared to projection and over time) from declining prices of nets and from operational streamlining. The school net distribution has been capable of maintaining coverage over time in Tanzania, which has come at a reasonable cost once the learning curve was overcome; however it has relied on high school enrolment.

*Discussion*

- It was commented that how the holes get into the nets is less important for users than whether or not holes are present. The tools for measuring holes were very good, and the weighting of holes can be adjusted according to where mosquitoes come in.
- It was asked if it would be dangerous to extrapolate the results of the ABDCR study to other parts of Africa because of behavioural factors in the house, and whether care and repair would extend net lifespan. Care was considered better than repair, and longevity would depend on location and people's living conditions, with sleeping space being particularly important. Behaviour change messaging would therefore be very important in this case.
- It was put forward that NetProtect is no longer on the market because it didn't receive a recommendation from WHO, but this study suggests it was at least as good as PermaNet. There is therefore an issue of how products are registered. The response was that fabric integrity (as well as insecticide) should be a part of product evaluation.
- It was asked whether a mechanism exists to link these findings with procurement decisions in Tanzania. A stakeholder meeting included the National Malaria Control Programme (NMCP) to let them know of the findings. The study may not directly affect current procurement, but studies are expected to feed into the net review process.
- It was asked whether the costs of the universal coverage campaign are known, for comparison with the school net distribution programme. These costs are not known. The cost per person year of protection has been estimated with crude assumptions.
- It was asked if washing conditions were taken into account in the damage to the net. These data have been collected but have not been analysed. However the majority of damage to the nets occurs in the bottom quadrant due to people tucking the net under a matt.

*Panel discussions*

*Panel 1: Stratification/Prioritization in Urban Areas for LLINs*

***How have NMCPs decided to stratify or prioritize LLIN distribution within urban areas? What challenges have they faced, and what recommendations do they have? Ikupa Akim, Swiss Tropical and Public Health Institute***

Ikupa Akim introduced the session on how countries are stratifying bed net distribution in urban areas, and invited Otubea Akrofi from NMCP Ghana, Perpetua Uhomoibhi NMCP Nigeria, and Dorothy Achu NMCP Cameroon. A fourth panellist from Tanzania was unable to attend.

In Nigeria, the NMCP strategy is universal coverage through mass campaigns. However, they have a rolling campaign that does not reach the whole population in a single campaign; the campaign has been running for ten years, and it is dependent on the availability of funding. Eighty million nets were distributed in eight states in 2018, and 13 states are targeted for this year with the support of President's Malaria Initiative (PMI) and the Global Fund (GF). At present, they have not yet achieved universal coverage.

In Ghana, they implemented a rolling campaign in the past, but in 2018 they decided to distribute to the whole country within a year, with the exception of one region and a few districts that have IRS.

They distributed over 15 million nets. They do not have an urban stratification strategy yet, but there are certain challenges in large cities that receive particular attention.

In Cameroon, they are about to implement their third campaign. They are doing micro-planning, and in the coming weeks, they will be starting the distribution of approximately 15 million nets. They do not have a rolling campaign, but they do their distribution in phases. They are going to include a stratification approach for urban areas, and their data indicate that they have slightly fewer malaria cases in urban areas than rural areas.

Even if there is no policy, there are issues concerning distributing nets in urban areas. Urban dwellers tend to be wealthier, choosier, and are more able to buy their own nets. They also use other protection measures, so at the registering stages there are some houses that feel they do not need to be registered. The panel was asked how can a country identify and address these issues, and what evidence do they use to make these decisions?

- In Nigeria, entomological surveillance, ecological, economic, and other factors are used to help the programme decide what would work best in each setting. For example, in Lagos there are still hotspots so it is important to have universal coverage. Going forward, a document will be prepared to help them address urban populations. The majority still get their nets free, and some use additional interventions in their homes.
- In Ghana, a planning committee is held of NMCP and other stakeholders involved in distribution. They realised that many people in urban areas do not want the type of nets being distributed, but there are pockets of poor people who need nets. They target 60% distribution here, which is much lower than in other parts of the country. Registration targets were tied to the money that staff received, so they made extra efforts to convince people to write their names on the registration list.
- In Cameroon, the demand for LLINs is high, even in urban areas; the question is more whether everyone needs a net. This year, domestic funding has to be found to cover the region around the capital, and if resources are limited they will have to make difficult decisions about who should receive a net, identifying the high burden areas/districts. It should be noted that distribution is expensive in cities, as there is a larger number of single person households receiving a net each; generally more personnel are needed for urban distribution.
- It was asked how urban dwellers (classified as mobile, employed) are reached, given the challenges of registering them and getting the nets to them during normal distribution hours. The response was that in urban areas staff often have to go back and can ask neighbours when residents are likely to be at home to ensure people are not missed. Messaging is also used to encourage people to be at home or to give their details to neighbours, and it is sometimes necessary to extend the distribution hours and periods to reach this demographic.
- It was asked how programmes envisage urban distribution strategies for the future. In Nigeria, case management would be strengthened to ensure people have access to diagnosis and treatment, and strengthen routine channels for distribution and surveillance. They could also have mini-mass campaigns to target specific populations. In Ghana, they hope to ensure that everyone who needs a net will get one and try to convince other people to register. In Cameroon, the marketing strategy is being strengthened, and the continuous distribution channels are being reinforced, which are very effective in urban areas.

- It was commented that in Tanzania, an ITN strategy of distribution is being prepared. This includes working with the commercial sector to make nets available in urban areas. In Cameroon, the private sector helps to distribute the nets as there are private health facilities, and the national plan includes these services. In Nigeria, the private sector sells nets however this is a negligible amount.
- A question was raised about the definition of a household in urban areas, because in some countries urban houses are more crowded and have more people than in rural areas. In Cameroun, a household is defined as a mother and her children, and this includes the father in monogamous households, whether it is rural or urban. Other people in the house are also counted, but there is a cap on the total number of nets that a household can receive. In Nigeria, a maximum of four nets if given to a household, even if there are more than eight people.
- It was asked whether there is a clear delineation between urban and rural areas, and what was being done in the poorer areas of urban sites. In Cameroon, there are many peri-urban areas, and the prevalence of malaria is also high here, so it is difficult to make clear distinctions. Similarly, in Ghana there are many metrics that can be used but no clear was to define an urban area. There are pockets of private sector malaria control programmes, which are not part of the national response, which do offer services in urban areas. There is no real segregation but efforts are made to ensure people in the poorest houses are registered.
- It was commented that some countries have looked at integration; in Nigeria there are 200 campaigns a year (including child health and vaccination), and in urban areas there are many children in schools, so it may be possible to reach target groups through these.

*Panel 2:*

***What data has been used to decide where to deploy NGN, and what processes have been helpful to facilitate decision-making? What recommendations do NMCPs have for others - Hannah Koenker, Johns Hopkins University***

Hannah Koenker introduced the session on where programmes are with their decisions to introduce next generation nets (NGNs), and invited Yacouba Savadogo, NMCP Burkina Faso, Keziah Malm, NMCP Ghana, Abdullah Ali, Ministry of Health Zanzibar Tanzania, and Dorothy Achu, NMCP Cameroon.

- The Zanzibar Malaria Elimination Program operates in an area where malaria prevalence is very low. Net utilisation is a critical issue, regardless of the type of net. They are in the initial stages of introducing NGN; they have started to procure and hope to distribute across Zanzibar.
- In Ghana, they are working with PMI to bring in NGNs through a school-based distribution programme. The decision to do this was based on resistance to pyrethroids in most of the country.
- In Burkina Faso, malaria incidence is more than 60% and prevalence is more than 40%, despite bed net distribution. There is resistance to insecticides in the south and west in particular, so they have decided to show this to donors to encourage them to make NGN available in these areas.
- In Cameroon, they have had a problem of insecticide resistance for more than ten years. Data indicate that it is no longer acceptable to use the same nets. With the help of PMI, they have been able to get PBO LLINs for the next distribution campaign.

- It was asked what additional data might be needed to help countries decide where NGNs should be deployed, and what constraints might they have. It was responded that in Zanzibar there has not been a problem to decide where they should be deployed; there is already sufficient data. In Ghana, they have sentinel site data and have seen the synergistic effect of adding PBO, so the NGNs will be distributed through the schools. It is not efficient to give them just to select individuals. In Burkina Faso, it was easy to decide because they proved that where resistance is high malaria incidence is also very high. They will deploy NGNs in these areas first.
- In Cameroon, the first challenge has been to match resistance with malaria morbidity, and demonstrate that it will be possible to improve the overall picture in the country. It is hoped that operational research will be gathered where nets are deployed to show what will be valuable in other regions. They also need to address issues of communication about why certain nets are being distributed, and funding for future distribution.
- It was asked what might be recommended to other programmes based on their experiences. It was responded that regularly monitoring susceptibility to the new nets was important. NGNs are more expensive, so it must be possible to justify their use from scientific data. In addition, there should be strong collaborations with researchers and negotiate with donors to prove that the NGNs are helpful where incidence of malaria is high. It is also important to prove that the nets will be used, and that partners are mobilised to make the decision to ensure funds flow.

*Plenary Discussion*

- It was asked whether the recommendations relating to PBO nets have changed, and how strong the data need to be. It was responded that the recommendations changed in 2017 following the trial data from Tanzania. There is now endorsement for PBO nets.
- It was asked about the cost implications for NGNs and whether they are used as a resistance management strategy; given that Burkina Faso has a high level of resistance, whether that country should distribute more NGNs than standard nets. It was responded that in Cameroon PBO nets are being used as an interim means while waiting for other interventions that require more resources. In Burkina Faso, 3 million NGNs are needed where resistance is very high, half of which will be PBO nets. The decision to use these is made through discussion with partners.
- It was commented that capacity building should be built at the national level, to allow insecticide resistance and durability studies to be conducted so there is less dependence on research institutions.
- It was commented that low, medium and high resistance might mean different things to different people. There is an implication that PBO nets are only deployed in situations of low to moderate resistance, as if they are not working in areas of high resistance. It was responded that where there is high resistance, for countries without other options, the benefit is not significant, but this does not mean there is no benefit. A significant benefit may be found.
- It was commented that Cameroon focused on malaria endemicity and burden, considering that resistance is everywhere, and this could be a decision factor for other countries. It was responded that if they can demonstrate resistance and a high burden there is justification to introduce NGNs, without waiting for representative data for the whole country.
- It was asked if the availability of NGNs has helped countries to mobilise more funding for entomological studies. It was responded that new commodities in a country had attracted

researchers, and they are looking for funding to see if they can monitor its introduction, but PMI is also already doing resistance monitoring. The GF is actively trying to ensure that countries have the resources to gather the data they need for decision-making. Manufacturing capacity for the development of new nets is limiting the supply of these nets, so Global Fund is trying to make sure they are given sufficient time to make them for campaigns.

# 9th Larval Source Management Work Stream meeting
# 10:30-13:30, Wednesday 31st January 2019
# Co-leaders: Ulrike Fillinger & Silas Majambere

*Welcome -Silas Majambere, Pan-African Mosquito Control Association*

Silas Majambere opened the session and reviewed the Larval Source Management work stream work plan 2018/2019. There are five main projects on-going. Project 1: Draft a consensus statement as RBM VCWG work stream with the aim to help countries optimise use of their resources when they choose to implement Larval Source Management and as a complement to the position of WHO. As more evidence is generated, it is expected that this will lead towards a clearer statement and position from WHO on adoption of LSM for malaria control. Some believe current WHO statement is misleading and that it does not encourage the use of LSM. Project 2: Advocating for environmental management including habitat modification and manipulation, and inter-sectoral collaboration as priority interventions in LSM. The working group hopes to pursue a relationship with the African Development Bank (AfDB), particularly around agriculture and dam construction projects. Project 3: Update and expand spreadsheets of World Health Organization Pesticide Evaluation Scheme (WHOPES) recommended (now WHO-PQ Listed) larvicides and compile standard operating procedures on testing larvicides and resistance. This is being done by Innovation to Impact (I2I). Project 4: State of the art technology for improving LSM operations. A project in Zanzibar is testing the value of integrating satellite imagery, drones, and mobile apps. Project 5: Reviewing operational LSM in NMCPs. The work stream has no funding to support LSM in different countries, but has interacted with NMCPs in Nigeria, Niger, Tanzania and Uganda over their plans for LSM.

*Updates on a larviciding program in Niger - Boubé Hamani, Ministry of Health Niger*

The NMCP in Niger includes the use of larvicides, along with LLINs, indoor residual spray (IRS) and other prevention tools, coupled with treatment and surveillance. The country has three zones, ranging from hypo-endemic in the north to hyper-endemic in the south, all three of which have LSM as part of their interventions. A partnership has been formed with Cuba to use BACTIVEC and GRISELESF in the national vector control strategy. Niger hosted Cuban experts and have larviciding equipment in place. Currently, they are training two NMCP technicians in applied entomology and public health, and fieldworkers in larvicide application. They have done baseline entomology and epidemiology surveillance, and are mapping and treating breeding sites. Future activities will include larviciding activities in second phase regions.

- It was asked whether economic activities are going on such as irrigation, dams, and mining that might influence breeding sites, and whether there has been a focus on the identification of these sites and elimination of them. It was responded that in the meso- and hyper-endemic zones there is mostly agriculture where it is wet, and in the north there is more mining. There has been specific interaction with these sectors to see if they can assist.
- It was asked if there are opportunities for draining at these sites or other measures to reduce sites for larvae. There is a diversity of sites in the hyper-endemic zone. The whole country is around the Niger river, so they have a lot of agriculture and they have done a lot of larvicide spraying. They also have standing pools that are a source of larvae.
- It was asked what additional epidemiological data they are collecting to assess the impact on disease. It was responded that they collected baseline data and have passive case detection. The effectiveness is measured by the perceived reduction. It was also clarified that they are also doing aerial spraying (adulticiding).

*Updates on a larviciding program in Uganda- Charles Ntege, NMCP Ministry of Health Uganda (Presented by Silas Majambere)*

In Uganda, larviciding was used within the national programme in the 1930s to 1980s in combination with administrative measures, and malaria was effectively controlled, but larviciding was abandoned in 1983 when the vector control units were disbanded. The NMCP is deploying three main interventions (LLIN, IRS and LSM). It was a recent decision to use SAFE (sunlight activated formulation extract) as a larvicide. It was considered to be more environmentally friendly than other options, and breeding sites for treatment are going to be identified by vector control officers when staff has been trained in implementation. A large-scale trial has been completed, with a reported reduction in malaria cases compared to previous months. The treated community has asked for the programme to be expanded because mosquitoes are coming back.

- It was commented that most reporting is done on larvae, with few data on adult mosquitoes or disease. It would be good to discuss with Charles how they will set up their surveillance. Other countries also should focus on adult mosquitoes and disease cases.
- It was commented that In Uganda, one of the problems is the areas of very high transmission. This work does not seem to focus on these areas, so it would be important to work with people in these areas where there are established teams (part of the NMCP) already collecting routine data, and an intervention could be launched on top of these to see if they can push malaria to elimination.

*Updates on a larviciding program in Tanzania - Winfred Mwafongo, Ministry of Health Tanzania*

Winfred was absent.

*Towards new safeguard requirements for health impact assessments to control vector-borne disease risks around AfDB funded large scale projects - Ousmane Fall, African Development Bank*

The AfDB is the first funding institution in Africa. It has an integrated safeguards system that is used in the evaluation of new projects. These include (i) a screening phase, (ii) a resettlement plan, (iii) ecosystem services for nutrition, health, well-being and livelihood, (iv) specific health aspects related to pesticides and other hazardous chemicals, (v) protective labour, health and safety conditions, and (vi) VBD control safeguards, which focuses on health issues associated with large capital projects and

how they affect communicable and non-communicable diseases. The AfDB will not provide funding unless the requirements of the operational safeguards are met. The bank helps the project through monitoring, verification, and supervision. LSM is important for AfDB because there are five priorities for Africa ('high five priorities'), most of which are related to large projects. AfDB-funded water projects shall be designed and operated to avoid water-associated diseases through LSM and water-borne disease control. There is a huge increase in dams, and these reservoirs could impact malaria and be part of the burden, so they want to be part of the solution. A specific health operational safeguard is needed, and this will include LSM. Challenges for requirements related to LSM include a lack of trained public health professionals, lack of qualified health assessment consultants, and none of the environmental laws in sub-Saharan Africa include occupational health and safety within the ambit of an environmental and social impact assessment.

- It was asked if AfDB will ask projects to include LSM in their proposals. It was responded that VCWG needs to work with them to develop guidelines.
- It was commented that in their negotiations, the AfDB tries to convince countries to adopt health impact assessments, but they will then have to have this as part of their loan. Some countries may offer help without such requirements. It was asked if they offer grants to support these measures. It was responded that clients commit to these operational safeguards, and if they do not respect these they cannot be funded. Environmental and health impact assessments need to be part of their implementation plan. This funding needs to cover this part. The AfDB does not have a health department, but a safeguard compliance department.

*Could Soper's success with larviciding be recreated in Africa with a mobile app? - Arnon Houri-Yafin, Zzapp Malaria*

Fred Soper had a campaign to eliminate *Anopheles gambiae* from eastern Brazil in 1938-1940. Presently the use of larviciding for vector control is minimal, and control programmes focus on adulticiding. The main challenge of larviciding has been coverage of water sources, the difficulty in returning to sites for re-spraying, and the need for a strong surveillance system. A mobile app shows the work divisions and highlights the path the fieldworker needs to take. The area that they need to treat is shown, and allows them to report on it and take a picture of it. An RCT in Obuasi, Ghana, was used to determine how many larval sites could be found in an urban setting using the app and with a routine scanning method. The app team found 28% more sites. Future studies will include a more large-scale operation with more villages, more time, and with both epidemiological and entomological impact.

- It was asked if the app uses existing satellites data. It was responded that the version in an upcoming study in Zanzibar will use drones, but the version presented here used Mapbox. The aerial images help them with coordination; it does not identify the larval sites.
- It was commented that in Madagascar, the government plans to use drones for distribution of medicine and other uses. Drones can be used for mapping and looking at sites, but for specific objectives you would likely need specific technicalities.
- It was commented that for most countries, getting the license to fly is the main challenge. When this is achieved, getting over the technicalities should be relatively easy.

- It was asked, given that drone technologies are going in the direction of fully autonomous systems, whether swamp drones could be used. They have a proof of concept project to identify swamps through acoustic cameras. These are interesting, but improving the efficiency of operations is the first step to improving larviciding. In a 65 x 65 km grid, drones can find 93% of the sources of mosquitoes, so they are getting to the point of fully automated systems.
- It was asked if larviciding gets much cheaper with the app. It was responded that the cost effectiveness is related to the scanning and spraying times. It appears to be 20% quicker, and you also have data ready to report. 20% of the cost of reports is compiling this data, so a further saving is made.
- It was asked, given that drone technology could very effectively operationalise larval source management, whether there should be concern that it could be subverted by terrorists. It was responded that the military and the terrorists already have these technologies.

*Open discussion: How do we make the LSM work stream useful for National Programs?*

Attendees were invited to contribute to discussion on the projects for the coming year.

*Project 1 - consensus statement*

- It was commented that LSM is already happening in some countries – primarily supported with local funding. International funders generally require WHO support for an intervention before supporting its implementation and without clarity in the WHO position these funders are not likely to choose LSM anyway. A clearer statement or document which helps countries optimise implementation of LSM when they choose to do so with their own resources is the goal.
- It was commented that the WHO statement currently does not provide clear direction to those that do not understand mosquito control. Therefore there is a gap which the VCWG work stream can help fill. History shows LSM can be done effectively and it is expected that its successes can be repeated.
- It was asked what the new WHO consolidated guidelines (referred to by Jan Kolaczinski during morning of VCWG Meeting) will say about LSM. This needs to be checked.
- It was noted that an email had previously been sent to WHO asking if the work stream could help countries that are known to be larviciding. The WHO response was that there is not enough evidence to support LSM, and not enough funding to allow diversion from those activities that are known to work. More evidence of efficacy is needed, if not from a scientific paper at least from a local report. It was added that PAMCA is trying to have a vector surveillance system in each country that will be used for all interventions, and this could provide such evidence. Further, this is WHO data from 1970s (Guideline no. 66 - larval source management for malaria control) that could be used.
- It was agreed that a VCWG statement be drafted to support the countries and that this would be aligned with RBM Leadership for acknowledgement by WHO.

*Project 2 – advocating for environmental management*

- It was reported that some of the work stream members have had dialogue with agriculture and other sectors, which create water bodies. The annual meeting of the Multi-sectoral working group will be held shortly, in which moving forward with this can be discussed.

*Project 3 – updating spread sheets of WHOPES approved larvicides*

- I2I were absent so this was not discussed.

*Project 4 - state of the technology for improving LSM management*

- Anyone in the work stream with information on how LSM can be improved was invited to share.

*Project 5 - Reviewing operational LSM in national malaria control programmes*

- It was commented that LSM is used in some countries but most are not rigorously monitored. Typically local public money is put into these programmes, and whilst they report reductions in larvae, the overall effectiveness of the programme is not known and there is insufficient monitoring. It was asked if there is a demand in the country for people to come and help them to do it correctly.
- It was commented that countries have not been told not to use LSM; PQ has already qualified some larviciding products, but in some countries PMI for example has said that it should not be done with their funding.
- It was added that there is already a guideline and a manual, but a question is whether this is the best guideline or if changes need to be made. There are misunderstandings about this intervention, and if these can be cleared up it would be helpful. The guidelines are more positive about LSM in municipalities, so more of a focus on this might allow budget to come from the municipality and be combined with sanitation programmes.
- It was summarised that there is evidence that LSM is a supplementary measure for malaria control. The thoughts of the work stream on LSM should be presented on the website. There is a need for countries to have consultants that can give them advice, so a list of experts should be prepared. Attendees were invited to join this list.

# 4th IRS IRM Priorities Work Stream meeting
# 14:30-18:00, Wednesday 31st January 2019
# Co-leaders: Mark Hoppé & Dereje Dengela

*Welcome and introduction – Dereje Dengela, Abt Associates & Mark Hoppé, Syngenta Crop Protection AG*

Mark Hoppé opened the meeting and welcomed the speakers and work stream members.

*NgenIRS update: Building an evidence base – Molly Robertson, PATH*

In the past, higher prices for new insecticides resulted in low uptake, poor forecasting and long lead times, a single supplier (Actellic®300CS) and weak evidence of impact and cost effectiveness were barriers to third generation IRS. Unitaid have funded a market shaping initiative to overcome these barriers. The project has achieved reversal of a market downtrend, the development of a market-forecasting tool, reduced average prices from $23 to $16, and compelling evidence showing impact and cost effectiveness of IRS in combination with LLIN and other interventions. This has been realised through studies with partners in five countries, such as an observational analysis of impact of IRS in Mali, which revealed 35% fewer malaria cases in 2014 in area with IRS treatment. In Mozambique, a cluster randomized trial found a 63% reduction in total *An. funestus* specimens in 2017 and 85% reduction in 2018. A 17% protective efficacy of IRS on top of LLINs was reported in a cohort of 1,536 children tested monthly as part of the Mozambique study. Cross-cutting activities have included harmonizing measurement methods and indicator definitions, as well as a costing framework.

- It was asked how much RCTs cost. It was responded that they typically cost between $1-5 million. Observational analyses are much cheaper, and if trends can be seen repeatedly in different countries, they can provide valuable information for decision-making without costing so much.

*What is new in IRS?*

Dereje Dengela introduced the next five presentations on 'what is new in IRS'.

*Sub-national insecticide rotation, the 2018 experience – Bradford Lucas, PMI VectorLink*

In recent years IRS had been used under the AIRS project and VectorLink in 14 countries with just one chemical, Actellic®300CS (pirimiphos methyl). The idea of a rotational strategy with longer-lasting IRS insecticides was only theoretical because the decision had been taken not to spray pyrethroid-based insecticides (to preserve their efficacy for LLINs) and carbamates were regarded as shorter lasting. When the PQ process approved SumiShield™ 50WG (clothianidin), it was introduced in seven countries in 2018. Throughout 2018, SumiShield™ 50WG was sprayed on 1,048,000 structures. Tanzania made a large-scale switch from Actellic®300CS, while others used it in pilot studies. In total, 82% of structures were sprayed with Actellic®300CS. PMI VectorLink would like to see within-country rotation, with a third of districts sprayed with one insecticide and the other two sprayed with other insecticides, and keep this moving. This is not complicated operationally because they are used at the district level, and average costs will smooth out insecticide cost variances. With Fludora Fusion (clothianidin + deltamethrin – PQ listed in December 2018) there are three PQ-Listed longer-lasting insecticides with non-pyrethroid modes of action, which should all be used.

- It was asked if insecticides are exchanged between two districts, and how this would be handled at a programmatic level, or if they are kept for use in a later rotation what would be the expiry period. It was clarified that the insecticides are not kept from year to year; they are ordered as needed for each campaign with a small buffer stock.
- It was asked what the cost implications are of using the new insecticides. It was responded that the use of IRS reduced considerably when the pyrethroids were phased out and the more expensive products introduced, Actellic®300CS or SumiShield™ 50WG have been introduced with co-payment support, and their costs have thus been temporarily reduced as volumes increased. The Global Fund is buying in increased quantities.

*Smooth deployment of more than one insecticide in IRS, experience from the field - Jocelyn Ratovonjato, NMCP Madagascar*

In Madagascar there has been geographical spread of resistance to pyrethroids in malaria vectors, and *kdr* mutations have been detected. Given that the WHO recommends the pre-emptive rotation of more than one insecticide for IRS as a strategy for insecticide resistance management, and there is no recorded resistance to the active ingredients of Actellic®300CS or SumiShield™ 50WG, the Malagasy government recommended the change of insecticides in two districts. These products were deployed in collaboration with PMI VectorLink. For 2019 there is a plan for the mixed and simultaneous use of insecticides: Actellic®300CS in two new IRS districts, SumiShield™ 50WG in two old IRS districts, and Fludora Fusion in one new IRS district.

*Cost effective approaches to IRS: Partial IRS applications - Aklilu Seyoum Abebe, PMI VectorLink*

Widespread resistance in Ghana has limited the use of some insecticides, so Actellic®300CS has been used in recent years, but there is a clear pattern of IRS coverage reduction due to costs. A cost-saving approach is therefore needed. As part of their initiative, they have evaluated if there is potential to use a partial spray schemes. Experimental huts were partially sprayed to assess if there is any impact on efficacy compared to a full spray scenario. The partial spraying scheme consisted of spraying either the upper half or the lower half of the hut, with or without spraying the ceiling. At baseline, the ceiling was the most preferred resting location inside the hut and outside, the top part from the veranda was preferred. After spraying, the fully sprayed house resulted in the highest mortality, but spraying the upper or lower part of the wall, together with the ceilings, resulted in a level of mortality that was not inferior. A lower level of mortality was seen when the ceiling was not sprayed. This partial spraying could have substantial cost savings, but a small scale field pilot study is needed.

- It was clarified that spraying only the ceiling was not included as a treatment arm in these experiments. A previous study also indicated that ceilings were preferred in huts, but this was not always the case in field conditions.
- It was asked if the WHO has any guidelines regarding ceiling-only spraying in experimental huts. It was commented that most people are moving towards corrugated iron ceilings, and spraying this type of ceiling has not been recommended in the past, but should be investigated further now.
- It was commented that work with other insecticides, that are non-volatile, sprayed onto ceilings only caused a 10-15% reduction in malaria, whereas walls and ceiling gave roughly 60% reduction. Further, Actellic®300CS has a vapour action, so there may not be a clear

correlation between areas sprayed, but with pyrethroids there is a clear correlation between areas covered and the mortality effect.

- It was clarified that the walls are cement, and the roofs have a thick polythene material.
- It was commented that mortality dropped quite quickly in this study (40% mortality after 13-14 weeks). It was responded that hut assays are different from cone bioassays, with the mosquitoes having relatively little contact. Further, there might be delayed mortality, so the results are not indicative of a short lifespan of the insecticide. It was commented that there are lots of other conditions to think about including species, material, temperature, and humidity, so it is important to consider these factors in small scale studies.
- It was commented that cost savings will come from the use of less insecticide, but also from time saved in not having to move furniture and possessions out of people's houses, as it may be possible to just cover these.

*Using the DHIS 2 platform to standardize data collection and reporting for IRS - Meghan Tammaro, VectorLink*

DHIS 2 (District Health Information Software 2) is an open source platform for data entry, analysis and dissemination that is helping VectorLink with improved project monitoring and informed decision-making. VectorLink Collect is the standardized project database that will house all project IRS and entomology data. It allows for data visualisations, so users can see the most up to date data, such as progress with IRS coverage and total population protected, and it is inter-operable, so Ministries of Health, which have at least a pilot GHIS 2 system, can easily pull VectorLink data into their systems. For entomological monitoring, DHIS 2 builds on standardized entomology data collection forms to minimize interruptions to data analyses, and is configured to align with the WHO entomology module.

*Increasing the use of data in IRS decision making - Megan Littrell, VectorLink*

For IRS decision planning, VectorLink makes use of multiple streams of data including disease surveillance, entomological, coverage, climatology, national and global guidance, and intervention costs. However, there are barriers to data use, such as data not being easily accessible or not summarized at granular levels optimal for planning. PMI VectorLink aims to address these barriers and support national level planning through stakeholder engagement to identify key questions and existing datasets, then developing a dashboard with visualizations to facilitate data review meetings for decision-making. They also build capacity in data review and visualization. The dashboard they have developed can display, for example, types of LLINs that have been distributed and insecticide resistance data. Having recent data like this will become increasingly important as more product options become available and rotations are introduced. When coverage data are brought together with malaria burden and risk data, it is possible to identify areas where there might be special issues such as high coverage and yet high burdens remain.

- It was asked why one of the health facility catchment areas in Zambia had 275% of the population protected by IRS. It was responded that denominators are a challenge because the choice of population estimates can affect their indicators, and this catchment area has been flagged because of an issue with the population denominator. It was commented that this likely relates to politics, with population estimates being altered around times of elections.

*Simple spatial intelligence approaches to optimize IRS planning, implementation and impact – Derek Pollard, Akros*

A concern in vector control is whether operations are not finding some houses, leaving communities unprotected. Spatial data suggest that many structures are not identified, so there is an overestimation of spray coverage. To address this problem, satellite images can be obtained, onto which all sprayable structures can be marked, allowing an accurate denominator of total structures to be established. The marked satellite image can be used in a data collection tool (mSpray) to help field operatives to navigate to all structures. The satellite mapping can also be verified by the operatives, so that the denominator becomes more accurate. When spraying has been completed, the tool can highlight those areas that need additional spraying and guide managers through the decision-making process to recommend where mop-up visits are needed to protect a community. Preliminary findings from Zambia suggest that this tool was associated with a significant reduction in confirmed case incidence through achieving overall higher household coverage.

- It was asked if the definition of coverage could play a role in the coverage. It was responded that the definition invokes a lot of debate. Field verification in the first visit to the community is important, whether this is registration for ITNs, IRS or MDA.

*Insecticide resistance in the main malaria vector in Sudan - Ayman Ahmed, University of Khartoum*

Sudan is considered a high-burden and high-risk country for malaria and its control programme relies heavily on IRS and ITNs, with organophosphates and carbamates the most commonly used insecticides. Resistance *of Anopheles arabiensis* to Malathion (5%) and bendiocarb (0.1%) was determined across the three ecological zones of the country. Insecticide resistance of the Sudanese population of *An. arabiensis* was found to be heterogeneous: mortality rates were 21% higher in urban areas than peri-urban areas, but there was no difference in mortality after exposure to Malathion. Resistance to bendiocarb was reported in the Red Sea region. The absence of *Ace-1* mutation in the population of *An. arabiensis* across all states was confirmed, with investigations ongoing into the possible involvement of cuticle resistance. Investigations of the temporal and spatial variation of IR are recommended, with coordination of both the ministry of health and ministry of agriculture to help improve IRM.

*Windows of selection: how do we expect selection pressure for insecticide resistance to change in the months after spray and net deployments? - Andy South, Liverpool School of Tropical Medicine*

When an insecticide is deployed there is a high concentration shortly after application, and over time the concentration decreases. Initially, the concentration may be strong enough to kill resistant strains, but as time passes the mortality of these strains also declines. More susceptible strains, however, continue to be killed, until the insecticide concentration becomes very low. At this point there is no evolution of resistance. A 'window of selection' has been established. This window of selection can be seen in experiments exposing *An. gambiae* to deltamethrin, with the WHO diagnostic concentration of 0.05% showing the greatest difference in mortality between resistant and susceptible strains, and is supported in the literature. There is also a 'window of dominance', where the mortality of susceptible homozygotes is greater than that of resistant/susceptible heterozygotes. Selection of

resistance is expected to be greatest within this window of dominance. This highlights the importance of using high doses to kill heterozygotes.

- It was commented that the behaviour of the heterozygote needs to be considered as well, and this can differ depending on the bioassay system used to measure dominance. A heterozygote can be semi-dominant in a fixed exposure bioassay, but in a different assay system where free behaviour can take place, the relative dominance of the heterozygotes may change dramatically. The heterozygote can display a dominant phenotype by minimising contact with the insecticide, hence not picking up enough to kill it.

*IRM MOOC update - Mark Hoppé, Syngenta Crop Protection AG*

The insecticide resistance management massive open online course will provide participants with a solid grounding in best practice in IRM in an integrated vector management, and resource constrained, environment. Everything is in place for the development of the MOOC but funding is sought ($80,000-100,000). The aim is to employ someone to support its production.

*Vector LearningXchange – Dereje Dengela, Abt Associates*

The Vector LearningXchange has reached over 6,800 users. In 2018, webinars were held in collaboration with various partners, and more are expected in 2019. New content will also be introduced on the website, including country-specific entomological data. They will facilitate best cross-country collaboration among vector control stakeholders, and are sharing documents such as training and study materials for best practice. They are reaching out to VCWG members to get feedback on how to better serve the vector control community and provide the most useful content.

*Work Stream discussion and feedback - Dereje Dengela, Abt Associates & Mark Hoppé, Syngenta Crop Protection AG*

- It was commented that some of the online tools will be wonderful to help with the distribution of new LLINs.
- It was commented that the LSM and IRS IRM work streams are working in parallel. Given that changing the insecticide affects the resistance of insects, LSM could become part of IRM and remove some of the challenges it faces as a vector control tool. It was responded that resistance management can only take place in an integrated resistance management system.
- It was commented that some historical challenges are becoming less challenging, such as the rotation of insecticides and this is encouraging. The data management planning tools show that the ability to capture data is increasing, and the missing of structures in IRS programmes shows that there is room for improvement.

Proposals for work stream packages going forward were invited. For further information, have a look at the complete IRS/IRM work stream work plan 2019/2020.

# 6th Vector-Borne Diseases and the Built Environment Work Stream meeting
# 14:30-18:00, Wednesday 31st January 2019
# Co-leaders: Steve Lindsay & Lucy Tusting

*Welcome & review of 2018-2019 - Lucy Tusting, London School of Hygiene & Tropical Medicine*

The work stream's name has been changed from 'Malaria and Housing' to 'Vector-Borne Diseases (VBD) and the Built Environment' to recognise its broader scope of work. The objectives of the group are to bring together housing and VBD specialists, identify which interventions work, and develop methods for scaling up interventions. The main mechanism for this work is currently through the BOVA network (Building Our Vector-Borne Diseases in Africa).

*BOVA network update (Building Out Vector-Borne Diseases in Africa) - Steve Lindsay, Durham University*

The BOVA network (Building Out Vector-borne diseases in Africa) was introduced by Steve Lindsay. The network is a multidisciplinary research network headed by Steve Lindsay and Mike Davies at University College London. Its activities include pump-prime funding, global advocacy, annual open network meetings for information exchange and grant writing workshops. Small-scale housing research projects that have been funded include looking at ways to reduce aquatic habitats in urban sites, the impact of new flooring on tungiasis, a modelling proposal to look at how air moves in houses and how the height of a house might affect mosquito entry. These projects aim to make the built environment more resilient to VBDs. The first annual meeting was held in London in March 2018 and BOVA was represented at MIM Dakar. The second network meeting is planned in UNHabitat Nairobi, 4-5th April 2019 and all are welcome.

*Research updates:*

*1. House entry of Anopheles gambiae changes according to building design - Steve Lindsay, Durham University*

Most malaria transmission in sub-Saharan Africa occurs indoors and at night. The main route of vector entry is through the open eaves. The challenge is to keep malaria vectors out while keeping houses cool so that people will sleep under a net. The importance of roofs, windows and doors has been assessed through experimental hut studies in the Gambia. Five different types of house were made, with either thatched or metal roofs, open or closed eaves, or screened or poorly fitting doors. Volunteers slept inside these, and over a five week period the houses rotated in position through a Latin Square. Mosquito entry and indoor temperature and relative humidity were monitored. It was found that closing the eaves reduces mosquito entry in thatched-roofed houses but not metal-roofed houses, screening doors or windows at night will help keep the house cooler at night, and screened windows may help reduce mosquito house entry if used in combination with solid doors. No insecticide was involved.

- It was asked, given that people living in metal roofed houses tend to be in higher income groups, and generally have better houses, whether experimental houses offer a realistic model. It was responded that these initial studies have just explored the basic components

affecting mosquito house entry. The other factor to consider is human behaviour. A well-screened house may not be effective if people open the doors frequently.

- It was commented that people in some countries leave their door open for cultural reasons, and in Tanzania studies have shown that doors left open allow three times more mosquitoes to enter compared with houses with closed doors.

*2. Repellent ribbons along open eaves - Arnold Mmbando, Ifakara Health Institute*

In Tanzania the economic transition has allowed people to change their types of housing, but many people still live in communities with open shacks that are often far from health care facilities. Simple and low cost interventions are needed. Strips of hessian impregnated with transfluthrin (eave ribbons) have been tested in semi-field and field settings. Eave ribbons significantly protected against outdoor and indoor biting malaria vectors and offered protection against Culicine in the field. The ribbons cost approximately $7 per house and can protect more than two people. They can be scaled up easily, and used in urban and rural settings. They require no energy for use, and do not confine people to specific behaviours; people can still be active around the outside of the house while being protected.

- It was clarified that the treatment can last for 6 months without retreatment.
- It was asked if mosquitoes were diverted to other houses, and if they have plans for follow up studies on a larger scale. The diversion effect was not studied here, but it is being investigated currently. They would like to scale up and look at malaria transmission as an outcome.
- It was asked if people should be advised to re-use old bed nets to make ribbons. It was responded that it would be possible to do this, but the efficacy would be less than with hessian. Previous studies showed that impregnation on plastic only lasted a few weeks, so a net would need more frequent re-treatment. Re-treatment costs had not been studied, but are expected to be less than $7. One just needs to remake the chemicals, so it may cost $3-4.
- It was asked if pyrethroid resistant mosquitoes get past the ribbon. A laboratory assessment with susceptible *An. arabiensis* showed more than 90% mortality, but tests haven't been conducted with *An. funestus*.

*3. New designs for poor communities: the CUBO house- Earl Forlales, CUBO*

CUBO is a bamboo mosquito-screened house that provides a potential low-cost housing solution for The Philippines. It is up to 3.8 times cheaper than concrete houses. Engineered bamboo is processed bamboo that is treated and lasts for up to 50 years internally and 25 years externally, much longer than raw bamboo. The houses are designed with larges windows and doors to allow ventilation and rainwater is directed for use by the household. These houses were introduced to meet housing shortages, but can also build out VBDs. There have been changes to the design such as closed ceiling space, screened windows and doors to prevent mosquito entry.

- It was commented that this challenge to orthodoxy could help to build out malaria. Investment in housing is already happening. The population of Africa will increase by 1.2 billion by 2050, so there are huge opportunities to improve housing.
- It was asked what the approximate costs are for the materials and labour in the Philippines. It was responded that it costs 167 Euro/$m^2$. A 14 $m^2$ house was shown.

- It was commented that a simple framework to compare costs (e.g. annualised cost per person protected) would be very helpful for this. Otherwise it is difficult to compare interventions. A common metric is proposed.
- It was clarified that studies have not been done with different colours to see if it makes a difference to mosquito entry.
- It was asked if these houses have strong foundations, so would be able to stand up against hurricanes. It was responded that the bamboo foundations are very strong and withstand typhoons in Philippines. The house is fixed strongly to the ground.
- It was clarified that social specialists have only been used in the Filipino market. For other countries, traditional housing will be studied and modified in order to provide a solution that is culturally and socially appropriate.

*Discussion:*

*House design recommendations for vector control: what do and don't we know? - Steve Lindsay, Durham University, & Lucy Tusting, London School of Hygiene & Tropical Medicine*

Steve Lindsay opened the session and invited work stream members to generate specific recommendations for good housing practices.

- It was commented that a randomised controlled trial in Ethiopia shows the effect of house screening, but in some rural communities people prefer to leave doors open for good luck or to allow chickens to enter. In urban communities the practices are different because people keep the doors closed because of concern about thieves.
- Human behaviour was noted as an important factor, as doors are opened frequently until midnight, and this allows mosquitoes to enter. Field studies show that self-shutting doors can reduce mosquito entry by two thirds.
- It was commented that in another study, odour coming from screened windows was found to attract the mosquitoes and fewer go towards the door. Screening windows and doors will help keep the house cool at night. The efficacy of screens may be improved though insecticide treatments. Insecticides are degraded by UV light, so they would lose their efficacy, but it might be possible to target mosquitoes on the way out as unfed mosquitoes are attracted to early morning light.
- It was commented that house screening is being driven on the basis that it is cheaper to do this than to build a better house, but these need to be replaced multiple times, so it is still expensive. If it is accepted that public health is expensive, perhaps more expensive houses should be build and the improvements will be permanent. Putting an expensive door on a mud house isn't a permanent solution. In many cases it is more efficient to build a complete house from scratch.
- It was added that the designs exit, such as in tourists camps where there are traditional housing that is made permanent. It is possible to make African houses permanent if there is the will.
- It was clarified that there are different tiers of interventions that could be introduced, according to the wealth of the house owner, until people can afford the ideal house that they would like as their economic status improves.

- It was commented that philosophically there is support for the idea for permanent housing, but there are constraints in terms of funding and reaching different sectors of the population. The Global Fund has confirmed that they will not fund housing improvements. There might be more traction by looking at existing donors and potential new ones who are interested in performance-related funding. Housing interventions are likely to be funded outside the health sector.
- It was discussed that there are other priorities, including health and education, so it is difficult to envisage a Marshall Plan for Africa. If there are not the means to build houses for every African, houses can be improved when projects are funded that affect them, such as dam requiring resettlement. Recommendations could be submitted to the African Development Bank (AfDB) for inclusion operational safeguards.
- Attendees were invited to contact Lucy Tusting to contribute to a one-page summary of ideas.

*View from the countries: How do the health and building sectors link at local level? How can protective house designs be incorporated into local architecture? Led by Steve Lindsay, Durham University, & Fredros Okumu, Ifakara Health Institute*

Two main approaches were discussed: (1) incremental and (2) more permanent solutions.

- It was commented that, from the AfDB perspective, there is no requirement for scaling up; they are interested in the best practices. Where people are relocated for dam projects developers are asked to scale up the houses in terms of wellbeing and vector control, thereby improving the livelihoods of people. The learnings from each project are transferred to the next project that is funded. It was proposed that experts in this area be named on the website to provide advice. This would be welcomed by AfDB and by the implementing countries that could use this expertise.
- It was clarified that the GVCR recognises the build environment, agriculture, and education; there is a need to link these together and get people from different fields to talk to each other.
- It was commented that there are differences between effects at your own household level and community level. Blocking the eaves has an effect on your own house, but insecticide screens on windows might only have an effect if everyone has one, because the effect of each one is quite small. Local architects are needed to ensure they are of suitable design.
- It was added that meticulous planning is needed: calculate how many screens need to be manufactured. Go to a mass-producing country, then bring the cost down through mass production. Planning sufficiently ahead allows these to become available. Working with a consumer company to develop packages that have eaves curtains, small and large window screens, and door curtains could be effective, then combine with education and community clean-up.
- It was noted that people are already making a lot of improvements by themselves, and a small subsidy or support could really help them. To make the ideas more attractive to investors they could be connected with climate change, or health and sanitation improvements.

- It was asked if local by-laws could be used to ensure better housing quality. In some cases including charging fines if an inspector finds insects inside people's homes, but subsidies might be needed to help people to avoid these charges.

Lucy Tusting and Steve Lindsay will be in touch with members of the work stream about these recommendations.

Priorities for 2019-2020:

- Make recommendations on 'good' housing practices for screening houses against mosquitoes, keeping the house cool, and the peri-domestic environment free from mosquitoes.
- Provide a list of experts willing to provide advice to those in the housing sector.
- Identify different models for scaling-up interventions.

For further information, please have a look at the VBDs and Built Environment work stream work plan 2018/2019.

# Day 2: Thursday 31st January 2019

## Session 2: Keynote presentations
## Chairperson: Keziah Malm

### *Keynote presentation*

***Mapping changes in housing in sub-Saharan African from 2000 to 2015 - Lucy Tusting, London School of Hygiene & Tropical Medicine.***

A halving of malaria prevalence from 2000-2015 was driven by bed nets, antimalarial drugs, and IRS, but these three interventions cannot alone explain the full decline. There are many other factors contributing to malaria reductions, and evidence suggests this is from economic development. Poverty and malaria are so closely related because of housing quality. Closing eaves, screening windows and having well-fitted doors can reduce mosquito entry. A systematic review revealed an association between modern housing and malaria infection. There are almost 50% lower odds of infection with good housing. In addition, bed nets were used as a comparison against housing. Benet use is associated with a 17% reduction in malaria in children, while housing is associated with a 14% reduction. Further, the changes in housing in sub-Saharan Africa were quantified through analysis of data from 62 household surveys comprising over 660,000 households in 31 countries. It was found that the prevalence of improved housing doubled from 11% to 23% between 2000 and 2015, and a pattern of housing improvements was revealed: first roof then walls then floor. Unimproved sanitation remains the most common deprivation. The transformation of housing in Africa is a huge opportunity for vector control.

- It was commented that the map of changes over time shows development in Africa. By 2050 there will be 1.2 billion more people in Africa so there is an opportunity to exploit for the sale of screens, nets that do not tear, treated nets, and doors to make better safer homes.
- It was asked if the effects shown were individual household effects or a community effect of fewer harbourages. It was responded that in the Gambia it has been shown that where there are lots of metal roofs you have less mosquito survival; there is an individual and community effect.
- It was asked who will pay for these interventions. Improvements to housing are related to other health outcomes and security and educational gamins, so there is a strong argument for housing as a public health intervention.
- It was asked, given economic development, how the stall in malaria reductions can be explained. There is clearly something else going on contributing to this.
- It was commented that closing the eaves will allow smoke to increase indoors. Two studies (Africa and India) show that this can lead to an increase in lung and throat diseases, so better ventilation of windows is needed. Air flow is also important for dissipating host odours so the house overall becomes less attractive.

# 4th New Tools, New Challenges in Vector Control Work Stream meeting
# 09:00-12:00, Thursday 31st January 2019
# Co-leaders: Fredros Okumu & Allison Tatarsky

***Welcome, objectives, overview of 2018 activities, and work plan - Fredros Okumu, Ifakara Health Institute & Allison Tatarsky, University of California, San Francisco***

Fredros Okumu and Allison Tatarsky opened the session and reviewed work stream objectives. The first project in 2018 was focused on mosquito ID, which came about through molecular and morphological ID mismatches. This work is on-going and described further below. The second project in the 2018 work plan was around the definition of residual transmission. Tessa Knox led the process in redefining the definition, which has now been updated in the WHO Malaria Terminology document. Third, draft guidelines for measuring and characterising residual malaria transmission are being prepared. This has included transmission studies that have been incorporated into guidelines to make cross-sites comparisons. Related to this is a publication reviewing human behaviour as it relates to mosquito behaviour and residual malaria transmission. Finally, a systematic literature review of the expanded vector control has been completed and published.

***Work plan updates on mosquito ID and emerging challenges***

***Mosquito ID: improving morphological and molecular ID - Fredros Okumu (on behalf of Neil Lobo, University of Notre Dame/University of California, San Francisco & Seth Irish, U.S. Centers for Disease Control and Prevention)***

Malaria mosquitoes are often wrongly identified morphologically, and as a result return inaccurate results when subjected to PCR for ID of sibling species. For example, some members of the *Anopheles funestus* group if wrongly classifies as *An. gambiae* complex may be identified by current PCR protocols as being *An. arabiensis*. Identification in advance of interventions is important to assess receptivity, insecticide susceptibility, and vector behaviours, which can inform intervention choice. Key characteristics of a mosquito, such as scales, can be altered or lost if the mosquitoes are stored, and many species are cryptic. The keys made in South Africa are widely used, as well as the Walter Reed keys, but a lot of training is required to use these. The team is creating a guide and protocols for collection and preservation and associating morphological ID with molecular ID, including DNA sequencing. An appeal was made to people with specimens that they are willing to share. They are also looking for funding for sample collection and ID.

- There was a suggestion that these efforts can feed into the revision of the 1975 WHO practical entomology guide.

For a detailed account, have a look at the complete work plan 2018/2019.

***Key to the females of Afrotropical Anopheles - Basil Brooke, University of the Witwatersrand***

The work of Maureen Coetzee was presented. The dichotomous keys of Gilles and Coetzee (1987) are being updated. The line drawings are still preferred because high resolution images may not represent what people see in the field. The draft revision includes a small number of newly described species. It is for the morphological identification of female *Anopheles* that does not supersede any

molecular identification. People are encouraged to take the keys into the field and provide feedback to Maureen Coetzee. Everything starts with accurate morphological identification, particularly for malaria vector surveillance because of the species complexes. Relying too heavily on molecular ID without morphological identification can lead to errors in identification. Basil Brook indicated that he could share electronic versions of the revised keys as well.

- It was asked if there is anything being done on Culicine identification. It was responded that they are focusing on Afrotropical *Anopheles*, but there are other people looking at keys for *Culex* and *Aedes*. The guides for *Culex* species of SE Asia are being revised. It is the most difficult group.
- The 1975 manual for practical entomology is being revised, which can include these updated resources.
- It was commented that line drawing really help amateur naturalists. Mark Rowland can put them in touch with some illustrators to produce good line drawings.

*Mosquito ID: PAMCA genomics project- Alistair Miles, Wellcome Sanger Institute, & Prosper Chaki, PAMCA/Ifakara Health Institute*

A new partnership between the Wellcome Sanger Institute, Bill & Melinda Gates Foundation and PAMCA will support nine new projects, which will collect mosquitoes and generate genome sequence data from a range of settings and countries across sub-Saharan Africa. There is currently the capacity to sequence 10,000 *Anopheles* specimens per year. Whole genome data can be valuable for identifying molecular mechanisms for insecticide resistance (IR), and where is it emerging and spreading to. Local groups collect mosquitoes and send ~50 for individual sequencing, genetic variation is identified, and used in population genomic studies. Data from the whole genome also informs the design of gene drive, and answer questions about IR. They can identify every known IR marker, as well as unknown markers. This allows them to make predictions about resistance profiles, and then link this with bioassay data. The dogma that there are four types of resistance is evolving as more mechanisms are being identified. All of this data can help programmes to decide where to prioritise interventions, and when to use rotations or mosaics of insecticides. All data will be openly available and made public as soon as possible. PAMCA will use this as a vehicle for the generation of new data and to improve surveillance. PAMCA also wants to strengthen these networks to train the next generation of entomologists.

- It was commented that having morphological collections at the same sites would be very helpful. PAMCA will be organising the tools and data capture systems to allow this and will link to the work of Neil Lobo and Seth Irish (above) as they develop ID protocols. The Gates Foundation specifically asked for morphological identification.
- Linkages between these and other on-going activities in local capacity building were emphasized.

*Mosquito ID: LabDisk - Nadja Wipf, Swiss Tropical and Public Health Institute*

There are several different methods for molecular diagnostics of malaria vectors, and these require reagents and other supplies. A LabDisk comes as single platform with all consumables pre-stored on it. It is an automated diagnostic platform that allows for straightforward data interpretation. After sample loading, the disk is placed on a reader. The samples travel to an extraction buffer, and DNA and RNA are extracted, then primers are added for a triplex TaqMan qRT-PCR, which is run for species

identification. The PCR can also determine whether the specimen is positive for malaria or filariasis parasites, and determine target site or metabolic resistance against insecticides. There are primers for *kdr*, cytochromes P450, and GSTs. The data collected are incorporated into maps.

- It was clarified that when more than one specimen is loaded an estimation of the proportion of each species in the pool is given. The allele frequency of mutations can also be observed. It should also be possible to use just part of an individual mosquito.
- It was asked if the pathogen identification give an indication of the lifecycle stage, since any *Anopheles* can be infected but not necessarily infective. The pathogen assays distinguish between the species or *Plasmodium*, and two RNA markers are used for sporozoites, to indicate if the mosquito was infective. They have the same for *W. bancrofti*.

***Plasmodium knowlesi spread: experiences of Pk vector surveillance and control in Malaysia - Christina Rundi, Ministry of Health Malaysia***

After five decades of the malaria control programme, Malaysia decided to aim for elimination. They have not had any indigenous cases in the last year, although cases of *P. knowlesi* are on the rise. Zoonotic cases were typically associated with forest activities, but now they are peri-domestic. *An. balabacensis* is one of the main *P. knowlesi* vectors, which rests and bites outdoors. Changes in land use patterns bring people close to the natural reservoirs of *P. knowlesi.* Risk factors include open roofed eaves and gaps in the wall. Residual spraying within the last six months has been shown to reduce the odds of infection. Prevention and control include surveillance, IRS, ITNs and larviciding, as well as outdoor residual spray (ORS) ongoing in Sabah and Sarawak. ORS was initially used for dengue control and is now being tried for malaria control.

- It was asked if the rise of *P. knowlesi* meant that Malaysia should forget about trying to eliminate malaria. It was responded that *P. knowlesi* has an animal host so it is not possible to get down to zero cases in humans unless the animals are treated. Malaysia is aiming for <1 case of *P. knowlesi* per 1,000, and elimination of human malaria.
- A parallel was drawn between *Pk* and Monkeypox, which occasionally appears despite elimination of small pox.

***Genetic engineering technologies. Oxitec: extending validated Aedes technology to Anopheles, progress and next steps - Enca Martin-Rendon, Oxitec***

First generation and second generation technologies work in the same way to suppress populations of mosquitoes, but the second generation has advantages: male progeny can mate and pass on the self-limiting gene to a proportion of their own offspring, so there is increased performance. In addition, insecticide susceptible genes in Oxitec males can dilute insecticide resistance genes in the wild. There are two genes: a self-limiting gene and a fluorescent marker gene. The fluorescence marker is much stronger than in the previous generation, and is visible in all life stages, which allows it to be more easily monitored in the field. Experimental data show that the self-limiting allele declines over time and becomes extinct after 5-6 generations. Second generation self-limiting mosquitoes are being deployed in Brazil with data expected in May 2019. Oxitec then plan to run more extensive trials. Strains of specific self-limiting *Anopheles albimanus* and *An. stephensi* are being developed.

- It was commented that IRS will likely kill released mosquitoes, but bed nets may allow for IR dilution because only the females will touch the insecticide on the net. It was added that most males are outdoors, so this should not be a concern.

*Target Malaria (population suppression): overview, progress, and next steps - Abdoulaye Diabate, Institut de Recherche en Sciences de la Santé, & Mamadou Coulibaly, University of Sciences, Techniques and Technologies of Bamako*

Genetically modified mosquitoes have never been tested anywhere in Africa. Target Malaria is a non-for-profit consortium working in Africa on two broad approaches. A mosquito population suppression approach relies on releasing genetically modified mosquitoes into the field. When they mate with wild type mosquitoes, the population will decline. The population suppression strategies being used are a driving Y chromosome method, in which all progeny are males, and a gene knock-out method. The second broad approach is population replacement, wherein the gene of interest spreads throughout the population, such as a gene that inhibits *Plasmodium* transmission.

The pathway is full of challenges, including legal, ethical, and safety issues. A step-by-step approach is being used from sterile male to the self-sustaining system, testing in small cages, large cages, contained use, and then small scale open field release if they have approval. There is resistance in Africa, and there is a strong civil society that could oppose the technology. To engage people, they started at the village level and moved up the hierarchy in society.

- It was asked if bordering nations or the African Union have any issues with this research. It was responded that the technology needs to be owned by Africa. The African Union have solar panel technology and gene drive technology. They have already been engaged and believe this is something that Africa needs.
- It was commented that there are cases of devastating consequences of new species introductions. This kind of interaction between species has been looked at in detail. There is no published research showing that predators rely on just one species of mosquito. Across the world there are 4,000 species of mosquito, and this work will affect just limited species.

*UCI Malaria Initiative (population replacement): brief overview - Rebeca Carballar and Anthony James, University of California, Irvine*

Presentation provided by video but unfortunately was not playable, but can now be accessed on the RBM VCWG website under: www.endmalaria.org/events/4th-meeting-new-tools-new-challenges-work-stream.

*Integral gene drive: Mosquito population replacement and malaria transmission blocking - George Christophides, Imperial College*

Integral gene drive is a concept that is being developed for the Transmission Zero project. They plan to replace wild mosquitoes with those that cannot transmit malaria. To make mosquitoes that are refractory to parasites, there are two parasite population bottlenecks that are being targeted, and the molecules involved in these processes are well studied. The traditional approach has fitness costs on the mosquitoes, and they can die before they produce enough progeny to continue the drive. In their proposal, the drive and effector are independent, so they can be tested in the field separately, with effectors that are not being driven. The drive can then be introduced. Further, the system allows for non-random insertion of the gene construct, which is much smaller, and they can have multiple drives and multiple effectors operating at the same time. Anti-microbial toxins are coming from diverse species, such as from scorpion, fungi and frog that can target the parasite molecules that help them to evade the insect immune system. They plan to test in the field before deployment, and so

developed mobile containment level 3 insectaries. The next phase will include the testing of these mosquitoes in the field in small-scale releases.

- It was asked how they will deal with concerns about mosquitoes with scorpion venom, and whether these mosquitoes could evolve in unfortunate directions. It was responded that it is major undertaking to engage the community. They believe they have the scientific knowledge to address concerns and are doing the risk assessments, and need to demonstrate that the drive mechanisms will not jump into other organisms.
- It was clarified that, apart from sterile male techniques, these technologies have not been used in agriculture, but this might be a turning point.

*Roadmaps for new vector control tools:*

*The bite prevention roadmap – new strategies for bite prevention and lure and kill strategies - Sarah Moore, Ifakara Health Institute/Swiss Tropical and Public Health Institute & Jason Richardson, IVCC*

Two volatile pyrethroids have generated interesting evidence over the last decade, and analysis is on-going for an emanatory product, but evidence overall is lacking. However, there are a number of funders looking at this area of product class, and there is a large consumer market, particularly in Asia.

Generating evidence is critical, and must include validated test methods that people agree on. If bite prevention products form a product class that donors are investing in, it is important that there is not just one active ingredient (AI); there needs to be investment in screening new AIs, so that there can be rotation and resistance management.

Bite prevention strategies can stop you being bitten, and can be used by mobile populations. However, epidemiological evidence for their efficiency is required for VCAG to form a new product class for these. Currently, it is known that topical repellents do not show efficacy because of compliance issues, and there is a large heterogeneity in results from studies with mosquito coils. A Cochrane review was produced, in which it was concluded that topical and insecticide-treated clothing may be useful to specific groups. Bite prevention products can work by confusing the mosquito, repelling the mosquito, or prevent it getting to the host by killing it. Efficacy needs to be at least 70%, but 100% for 6 months would be desirable for a product profile, and it is desirable that it kills vectors. Transfluthrin kills more mosquitoes than metofluthrin. Bite prevention can be improved indoors and outdoors through the use of repellents in the eaves. Transfluthrin applied to a cellulose matrix in the eaves has a long lasting efficacy, and can kill mosquitoes at a distance from the house. With regard to insecticide-treated material, etofenprox lasts for over 75 washes, and could be very useful for mobile populations. It kills mosquitoes, so could have a community effect for displaced populations. For long-lasting topical bite prevention, large reductions in malaria can be achieved only with very high efficacy and compliance. Fatty acid compounds from coconuts applied to the skin can last for a whole week, which might be an acceptable option for consumers and only need application once per week. There are guidelines for spatial repellents and clear guidance for skin repellents, but the same endpoints for bed nets and IRS could be used, such as whether the mosquito is alive or dead, fed or unfed.

- It was asked, given that the two main scenarios are long-term use for community impact and short-term use for personal protection, what are the potential for use over 3-4 nights for forest workers in the GMS. It was responded that compliance for a few nights is good, and we

know that repellents prevent bites, so these products are suitable for these groups. The long-lasting repellents could be very useful in these scenarios, as well as treated clothing. They might be particularly important in low transmission areas.

- It was clarified that coconut oil is food grade, so the toxicology aspect will be straightforward, but it will be necessary to check the next steps with the USDA.
- It was commented that the public health benefits of topical repellents are very context specific, but it is also important that people do not conclude that topical repellents are ineffective.

*The ivermectin roadmap - Carlos Chaccour, ISGlobal, & Regina Rabinovich, ISGlobal/Harvard T.H. Chan School of Public Health*

In the context of residual transmission, new tools are needed. Ivermectin could be made a complementary tool to reduce malaria disease burden, accelerate elimination, and reduce vectorial capacity through introduction into humans and/or cattle. The roadmap aims to create a critical path towards the target product profile in at least two different settings and develop the regulatory pathway. A group of experts was gathered and seven work streams were created. The main use scenarios for ivermectin have been identified. All are in a high transmission setting, and in each case it is a complementary tool. Six trials involving ivermectin have been mapped that are happening at the moment in the Gambia, Burkina Faso, Mozambique and Tanzania, Guinea Bissau, and Thailand, which are expected to generate evidence in the next three years. They differ in dose and regimen. Modelling has shown that three rounds of mass drug administration with ivermectin alone reduce the peak of transmission. In a theoretical impact analysis involving 20 African countries, with a pilot that covers 5% of the at-risk population and 3% added each year up to 2027, it is projected that up to 167 million people would be protected. Adding a veterinary target would increase the killing effect, particularly in vectors that switch between humans and cattle. This would provide an opportunity to use longer-lasting formulations. There are strategies to evaluate risk of resistance and environmental impact, and to maximise community engagement and understanding.

- It was clarified that a roadmap approach allows them to get different stakeholders to communicate and align with each other. A research agenda is included in the roadmap agenda, as well as timeframes.
- It was commented that a problem with ivermectin is that it has a short half-life and a high dosage is needed. It was asked what happened with the project in Montpellier where a sustained release polymer is being developed. It was responded that this is for cattle. It releases the active ingredient over months. Modelling shows that even with a short half-life and the standard formulation there is a big impact.
- Carlos and Regina also mentioned that UNITAID was considering an award to an ISGlobal Consortium to conduct trials on ivermectin in two African countries, Tanzania and Mozambique.

A survey will be sent to all members to try to help the work stream manage this space, such as tracing an inventory of products, a consolidation of roadmaps, and addressing emerging country priorities.

Fredros Okumu announced that he will step down as co-chair and welcomes a volunteer to take over with Allison Tatarsky.

## *Keynote presentation*

### *Increasing the involvement of women in vector control - Mary Hayden, University of Colorado*

A project has been run with the aims of understanding the current role of women in vector control, and identifying strategies to increase the involvement of women. Indonesia and Kenya were used as project field sites, with a mixed methods research approach that included an online stakeholder survey, focus groups and key informant interviews with ministries, community leaders and vector control workers, a cross-sectional household survey, and stakeholder workshops. The online survey revealed perceived gender roles in vector control, with pesticides, vector collection and oversight seen as male role, and selling PPE and providing education considered females roles. Stakeholder-perceived barriers included a lack of awareness of career opportunities, and cultural norms were also noted as being restrictive. Protective clothing not fitting women was frequently mentioned, as were concerns for having places to wash separately after IRS activities.

The best strategies to increase the number of women in vector control leadership activities were revealed as short courses and cross-disciplinary training, higher education scholarships, and mentorship programmes. The stakeholder workshops were held to bring together people from multiple sectors, and they worked out a consensus workshop to talk about the barriers to women, and what would be necessary to increase more participation. Some of the benefits of having women is that they can act as role models and have a diversity ideas. Women were seen as being more trustworthy and accountable, better communications and agents of change. Ways to overcome barriers, such as lack of training opportunities, no community acceptance, conflicting priorities and no policies to protect women in the workplace, include more training opportunities, women champions, and school based curricula to sensitize people to the idea of having women in these roles. Commitment by government leaders was also seen as important.

- It was commented that PAMCA has been doing something similar to increase female participation, so it would be good to compare notes.
- It was commented that there were interesting differences between Kenya and Indonesia. More in-depth analysis is being done, and the results are being published separately.
- It was asked what stakeholders can do. It was responded that getting council members involved was important, then working up to the government, ensuring they get people all the way up the ladder.

# 4th IVM, Evidence and Capacity Work Stream meeting and overview
# 14:30-18:00, Thursday 31st January 2019
# Co-leaders: Josiane Etang & Michael Macdonald

*Work Stream introduction - Josiane Etang, University of Douala, & Michael Macdonald, Consultant*

The work stream mandate is to generate and share evidence on integration of all vector control tools, including lessons from other regions and disease eradication programmes, and to work with WHO and RBM partners to build entomology and vector control capacity at all levels in endemic countries. Four basic elements to concentrate on for the 2018-19 work plan include a directory of training institutions, programmes and resources, build capacity to manage insecticide resistance in the African Region, share best practices for entomological monitoring and outdoor/residual transmission across regions, and improve vector control in humanitarian emergencies.

*The malaria capacity strengthening landscape - Konstantina Boutsika, Swiss Tropical and Public Health Institute*

To identify gaps in training and to evaluate the quality of training available, a WHO course repository tool is being developed. The tool needs to be user friendly and have a comprehensive design. Courses ranging from short courses to PhD programmes, provided by ministries, WHO, academic institutes were identified by online searches and discussions with malaria experts. For each course to be included on the database, a minimum of 20 training hours was needed. Ninety-five courses have been identified, the majority being in English. Two thirds of these courses were taught in person, but MOOCs are also becoming more popular. The next steps for this tool are to include the private sector, make the report available, maintain the resource and host it on the WHO website. A second tool was developed to identify the required level of malaria knowledge for key positions working at all levels of a malaria programme. Twenty one malaria experts have assisted, of which the majority are from the African region. A questionnaire was sent out, asking people at four levels of the health system to give information on their responsibilities, main functions, education requirements, hard skills, training completed and transferable skills. The tools need to be translated into French and Spanish, and then tested in high and low endemic countries. Input and ideas from members were welcomed.

- It was asked if courses in other languages will be translated. In response, it was argued that the ideal solution would be if the information of these courses could be extracted and translated. When the tool is available, people will be able to add their courses to it (with a quality control step in place).

*Modelling vector control interventions against malaria on Haiti - Tom Smith, Swiss Tropical and Public Health Institute*

Most field trials of the impact of vector control interventions against malaria have been carried out in Africa, but vectors elsewhere differ in key behavioural parameters. Mathematical models can be used to infer the likely impact of different interventions. The research started with a list of vectors, including *Anopheles albimanus*, the main vector in the Caribbean. Data for most of the parameters of the study can already be found from medical entomology studies. For *An. albimanus*, field data such as human blood index and resting period duration has been studied in local settings, while standard

data were used where there was no specific data available. This species bites throughout the morning and is an opportunistic biter. In Haiti, the times at which people go to bed is known, so this can be combined to understand the exposure of people who are net users and non-net users, and model the effects of different interventions. Modelling shows that the relationships between coverage and human behaviours enabling man-vector contact is very different for *An. albimanus* in Haiti than *An. gambiae* in Africa: nets are less effective, but house screens and spatial repellents might be more important. It also supports the idea that housing improvements would be very useful in the Americas.

- It was commented that this work connects with how recommendations are made. Making generalisations across vastly different transmission ecologies has slowed the implementation of some interventions, so this type of study is highly valuable.

*Integrating Aedes into existing malaria vector surveillance and control system in Africa - Mamadou Coulibaly, University of Sciences, Techniques and Technologies, Mali*

*Aedes*-borne emerging and re-emerging diseases include chikungunya, dengue, yellow fever and Zika. The estimated population at risk of at least one of these diseases is 11% globally, and 70% in Africa. Two main vectors, *Aedes aegypti* and *Ae. albopictus*, occur and are proliferating in this continent. WHO is recommending the implementation of multifaceted vector control programmes through the Global Vector Control Response (GVCR). Pillars of this call for intra-sectoral collaboration and integration of tools and approaches. The Worldwide Insecticide Resistance Network (WIN) and other network such as ANVR and West African *Aedes* Surveillance Network are working on *Aedes* control. Whilst malaria programmes use very similar tools for collecting *Anopheles*, they often discard *Aedes* samples, which could be kept for surveillance and monitoring purposes. Challenges to integration of *Aedes* surveillance include funding: there is not enough funding for *Aede*s surveillance and control, and there is sometimes reluctance by malaria programs of sharing a small budget with *Aedes* programs. There is also a lack of well-trained staff, and lack of political will. It is important to identify disease overlaps and control opportunities, and add expertise on *Aedes* to *Anopheles* expertise and competence.

- It was commented that there are often short-term campaigns that are successful, but trying to carry them on for decades has not worked. It is important that the cost of excluding all breeding sites is estimated, as this is the alternative to control.
- Community engagement for *Aedes* control is different than it is for *An. gambiae* because the larval habitats can be seen clearly. It was asked what should be done in the field to engage the community in *Aedes* control. It was responded that in Mali they are still at the beginning, and engagement is part of the agenda.

*ANVR: Filling the gap in vector control in the African Region - Birkinesh Ameneshewa, World Health Organization*

The African Network on Vector Resistance was established in 2000, and is an institutional membership for research institutions, universities and vector control programmes. It has a steering committee that advices the network. Only 30% of medical entomologists work in the health system, with 70% working in research institutes and universities, so there is a lack of entomology capacity in the health system. However, those in research can be useful; the goal of the network is to enhance integrated vector surveillance and control for VBDs, and to promote operational and advanced research in Africa. They assist member states in monitoring IR, and support local research institutions.

With situation analyses in 8 countries, they identified gaps, and could provide logistics, training and equipment. Capacity building has been at both institutions and control programmes. Short-term training programmes have involved more than 1,500 people. Furthermore, ANVR has developed a database on WHO website for medical entomologists. IR is well covered but other entomological components are not very well informed. During the last decade, data collection capacity has increased significantly, as well as the number of sites that are providing data. More recently, in addition to *Anopheles* work, ANVR has been supporting capacity-building for *Aedes* surveillance and control.

*Integrating scientific strategy with governance - Eva Veronesi, University of Zurich*

Infravec2 is a consortium of institutions. They offer free on-line training courses as well as eggs and other no-cost vector research products, allowing research that is needed by the vector control community and improving knowledge. They also have a work package for integrating scientific strategy with governments, which involves strengthening networking, particularly with non-European disease emergence sites, and strengthening capacities in surveillance and outbreak response where needed. Infravec2 is also trying to implement procedures to standardise research, and to make sure that the same guidelines are referenced. Its achievements include the creation of tools, such as a website for conferences on vector control and interdisciplinary topics. An experts' database has been established that will help people to identity subject matter experts; it is not yet live, but will show who is working on what, where they are, and what their capacities are. The main weaknesses have been identified as *Aedes* and arbovirus research in Africa, while in Europe there is this strength but less work on malaria, so the aim is to build long-term connections between institutions.

*APMEN online resource exchange network to support entomology/vector control in the Asia-Pacific region - Michael Macdonald, Consultant*

The purpose of the resource exchange network is to develop a community of public health entomologists and vector control professionals dedicated to sharing best practices, skills and career opportunities, and to enhance the contribution of public health entomology in the Asia-Pacific region. The target audience for the online programme is those working on vector control, and students and faculty from research and training institutions. It will include guidelines and SOPs for *Anopheles* and *Aedes* surveillance and control, and SOPs for laboratory work and field trials, as well as training for basic data analysis tools like Excel, EpiInfo, DHIS-2 and SPSS to help programmes collect the right data and analyse it correctly. The third element is management training and communication support. Communications support includes on-line training for entomologists to better communicate their findings, including trainings on giving presentations, writing reports, manuscripts, and resumes to help their career development. All the participants to IVM session were invited to look at the prototype, to see where improvements might be made, and to encourage young scientists who may be interested in careers in public health entomology.

*Sublethal acoustic tracheal rupture provides novel insights of larval mosquito respiration – Herbert Nyberg, New Mountain Innovations, Inc.*

Acoustic larvicide can kill mosquito larvae by resonating the gas in the dorso-tracheal. Their research on the tracheal system indicates that larvae do not breathe atmospheric oxygen through the siphon; there are no different from related insects in the water column that source all their oxygen from the environment. If the tracheal system was open, acoustic larvicides would not work. The resonance

phenomenon kills all stages from first instars to pupae. If mosquito larvae are far from the source, only the tracheal trunk is ruptured, and the larvae do not die, which indicated that tracheal trunk has no obligate role in respiration. There is a tracheal occlusion that isolates any air from passing in or out. Rather, oxygen is likely obtained from the ventral fan. The stratum at the top of the water is highly oxygenated, so larvae come to the surface to put the ventral fan in the highest column of water; when kept down deep they cannot survive. Petroleum surfactant on the water is a neurotoxin that rapidly kills larvae; suffocating is secondary.

- Details of the acoustic device were elaborated. The resonant frequency is a function of the amount of gas in a tracheal system. The first and second instar larvae have a resonant frequency of around 30 kHz. The larger larvae have a frequency of around 18 kHz. The larger piece of equipment sweep up and down between frequencies. They can treat a drum of 55 gallons in 4 seconds. When the sources of larvae have been identified, their equipment can be taken to these sources to kill larvae, and ovitraps can be used in an integrated programme.
- It was asked if the frequencies pose any dangers to other living creatures. It was responded that the US Navy has done lots of studies on zooplankton and protoplankton. Their resonant frequencies are much higher, so they will not be killed. No one has been able to kill anything else with their machines.

*Vector Control in Humanitarian Emergencies – Valentina Buj, UNICEF*

While there was not a plenary presentation on this activity, Vector Control in Humanitarian Emergencies is still an important element in the WS work plan.

Following from the September 2017 workshop, the group is looking for case studies and examples of vector control in humanitarian emergencies where evidence is being collected. Members were encouraged to contact Valentina and Michael if they have anything to share and want to be included in the communications.

- It was commented that hurricanes and earthquakes have happened in Florida, Indonesia, Haiti and Puerto Rico. Some realities for vector control are that (1) no country is prepared for a disaster as the scale of some of these events, and vector control is not a priority in these places. The number of mosquitoes per person per night can increase significantly after a hurricane, so aerial spraying may be the only option in these settings. (2) Vector control for disease control is often not a priority in humanitarian emergencies, following security, shelter, water and sanitation. Existing facilities can be destroyed, so you have to rethink your position. (3) Transport is an issue because of the different priorities. Not all disasters are emergencies, but most will require entomological assistance.
- It was asked what this work stream should be involved with in terms of vector control in humanitarian emergencies. There are two objectives: improve programmes with existing tools, and provide a platform for the development of new tools that could be used in some of these situations.
- It was commented that complex vector control interventions are possible, even in conflict areas, so the populations that need assistance should not be forgotten. Vector control in

humanitarian areas is so important that maybe it needs its own work stream. It is often implemented through the WASH or the Shelter Cluster rather than strictly the Health Cluster implementing partners.

- It was commented that in the acute phase of emergencies, tools like nets and IRS are not always appropriate, but working with shelter materials has been critical, such as impregnated tarpaulins and tents. Pyrethroid-impregnated materials got lots of traction, but resistance has been a problem. Shelter materials need to be reinvigorated with the new generation tools.
- It was commented that a problem is that the budget for emergency responses often does not allow for insecticide-impregnated materials, unless they cost the same as materials without insecticides.
- It was agreed that vector control in humanitarian emergencies is an important area of work for the RBM VCWG and should be reinvigorated.

*Capacity Building – Prosper Chaki, Ifakara Health Institute, PAMCA*

The Pan Africa Mosquito Control Association (PAMCA) is a network of professional and non-professionals interested in public health entomology. Their strongest pillar is capacity building, knowledge building, governance and advocacy. A generation of vector biologists is needed that can mentor the next generation until Africa is free of vector-borne diseases (VBDs). A survey last year found that the continent is not short of medical entomologists (250 at PhD level), and 90 institutions with vector control activities, but it is important that they do not work in silos, and that they are accessible.

- It was commented that an experience from the Americas is that there are few mid-level managers. Students could be brought in as interns, to give them an idea of careers in vector control and help to build the staff for people who may want to do this for a living.
- It was asked if there are the policy opportunities for the heads of state about meeting career development and putting budgets into national governments for entomologist positions. APLMA is working on this critical issue and may be taken up by ALMA.
- It was commented that In Malaysia, entomologists are team players within the district and state health departments and their contribution is valued. This model could be used by other countries to increase their strengths in entomology. Further, those that are policy makers should be sensitised to this issue, so they understand the value of entomologists. A database of medical entomologists can be shared so that countries will know who will be available. Infravec2 is focused on Europe, but this needs to be linked with other databases, particularly because European researchers can have activities in other regions. PAMCA has a list of entomologists in Africa. AfDB was looking for experts, and it would be good to share this with them.

*ANVR discussion – Mamadou Coulibaly, University of Sciences, Techniques and Technologies of Bamako, Birkinesh Ameneshewa, World Health Organization, & Josiane Etang, University of Douala*

- It was discussed that there are limited resources, including human resources for *Aedes* surveillance, so it is important that information is shared. The distribution of *Aedes* species is not known, so there is a huge demand and need to collaborate, not to work in isolation.

- It was noted that in Angola there were 3,000 cases of yellow fever, and 600 lives were lost. So, the malaria control programme had responsibility to control *Aedes* mosquitoes, but they had little idea of how to deal with them. It is important that they know what to do, so collaboration and integration are important: networks need to be connected, and the knowledge and means to support the health system when facing epidemics of arboviruses shared. It was added that there is an important role of universities and research institutes as the anchor point for this work. Linking universities with programmes has been very important. The suggestion was to institutionalise the linkage between research and the control programmes, through a memorandum of understanding. This has been very powerful in guiding programmes, because they are recognised by the ministries.
- It was asked, if there is full integration? Also if *Aedes* and *Anopheles* are understood, but *Culex* is neglected? *Culex* are often neglected but can be extremely important, not just for lymphatic filariasis but for a wide range of potentially emerging viral pathogens.

Members were encouraged to offer ideas on strengthening ANVR. People from different regions are invited to collaborate. An electronic discussion was welcomed on the three areas of focus (vector control in humanitarian emergencies, capacity building, and ANVR collaboration).

# Day 3: Friday 1st February 2019

## Session 3: Updates and Feedbacks
## Chairperson: Keziah Malm

***Update from WHO on roll out of Global Vector Control Response - Anna Drexler, World Health Organization***

The GVCR is a strategic approach to tackling VBDs. It provides a way to strengthen VBD control globally, and works across a range of diseases. It provides a broad approach for implementing locally adapted vector control, and is aligned with SDGs. Whilst VBD control has contributed to reductions, it hasn't been implemented fully against the NTDs. Specific aims include reducing mortality due to VBDs globally by at least 75% by 2030, and reducing the incidence of VBDs globally by at least 60% by 2030. The strategic approach is based on a foundation of enhanced capability and capacity. Three regional plans have been reviewed and endorsed by regional committees (Americas, Southeast Asia, and Europe). Those of Africa, Eastern Mediterranean and Western Pacific Region are still being developed. The GVCR Joint Action Group will coordinate and support the implementation of the GVCR at HQ level, such as through supporting regions and countries to train staff in medical entomology and public health, and identifying key guidance for the implementation of GVCR at country level. Regional staff focal points have been assigned to this joint action group to coordinate and guide the response. Other activities include the consolidation of a website for all WHO vector control activities, and an advisory committee is being constituted with scientific, technical and strategic input in the planning, prioritization and review of GVCR implementation.

## *Feedback from Networks*

***APMEN - Christina Rundi, Ministry of Health Malaysia***

APMEN now has 18 countries, 34 partner institutions and four working groups. They have found that each country partner is on a different level on its journey to elimination. APMEN has a vector control working group annual meeting once per year, and target two fellowships and capacity training twice per year. At the 2nd APMEN VCWG meeting in September, regional and sub-regional solutions to the challenges of entomology capacity building were discussed as well as practical approaches to surveillance. Capacity building has included risk and receptivity mapping using GIS technology, an outdoor entomology surveillance tools workshop, and an integrated vector management course. They also have an online platform, and plan to improve linkages with SRWG and the *P. vivax* working group. The purpose of the network is to support individual countries, and they have identified the needs of each country by group.

***Eliminate 8 - Lesley-Anne van Wyk, Southern Africa Malaria Elimination 8 Secretariat***

Elimination 8 is partnership of 8 countries in southern African aiming to eliminate malaria by 2030. They conducted a capacity needs assessment, and from this it emerged that there is insufficient intelligence to understand the trends of outbreak and transmission patterns. They also found a lack of

a network that will allow collaboration. Elimination 8 launched a fellowship programme to build up capacity within their eight countries. The fellows were selected through an open call, and are engaged in many different activities of the NMCP portfolios. The fellowship programme includes residential weeks at research institutions to allow fellows to engage in intensive training programme, such as courses in insecticide resistance, GIS and insectary set-up and management. Elimination 8 are also building their network with a focus on enhanced collaboration and data sharing.

*PAMCA – Prosper Chaki, Ifakara Health Institute*

The Pan African Mosquito Control Association is a network committed to seeing the continent free of VBDs. It is organised into five regions, with members coming from 30 countries. An area they have focused on is a platform for women working in entomology to share their experiences and opportunities for them to be join the network and build careers in this area. They have also held a regional coordination meeting to discuss how they can improve knowledge and preparedness for VBD disease control and surveillance. They identified the needs for harmonizing key indicators for VBDs, and integration of tools for monitoring and evaluation. PAMCA has formed a partnership with the Gates Foundation and Sanger Institute to strengthen surveillance systems in the continent. This is starting in nine countries, and the end goal is to scale this up across the continent. Finally, they are working with others to join them in developing strategies for community engagement and getting the right people into vector control.

*PIAM - Ahmad Raeisi, Ministry of Health and Medical Education*

The Pakistan Iran Afghanistan malaria network has two countries (Afghanistan and Pakistan) with a malaria control program, and Iran with a malaria elimination program. Afghanistan has more than 35 million people, 10% of which live in the high risk area. The border region with Pakistan is the main area for *P. vivax* cases, and is the main area of focus. Pakistan has more than 200 million people, and more than 50 million people live in high risk areas. Iran has a different situation, with patchy areas of *P. vivax* and *P. falciparum*, close to the border with Pakistan. They are aiming for a 100% confirmation rate, which is much higher than in the neighbouring countries. There are seven vectors, making it difficult to control. Current collaborations on vector control and VBDs is mostly focused on monitoring insecticide resistance, and they hope to continue this. In addition to malaria, Afghanistan is having frequent outbreaks of dengue, and *Ae. albopictus* has been identified in Afghanistan and Pakistan, so there is an increasing need to control dengue vectors.

*SaME Initiative - Balla Kandeh, National Malaria Control Programme Ghana*

The Sahel Malaria Initiative compromises eight countries. It is helping to accelerate the fight against malaria by mobilising internal and external financial resources, implementing a joint action plan, and developing mechanisms for monitoring the progress of implementation of the action plan. They are committed to supporting national programs, and increasing political engagement in each of the eight countries, strengthening cross boarder collaborations. Key milestones include the meeting of minsters of health from six Sahelian countries and meeting of programme managers form seven countries. Technical committee and ministerial meetings are planned for 2019.

## Encouraging collaboration between the working groups

*Feedback from Justin McBeath, Bayer, & Konstantina Boutsika, Swiss Tropical and Public Health Institute*
Feedback from a small meeting of Co-chairs and work stream leads alongside ASTMH in New Orleans in November 2018 highlighted interest from Working Groups in being more aware of what each WG was working on. The updates from the other Working Groups (CMWG, MiPWG, MERG, MSWG, SBCCWG) scheduled for this session are an acknowledgment of the intent to continue with this collaborative approach.

## Updates from other Working Groups

*Monitoring and Evaluation Reference Group (MERG) – Molly Robertson, PATH on behalf of the co-chairs Arantxa Roca-Feltrer and Medoune Ndiop*
A meeting was held in September 2018, with 42 participants from NMCPs, research organisations. The MERG looks at how indicators for evaluation and monitoring can be standardised and covers a range of interventions. They discussed data visualisation and the operationalisation of surveillance guidelines. Active task forces include surveillance task force, routine health information systems task force, seasonal malaria chemoprevalence task force, indoor residual spraying task force, and evaluation task force. The MERG list serve is active, and they have household survey indicators for malaria control, as well as an updated malaria indicator survey toolkit.

*Multi-sectoral Working Group (MSWG) - Robert Bos, Consultant, co-chair*
The Multi-sectoral Working Group is the newest work group. It looks at how non-health sectors can contribute to the promotion and prevention and control of malaria. They have tried to identify gaps and partners to address, and see what model they can identify, and how additional resources can be found in this area. They are focusing on a range of VBDs, and even beyond this to include water-related diseases. Social engineering interventions will be key in this working group, so they are mapping what is happening as multi-sectoral actions in different countries. These include: settlement and infrastructure, agriculture and forestry, tourism and the extractive industries. The group discussion helped develop three groups of focus: agriculture, irrigation, livestock; urban management; and the private sector. They will meet next week to discuss what non-health sectors can do in countries close to elimination, and what can they do to help carry the burden of maintaining malaria-free status. A particular area they would like to look at is housing, to see which parts fit into vector control and which into policy development.

*Social and Behavioural Change Working Group (SBCCWG) – Gabrielle Hunter, Johns Hopkins Center for Communication Programs, WG Secretariat*
The SBCCWG approaches behaviour change form a technical perspective, and recognises that it cuts across all malaria interventions. The have collaborated with the LLIN work stream to develop a consensus status on LLIN repurposing, and misuse. They also have a framework to support their strategies, and have developed the second edition of their reference indicator guides for SBCC activities. It includes adaptable survey questionnaires for monitoring and evaluation of malaria SBCC. Future activities include the development of a standardized SBCC survey module, a toolkit for

community health workers to improve their abilities in behaviour change, and collaborating with other working groups.

*Case Management Working Group (CMWG) – Konstantina Boutsika, Swiss TPH on behalf of the co-chairs Elizabeth Juma and Larry Barat*

The CMWG aims to achieve consensus on scaling up of implementation policies. There has been four years of no activity due to a lack of funding. The group has now been revised with funds from the Swiss Agency for Development and Cooperation (SDC), and they have 200 members, of which 70 will meet soon. Their meeting will allow them to define the priorities of this working group. They have invited participants to give presentations, and may rearrange their working structures and work streams accordingly.

*Discussion session*

- It was commented that it was helpful to have WHO presenting on the GVCR. This could be on the first day in future meetings. A lot of what the work streams do is related to the GVCR, but it is not recognised as that.
- It was commented that collaboration between the regional groups would be very good, as well as between the working groups. South-south collaboration would be very valuable, particularly for those now starting to work on *Aedes*.
- It was asked if anyone from PIAM has thought about including Yemen in their group. A malaria needs assessment found that there were over 900,000 cases on malaria in 2015, and most of these are *P. falciparum*. There is a huge unaddressed need, made worse by the humanitarian crises. It was added that one region clearly missing from the meeting is the Americas. They have a lot of dengue and Zika experience, and they should be included in this global collaboration. It was responded that it is difficult to get travel approvals for Afghanistan, and for Yemen, and VCWG always try to get representatives from the Americas, but fail because of the hierarchical approval process. The technical people are desired, but are not allowed without their superiors travelling with them.
- It was commented to the environmental group that re-designed pumps would help them to reduce malaria and get more water for irrigation.
- The Global Vector Hub was introduced as an online resource that incudes capacity building, networking, and a database of vectors and VBDs.

## Work stream highlights

*LLIN priorities work stream - Hannah Koenker, Johns Hopkins Center for Communication Programs, & Ikupa Akim, Swiss Tropical and Public Health Institute*

Results from the Tanzania study with nets with holes were presented, and showed that mosquitoes get trapped in these nets and they still provide protection. Users tend to throw these away earlier than they need to, so it is important to find ways to encourage people to keep using them. The Tanzania in-school net distribution programme has helped to maintain ITN access in the area of this programme. The NMCP managers and VC people provided their experiences in a panel discussion about the challenges that they face, rather than through a top down view as is often presented. The

highlights included acknowledging the unique challenges of distribution in urban areas, such as urban areas being more likely to have preferences of nets, and the difficulty to reach houses in dense areas. Quantification is also an issue because of the fast growth rate of urban areas. Also, all countries seem to recognise these challenges, and they need to work on specific ways to address them in future campaigns.

*LSM work stream - Silas Majambere, Pan-African Mosquito Control Association*

There has been a long debate on the consensus statement for best practices for LSM. Attempts have been made to talk to WHO, so a position statement will be made and discussed with RBM to see if they will put this on their website. Secondly, intersectoral participation is vital, so it is important to connect with the MSWG, and to get involved with the big water management projects. Finally, there are projects using drones; it is important to integrate new technology in larval source management. The working group tries to support countries to do LSM correctly. Most do not go through the traditional funders, and the monitoring system is not as good, so it is important to help them set up a good programme and have appropriate monitoring. Those countries using LSM are not using PQ listed products, so WHO may need to be involved and countries should be encouraged to use approved products.

*IRS/IRM priorities work stream - Mark Hoppé, Syngenta Crop Protection AG, & Dereje Dengela, Abt Associates*

Reasons to be optimistic included a second Next Generation class of IRS product available, with two products from class 4 now available. There were presentations about data being turned into actionable information, and while we often hear that IRM can be difficult, the logistical challenges we found to be much smaller than anticipated. There are new ways of using IRS, with evaluation going into whether partial wall coverage is effective, and it was shown that perhaps not all sprayable buildings were being reached or recorded, and this suggests that outcomes could have been even more successful. In the coming year funding will be sought for the IRM MOOC, and scaling up of the partial IRS work, and there is ongoing resource development in the vector learning exchange. The deployment of two insecticides without any operational challenges indicates that the GPIRM initiative can be implemented, and the challenges of IR can be partially mitigated. The sub-national rotation of insecticides contributes to IRM and keeps products on the market, and was not found to be difficult, so there are reasons to be optimistic. As more expensive nets are introduced, more data are needed, and it is encouraging that there are efforts to make data easily accessible to NMCPs.

*Vector- borne diseases in the built environment work stream - Steve Lindsay, Durham University, & Lucy Tusting, London School of Hygiene & Tropical Medicine*

The work stream has expanded to include diseases other than malaria and will reach out to the MSWG. Priorities for the next year are to: make recommendations on 'good' housing practices for screening houses against mosquitoes, keeping the house cool, and the peri-domestic environment free from mosquitoes; provide a list of experts willing to provide advice to those in the housing sector and identify different models for scaling-up interventions.

*New tools, new challenges in vector control work stream - Fredros Okumu, Ifakara Health Institute, & Allison Tatarsky, University of California, San Francisco*

Reporting back on the 2018 work stream was covered in the session, with a key message that Maureen Coetzee has encouraged people to use the mosquito identification keys and provide feedback on these. Agreement was made on what residual transmission is, and a review of evidence on the vector control toolbox has been published. The second objective related to sharing information about emerging challenges from NMCPs, including from Malaysia where *P. knowlesi* cases are on the rise. Whether Malaysia would be able to reach elimination in this context was discussed. Third, sharing evidence about vector control interventions included presentations on genetic control, including mosquito population suppression and replacement strategies and research efforts. The roadmaps for new tools and their role in NTNC session included presentations on bite prevention and ivermectin roadmaps to consolidate the evidence and identify the key questions that remain. Finally, a brainstorm session was held for the 2019 work plan and next steps. A survey will be circulated to focus the agenda in this area and get more input from NMCPs.

*IVM evidence and capacity work stream - Josiane Etang, University of Douala, & Michael Macdonald, Consultant*

The session presentations focused on training opportunities and other online resources, and the opportunities for integrating surveillance of *Aedes* with *Anopheles* to cover many different diseases. The ANRV network experiences shared their experiences, including the importance of collaboration between academia and programmes. A European network on training and resources (Infravec2) showed the possibility to collaborate with institutions across the world, and the APMEN online resource exchange was presented, showing how people can apply for funding. Finally, a presentation was given on larval mosquito respiration, and how this could be used to develop new tools. Three work plan discussions were organised (i) vector control in humanitarian emergencies, to engage other sectors such as water, sanitation and shelter, (2) capacity building, including online resources, to build collaborations and link on-line networks, and (3) a discussion about integration between *Aedes* and *Anopheles* surveillance, with replication of the ANVR in other regions. To close, the Global Vector Hub was introduced as a network of networks for the vector control community. It will establish a global community of practice though SOPs and manuals, quick access to training resources, and a graphic interface for displaying surveillance data. It will start with a focus on *Aedes* and Latin America, but expand to other vectors and diseases. Those interested in learning more were encouraged to contact Frederick Seelig at London School of Hygiene & Tropical Medicine.

*Way forward in 2019*

It was commented that it has been a very rich, lively and interesting meeting, where 'connections' and 'dialogue' have been key words. For next year's meeting, it has been acknowledged that more space should be given in the agenda for humanitarian emergencies and for discussion around general updates from WHO and other organisations on Day 1. Further feedback from participants was invited.

*Any other business*

Co-chairs Keziah Malm and Justin McBeath thanked participants and the work stream leads. Konstantina Boutsika thanked the support team.

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*List of acronyms and initialisms*

| | |
|---|---|
| 3GIRS | 3rd Generation IRS |
| AfDB | African Development Bank |
| AI | Active ingredient |
| ALMA | African Leaders Malaria Alliance |
| AMCA | American Mosquito Control Association |
| AMP | Alliance for Malaria Prevention |
| ANVR | African Network on Vector Resistance |
| APLMA | Asia Pacific Leaders Malaria Alliance |
| APMEN | Asia Pacific Malaria Elimination Network |
| BMGF | Bill and Melinda Gates Foundation |
| BOVA | Building Out Vector-borne disease in Africa |
| CDC | Centers for Disease Control |
| CIPAC | Collaborative International Pesticides Analytical Council |
| CMWG | Case Management Working Group |
| CRSPC | Country/Regional Support Partner Committee |
| DHIS 2 | District Health Information Software 2 |
| GF | Global Fund |
| GMP | Global Malaria Programme |
| GMS | Greater Mekong Subregion |
| GSTs | Glutathione S-transferases |
| GVCR | Global Vector Control Response |
| I2I | Innovation to Impact |
| IR | Insecticide resistance |
| IRM | Insecticide resistance management |
| IRS | Indoor residual spraying |
| ITN | Insecticide-treated net |
| IVCC | Innovative Vector Control Consortium |
| IVM | Integrated vector management |
| JAMCA | Journal of the American Mosquito Control Association |
| JMPS | Joint Meeting on Pesticide Specifications |
| LLIN | Long-lasting insecticidal net |
| LSM | Larval source management |
| M&E | Monitoring and Evaluation |
| MDA | Mass drug administration |
| MERG | Monitoring and Reference Evaluation Reference Group |
| MiPWG | Malaria in Pregnancy Working Group |
| MOOC | Massive Open Online Course |
| MSWG | Multi-Sectoral Working Group |
| NEPAD | New Partnerships for Africa's Development |
| NGenIRS | Next Generation IRS |
| NGN | Next generation nets |
| NGO | Non-governmental organisation |
| NMCP | National Malaria Control Programme |

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|---|---|
| NTNC | New Tools New Challenges |
| OP | Organophosphate |
| ORS | Outdoor residual spray |
| PAMCA | Pan African Mosquito Control Association |
| PBO | Piperonyl butoxide |
| PCR | Polymerase Chain Reaction |
| PIAM | Pakistan Iran and Afghanistan Malaria Network |
| PMI | President's Malaria Initiative |
| PPE | Personal protective equipment |
| PQ | Pre-Qualification |
| RBM | Roll Back Malaria |
| RCT | Randomised Controlled Trial |
| SAFE | Sunlight activated formulation extract) |
| SBCCWG | Social and Behaviour Change Communication Working Group |
| SDC | Swiss Agency for Development and Cooperation |
| SOP | Standard Operating Procedure |
| SSA | Sub-Saharan Africa |
| TDR | WHO Special Programme for Research and Training in Tropical Diseases |
| USAID | United States Agency for International Development |
| USDA | United States Department of Agriculture |
| VBD | Vector-borne disease |
| VCAG | Vector Control Advisory Group |
| VCWG | Vector Control Working Group |
| WASH | UNHCR Water Sanitation and Hygiene |
| WG | Working Group |
| WHA | World Health Assembly |
| WHO | World Health Organization |
| WHOPES | World Health Organization Pesticide Evaluation Scheme |