

VCWG-18 Poster Session



Time: Lunch break and Afternoon break

Date: Monday 6 February – Wednesday 8 February 2023

Location: Ball room

P001

Digitalized mass distribution campaign of insecticide-treated nets (ITN) in the particular context of covid-19 pandemic in benin: challenges and lessons learned

Rock Aikpon, Ministry of Health Benin/ National Malaria Control Program, Benin

Background: In 2020, Benin has implemented a digitalized mass distribution campaign of insecticide-treated nets (ITNs) in the particular context of COVID-19 pandemic. This paper describes the implementation process as well as the challenges and lessons learned.

Methods: A descriptive design was used for reporting the implementation process of ITNs campaign. Moreover, the changes and adaptations related to COVID-19 pandemic are described.

Results: A total of 3,175,773 households were registered for a total of 14,423,998 population. A total of 7,652,166 ITNs were distributed countrywide through door-to-door distribution approach. High political commitment add to the financial and technical supports from partners were the essential factors that make 2020 ITNs mass campaign success despite the context of COVID-19 pandemic.

Conclusion: It is essential to maintain the prevention activities for malaria and this could substantially reduce the overall impact of the COVID-19 pandemic for the populations at malaria risk. (E-mail: rockypremier@yahoo.fr)

P002

Larviciding trial in the city of Yaoundé Cameroon

Christophe Antonio-Nkondjio, OCEAC, Cameroon

With the rapid expansion of insecticide resistance and outdoor malaria transmission all affecting core interventions efficacy, the use of larviciding as a complement to these interventions could improve the control of malaria in urban settings.

I will present data of a successful larviciding trial we conducted in the city of Yaoundé from 2017 to 2020 who permitted a significant reduction of malaria vector densities and malaria transmission intensity (>20 scientific publications released). Although implementing larviciding in the city could be cost-effective, I will in my presentation discuss challenges in the implementation and monitoring, community participation and adherence. Data of the possible impact of larviciding in managing insecticide resistance will also be presented. The presentation is suited for work stream 2 “Expanding the vector control toolbox” and will help explore possibilities to improve the scaling-up of larviciding across Africa, addressing challenges affecting the implementation and opportunities for integrated vector management. (E-mail: antonio_nk@yahoo.fr)

P003**Monitoring insecticide resistance in *Anopheles coluzzii* from a high malaria burden district prior to the implementation of new compounds candidates for indoor residual spraying: case of Sakassou, central Côte d'Ivoire**

Golou Louise Bellai, Swiss TPH, Côte d'Ivoire

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1) University of Basel, Basel, Switzerland

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4) Abt Associates, Vectorlink, PMI, Abidjan, Côte d'Ivoire

Objective: This study evaluated *Anopheles* vector resistance to the common classes of insecticides and new compound candidates for IRS and determined the associated resistance mechanisms in malaria vectors in Sakassou, central Côte d'Ivoire.

Material and Methods: *An. gambiae* s.l. mosquito larvae were collected in the health district of Sakassou, from 2018 to 2020. Emerged adult females were tested against pyrethroids (permethrin 0.75%, deltamethrin 0.05%, alphacypermethrin 0.05%), organophosphates (pirimiphos-methyl 0.25%), carbamates (bendiocarb 1%) and new compounds including the pyrolle (chlorfenapyr 200 ug/bottle) and neonicotinoid (clothianidin 2%) using WHO standard protocol for bioassay. *An. gambiae* s.l. species and the presence of mutation genes were analysed by PCR.

Results: *An. gambiae* s.l. populations were exclusively *An. coluzzii* (100%). Overall, they were resistant to the common insecticides. Especially, pyrethroid mortality rate ranged from 0% to 6% over the three years of observation. *An. gambiae* s.l. was susceptible to clothianidin. The 200 µg/bottle dose of chlorfenapyr yielded less than 98% of mortality in year two, but 100% mortality in year three. High L1014F frequency ranging from 54 to 71% was recorded while L1014S and G119S allele being detected at lower frequency compared to L1014F.

Conclusion: *An. coluzzii* from Sakassou showed strong resistance to the common insecticide classes with presence of target-site mutation while being susceptible to the newer candidates. Therefore, chlorfenapyr and clothianidin-based tools and interventions could be promising strategy for vector control in Sakassou health district. (E-mail: louise.bellai@swisstph.ch)

P004**Evolution of the Pyrethroids Target-Site Resistance Mechanisms in Senegal: Early Stage of the Vgsc-1014F and Vgsc-1014S Allelic Frequencies Shift**

Moussa Diallo, Laboratoire d'Ecologie Vectorielle et Parasitaire of Université Cheikh Anta Diop, Senegal

My study aims to retrospectively determine the evolution and spread of pyrethroid resistance mechanisms among *Anopheles gambiae* s.l. in Senegal. Samples were randomly collected in 2013, 2017, and 2018 from 10 sentinel sites. Molecular species of *Anopheles gambiae* s.l. and the resistance mutations at the Voltage-gated Sodium Channel 1014 (Vgsc-1014) locus were characterised using PCR. The genetic diversity of the Vgsc gene was further analyzed by Sanger sequencing. The overall species composition

revealed the predominance of *Anopheles arabiensis* followed by *An. gambiae* s.s., *Anopheles coluzzii* and *Anopheles gambiae-coluzzii* hybrids. Both Vgsc-1014F and Vgsc-1014S mutations were found in all studied populations with a spatial variation of allele frequencies. The two mutations have been detected since 2013 across all the selected health districts, with Vgsc-L1014S frequency increasing over the years while Vgsc-1014F decreasing. The Vgsc gene was found to be highly diversified with eight different haplotypes shared between Vgsc-1014F and Vgsc-1014S. (E-mail: diallalomoussaah@gmail.com)

P005

IK SMART LIGHT: A new tool to enable more efficient delivery of indoor residual spraying

Iñigo Garmendia, GOIZPER Group, SPAIN

Indoor residual spraying (IRS) is an effective tool but training IRS teams and insuring efficient and effective spraying of communities is limited by technical and logistical challenges. IVCC and Goizper Group, working with IRS implementors, have developed a new tool, the IK Smart Light. The device provides immediate feedback to spray operators to help them deliver accurate target dosage of insecticide. It also assists supervisors and program managers to train spray operators more efficiently and each device collects data during use which allows to monitor spray applications in real time. The spray data can be uploaded to the cloud and visualized remotely to alert managers about potential problems immediately. Prototypes were piloted in Mozambique (2019) and Ghana (2021-2022) and supervisors' feedback clearly expressed that, that tool is a "game changer" in helping them improve spraying performance and manage more efficient and effective programs in the future. (E-mail: igarmendia@goizper.com)

P006

Pyrethroid resistance in Ethiopian major malaria vector, *Anopheles arabiensis*

Aduugna Belew, Deriba Abera, Sisay Dugassa, Lemu Golassa, Addis Ababa University, Ethiopia

Studying allele frequency change is very important in understanding the direction of evolution in specific population due to environmental challenges and pressure. For instance, the use of insecticide Pyrethroid and DDT put a pressure on different agriculturally and medically important insects including *Anopheles arabiensis* mosquito. This pressure make mosquitoes to undergo the process called purifying selection (removing specific alleles from population) or positive selection (increasing the frequency of specific alleles in population). To discover specific allele and determine magnitude of allele frequency in vgsc (kdr) gene of Ethiopian *Anopheles arabiensis* due to pyrethroid and DDT pressure, we sequenced and analyzed 85 samples' voltage gated sodium channel gene sequences. We found five non-synonymous SNPs with allele frequency greater than 1% (R254K= 1.2%, L995F=11.8%, F1030S=2.9%, L1480V=1.2%, G1989R=5.3%) and two of them have allele frequency greater than 5% (G1989R=5.3% and L995F=11.8%). L995F which had a significant allele frequency (11.8%) was confirmed to confer pyrethroid and DDT insecticide resistances in *Anopheles gambiae* and *coluzzii* which is true for *Anopheles arabiensis* as well. Other alleles found in Ethiopia might play the same or enhance the intensity of insecticide resistance in *Anopheles arabiensis*. To know whether these alleles were unique to Ethiopian *Anopheles arabiensis* or distributed across East Africa, we analyzed vgsc sequences of *Anopheles arabiensis* from Kenya (13 samples), Malawi (41 samples), Tanzania (85 samples) and Uganda (82 samples) along with Ethiopian samples. We didn't

find similar allele in East African *Anopheles arabiensis* except G1989R which was found in Uganda with allele frequency of 1.2%. The majority of alleles found in other East African *Anopheles arabiensis* had allele frequency less than 5%. But, there were two SNPs with allele frequency greater than 5% (A656V=6.1% and T2044A=25.6%) in Malawian *Anopheles arabiensis* and their role in insecticide resistance is unknown.

Three of four (R254K, F1030S, L1480V) alleles in Ethiopian *Anopheles arabiensis* were in perfect linkage disequilibrium with known insecticide resistant allele L995F ($D'=1$) which means they would be inherited together from the parents to the offspring and affect magnitude of allele frequency in *vgsc* gene and insecticide resistance level in Ethiopia in the future. G1989R allele had low linkage disequilibrium with L995F allele ($D'=0.2$), even though it had significant allele frequency greater than 5%. (E-mail: lgolassa@gmail.com)

P007

Advancing Evidence for Global Implementation of Spatial Repellents

John Grieco, University of Notre Dame, USA

We will provide a status overview of the Unitaid-sponsored Advancing Evidence for Global Implementation of Spatial Repellents (AEGIS) program. This will include updates from cluster randomized control trials (cRCTs) in Africa that are evaluating the protective efficacy (PE) of a novel spatial repellent product (SR) against malaria infections among children living in established communities (Kenya, Mali). We will also present updates on the cRCT underway in Sri Lanka to quantify the impact of the same SR against Aedes-borne viruses. Interim outputs of PE from the Kenya cRCT are anticipated to be presented which is planned to facilitate program-specific decisions on launching operational research in a displaced-persons camp in Uganda to measure PE under varying SR distribution mechanisms. Kenya cRCT PE will also provide early estimates of the public health value of a spatial repellent paradigm in support of expanding the vector control toolbox with an innovative vector control strategy. (E-mail: jgrieco@nd.edu)

P008

Population dynamics, biting activities and resting behavior of *Anopheles* mosquitoes in Jabi Tehnan district, Northwest Ethiopia: implications for indoor malaria vector control

Alemnesh Hailemariam, Ethiopia public health institute, Ethiopia

Background: Effective malaria control programs rely on the implementation of evidence-based interventions. Careful assessment of *Anopheles* mosquito behavior like population dynamics, biting and resting behavior of mosquito vectors strengthen the sustainability and efficacy of the deployed vector control tools.

Methods: The study was conducted from September 2016 to August 2017. Adult mosquitoes were collected both indoors and outdoors in selected villages of Jabi Tehnan District, North West of Ethiopia. Adult mosquitoes were collected from indoor and outdoor using human landing catch (HLC), and CDC light traps (CDC-LT);, from indoor using pyrethrum spray catch (PSC) () and outdoor using pitfall shelters (PS).. A total of 35 houses were selected for sampling mosquitoes, 10 houses each for CDC-LT, PSC and PS, and five houses for HLC. Mosquito collection was carried out twice a month for 12 months.

Results: In the 12 months sampling period, 9,258 mosquitoes were collected and morphologically identified to species level using standard keys. Of these, 5,098 (55.1%) were *Anopheles* mosquitoes belonging to five species, and the rest 4,160 (44.9%) were *Culex* spp. The five *Anopheles* species comprised *Anopheles gambiae* s.l. (58.5%, n=2,982), *An. phroensis* (11.9%, n=605), *An. funestus* (3.4%, n=176), *An. coustani* (15.2%, n=774) and *An. cinereus* (11%, n=561). The peak biting time for *An. gambiae* s.l. was between 22:00 to 00:00 hours. However, the activity decreased sharply after 23:00 - 24:00 hours and stopped completely after 04:00. *Anopheles gambiae* s.l., *An. phroensis* and *An. coustani* s.l. exhibited different peak biting activities throughout the night. *Anopheles gambiae* s.l. was the most abundant malaria vector species in the district. The *Anopheles* mosquito population peaked right after the long rains in October and during the short rainy season in March.

Conclusions: The results indicate that *An. gambiae* s.l. (primarily *An. arabiensis*) is the most abundant malaria vector in Jabi Tehnan District and showed marked high biting activities during peak sleeping hours. Thus, in addition to the indoor-based interventions (LLINs and IRS) in place, additional vector control methods should be designed to address the problem of outdoor biting mosquitoes. (E-mail: entomologyat@yahoo.com)

P009

Control of mosquito larvae using sodium bicarbonate (NaHCO₃)

Ruqayyah Hamidu Muhammad, Department of Biological Sciences, Yusuf Maitama Sule University, Kano, Nigeria

The mosquito-borne diseases spread, irrespective of borders with socio-economic and public health consequences. Sodium bicarbonate, is a naturally occurring substance that has been shown to remove up to 96% of pesticides from fruit and vegetables, used as an efficient and cost-effective fungicide and insecticide. Different concentrations were prepared and larvae of *Anopheles* species and *Culex quinquefasciatus* mosquitos were added, molality was observed for a period of 10hrs. No mortality was seen after 1hr for all the species, after 2 hours a large number of mortalities was observed in the *Culex quinquefasciatus*, while a large number of mortalities was observed in *Anopheles* at 3hrs and total mortality for the *Culex* at the third hour. The *Anopheles* species showed gradual mortality over a period of 8 hours where all mosquitos died in the experimental sets, except one that survived beyond 10hrs. Results showed that mosquitos can be effectively controlled with sodium bicarbonate. (E-mail: ruqayyahmohd@gmail.com)

P010

Use of biolarvicides as part of the integrated vector management strategy during the COVID-19 pandemic, in two Angolan provinces

Mavy Hernández Rodríguez, Entomologist - Biological and Pharmaceutical Laboratories, Cuba; Olga Lidia Real Rodríguez, PhD. Martins ; PhD. Cani Pedro Jorge, Jesus Joya, Juan Luis Sierra

The global health crisis triggered by the COVID-19 pandemic has jeopardized the malaria control strategy in many countries. Disruption of prevention, diagnosis, treatment, and financing services led to increased malaria cases and deaths in sub-Saharan Africa. Some endemic countries made efforts to maintain services during the pandemic, such as the Republic of Angola. The objective was to show vector reduction with the application of biolarvicides and adulticides, following the criteria of epidemiological stratification in the

period 2019 - 2021. The work was carried out in 1445 neighborhoods of Luanda and Huambo in an integrated way with the municipal health departments. A significant number of breeding sites close to the communities were identified and treated. The main species collected were *Anopheles gambiae* sl, *Anopheles funestus*, *Culex quinquefasciatus* and *Aedes aegypti* in ditches, puddles and tanks. The biolarvicides Bactivec and Griselesf were applied at rates of 2-5 ml/m². Significant larval reductions ($\geq 90\%$) were achieved in the worked areas. Malaria incidence rate was not affected by the pandemic in both provinces, during 2019 - 2020; however, a comparative analysis in 2021 showed an increase of 50% and 200% respectively, proving the impact of Covid-19 in reducing vector prevention activities. (E-mail: mavygaby05@yahoo.com)

P011

Use of environmental DNA (eDNA) for monitoring the presence of *Anopheles stephensi* and associated insecticide resistance mechanisms

Mojca Kristan, London School of Hygiene & Tropical Medicine, UK

The invasion and establishment of *Anopheles stephensi* mosquitoes in the Horn of Africa represents a significant threat, which may jeopardise malaria control, particularly in urban areas which were previously largely malaria-free. Novel, simple-to-implement vector surveillance methods are urgently needed. Using multiplex TaqMan assays, specifically targeting *Anopheles stephensi* and *Aedes aegypti* mosquitoes, we validated the use of environmental DNA (eDNA) for simultaneous vector detection in shared artificial breeding sites.

Study findings demonstrated that *An. stephensi* and *Ae. aegypti* eDNA deposited by a single larva in 1L of water was detectable. Characterization of molecular insecticide resistance mechanisms, using novel amplicon-sequencing panels, was possible from eDNA shed by larvae. eDNA was also remarkably stable. eDNA surveillance has the potential to be implemented in local endemic communities and points of country entry, to monitor the spread of invasive vector species. Further studies are required to validate the feasibility of this technique under field conditions. (E-mail: mojca.kristan@lshtm.ac.uk)

P012

Locally Led Community Mobilization at Scale for IRS in Uganda's Eastern Region

Bradley Longman, Abt Associates/PMI VectorLink Project, USA

Successful malaria vector control programs must grow from the priorities, practices, and political will of their targeted communities in order for malaria gains to be truly sustainable. Consequently, the U.S. President's Malaria Initiative (PMI) is committed to meaningfully and equitably strengthening the power of local actors to inform and lead efforts to combat malaria in their communities. In Uganda, the PMI VectorLink Project partners with the Communication for Development Foundation Uganda (CDFU), a local organization with strong ties to the community, to provide expertise and leadership for IRS community mobilization as well as the project's ongoing social and behavior change activities. CDFU works closely with district and sub-county task forces to lead interpersonal communication, community mobilization, community dialogues, mass media, and distribution of IEC materials. This presentation will highlight the methods and approaches CDFU and the PMI VectorLink Project use in Uganda to build community understanding, knowledge, and support for IRS. (E-mail: brad.longman@yahoo.com)

P013**Zanzibar Malaria Elimination efforts: Entomological foci investigation and responses**

Juma Mcha, Zanzibar Malaria Elimination Programme, Tanzania

Background: Following the low levels of malaria prevalence of less than 1% over the last decade on the Island, malaria residual transmission was recorded. Routine entomology surveillance was conducted in 10 sites on the Island of Zanzibar to monitor the important entomological parameters. Entomological foci investigation and response are additional efforts conducted proceeding with the notification of local malaria cases to identify entomological risk factors that drive the residual transmission within the community.

Methodology: Three methods for adult mosquito collection were deployed, including HLC, CDC Light traps, and PSC. Two houses were selected for HLC, and baits were used 2 indoor and 2 outdoor from 6:00 pm – 06:00 am hours. The CDC Light traps are used to catch host-seeking vectors while the PSC method is used to collect endophilic mosquitoes.

Conclusion. Malaria Index houses found with malaria vectors are sprayed with Clothianidin. (E-mail: jhmcha@gmail.com)

P014**Impact of next-generation dual-active ingredient long-lasting insecticidal net deployment in Tanzania on insecticide resistance in *Anopheles funestus* s.l. and *Anopheles gambiae* s.l.**

Louisa Messenger, University of Nevada, Las Vegas, USA

Insecticide resistance among mosquito species is now a pervasive phenomenon, which threatens to jeopardize global malaria control efforts. Novel vector control tools, including long-lasting insecticidal nets (LLINs) incorporating new active ingredients with different modes of action are urgently needed to delay the evolution and spread of resistance. During a four-arm cluster-randomised trial in Misungwi district, Tanzania, evaluating the effectiveness of (1) Royal Guard, a LLIN combining pyriproxyfen and alpha-cypermethrin; (2) Interceptor G2, a LLIN combining chlorfenapyr and alpha-cypermethrin; (3) Olyset Plus, a LLIN combining piperonyl butoxide (PBO) and the pyrethroid permethrin; compared to (4) Interceptor, a standard alpha-cypermethrin LLIN, we measured longitudinal trends in insecticide resistance among >46,000 wild mosquitoes collected over 36 months. Prior to LLIN distribution, pyrethroid resistance was high, with 30-min knock-down ranging from 43.7-59.4% for *Anopheles funestus* s.l. and *An. gambiae* s.l. following exposure to alpha-cypermethrin and mean 24-hr mortality of 38.3-56.5% in permethrin bioassays. Following LLIN distribution, we detected a significant increase in permethrin resistance intensity in *An. funestus* s.l. across all trial arms. Levels of alpha-cypermethrin resistance also increased but only in clusters which received Interceptor® or Royal Guard. PBO pre-exposure restored permethrin susceptibility among vector populations and high levels of chlorfenapyr susceptibility were also observed. We assessed oviposition inhibition to pyriproxyfen using dissection 3-days after exposure with variable results between trial years. Study findings highlight increasing pyrethroid resistance intensity in *An. funestus* s.l. associated with the deployment of next-generation LLINs, with additional work required to thoroughly understand the operational implications and potential mechanisms driving cross-resistance. (E-mail: louisa.messenger@unlv.edu)

P015**Policy, People and Resources: Why some countries have scaled up with School-based distribution, others have not, and subsequent recommendations.**

Jane E Miller, PMI VectorLink, PSI, UK

School-based distribution (SBD) channels, where ITNs are distributed to students in schools, have been piloted by several National Malaria Programs (NMPs). In two countries, SBDs have been scaled up to national level. To explore how countries determine whether to scale up SBD following pilots, VectorLink conducted 30 key informant interviews with NMPs, implementing partners, donors and global experts. Additionally, the study aimed to gather lessons learned from SBD implementation as well as recommendations for future scale up.

The importance of getting the right people in the room with the right evidence and resources was emphasized. Existing stakeholder commitment or project support is needed to drive the agenda during the initial stages of SBD implementation. To enhance SBD implementation, countries with existing, mature SBD channels should provide technical assistance to help scale-up in other countries. Additionally, future scale up of SBD could consider how to increase coverage of hard-to-reach groups.

This activity straddles both Task team 3 and 4 of the EICI Work stream 1. From Task team two it touches on capacity building and localisation of ITN distribution and also it addresses issues of access to ITNs (Task team 4). (E-mail: jmiller@psi.org)

P016**Resistance Pattern of Major Malaria Vectors to Insecticides Commonly Used for Malaria Control in Africa: Meta-analysis and Systematic Review**

Awoke Minwuyelet, Debre Markos University, Ethiopia

Background: Malaria is the major public health problem in the African region. Since the 1940s, different classes of insecticides were used to reduce malaria transmission and vector control. However, the efficacy of insecticides is reduced periodically. This study aimed to assess the susceptibility status of dominant malaria vectors to insecticides commonly used for malaria control in Africa.

Materials and Methods: Public databases were used to access relevant published articles from 2002-2021. Data were extracted from the included articles' text, tables, figures, and supplementary files. Finally, the findings of those studies were presented in a table, graph, and maps.

Results: From 1742 searched articles, fifty relevant articles were retrieved and extracted. Of those articles, different insecticide resistance was reported in different countries and countries used insecticides selectively which *Anopheles gambiae* sensu lato and *An. funstus* susceptible. Organochlorine, pyrethroid, and carbamate resistance of *An. gambiae* s.l and *An. funstus* was recorded across Africa in last 20 years. However, the resistances of those malaria vectors were different in various locations or countries. Organophosphate especially malathion, pirimiphos-methyl 0.25% and fenitrothion, have shown the current option of insecticide used to prevent malaria vectors in areas where the resistance of other insecticide classes was recorded. Insecticide resistance was highly recorded from 2010-2015 in Africa. Currently, organophosphates are receiving considerable attention as

candidate chemicals for residual spraying in the malaria control program. (E-mail: awokeminwuyelet5@gmail.com)

P017

Potential of Metal-Based Nanoparticles in the Fight against Mosquito Vectors (Diptera: Culicidae): A Systematic review

Awoke Minwuyelet, Debre Markos University, Ethiopia

Background: Nanoparticles (NPs) are small particles which have strong mosquitocidal effects. They are cheap, simple to prepare and eco-friendly. The aim of this review is to explore the application of metal NPs against the fight of medically important vectors.

Methods: International electronic databases were used to access potentially relevant articles published from 2011-2021. Relevant data were extracted from text, table, and figures of the included articles. The validity of all included articles was checked before inclusion by undertaking critical appraisal using standardized tools.

Result: In total 65 original articles were reviewed. A total of 83 laboratory experiment were tested using metal NPs, like, Silver (Ag), Gold (Au), Palladium (Pd), Cobalt (Co), Titanium dioxide (TiO₂), Nickel (Ni), Copper (Cu), Cadmium (Cd), Selenium (Se), Zinc (Zn), Magnesium oxide (MgO), Iron and Iron oxide (Fe and Fe₂O₃) and Aluminum oxide (Al₂O₃) NPs and found effective against different larval instar, pupa and adults of *Aedes aegypti*, *Ae. albopictus*, *Anopheles stephensi*, *An. subpictus*, *Culex. quinquefasciatus*, and *Cx. pipiens* with satisfactory LC₅₀ and LC₉₀ value. The effect of each NP to non-target organism needs detailed analysis. In addition, guidelines for the application of NPs should be adopted. (E-mail: awokeminwuyelet5@gmail.com)

P018

Effect of Health Education Community Leaders among Households on Utilization of Long-Lasting Insecticide Treated Nets for Malaria Prevention in New Halfa Locality, Kassala State, Sudan (2017-2020)

Bakri Nour, Faculty of Medical Lab. Sciences, Depart. of Parasitology, University of Gezira, Sudan

Malaria fever is still a major global public health problem with over 3.3 billion people at risk annually. Most deaths from malaria occur in children under 5 years of age. This study aimed to assess the effect of health education on the usage of LLINs as a malaria prevention intervention in New Halfa locality in 2017. A randomized community trial (control intervention) study was conducted in New Halfa locality among two communities were randomly assigned to intervention group which receive health education messages regarding the use of LLINs and control group where there is no health education. A total of 3583 household from 10 villages were randomly selected, 1825 households from intervention villages and 1758 were from comparison villages. The overall mean knowledge of households, in intervention villages, about breeding sites was significantly increased from 2.2 to 2.4 ($p < 0.05$), malaria control from 1.9 to 2.1 ($p < 0.05$), uncomplicated malaria symptoms from 2.5 to 2.7 ($p = .000$), severe malaria symptoms from .7 to .9, ($p = .000$), uncomplicated malaria treatment from (.8) vs. (.9), ($p = .028$), severe malaria treatment (.8) vs.

(1.0), ($p=.003$) and net washing from (5.1) vs. (5.4), ($p=.000$) were greater in intervention villages versus control village due to health education intervention during LLINs distribution campaigns in the targeted villages, $p < 0.05$. The ownership of bed nets was 100% in control village during survey, survey II and survey III, but the ownership was slightly decreased in intervention villages during survey (99.4%) and during survey III (99.6%). The proportion of households slept under nets was not significantly slightly increased in intervention villages (51.9%) compared to control villages (48.1%). This study has demonstrated the effectiveness of health education packages through community leaders as vital tool for improving the knowledge of malaria and LLITNs utilization. (E-mail: bakrinour@gmail.com)

P019

Different approaches to measure the quality of facility based ITN distribution

Luigi Nuñez, PMI VectorLink, PSI, USA

In the WHO African Region, 32 countries distributed ITNs through ANC and 24 through EPI in 2022. Studies and routine DHIS2 data revealed these channels perform drastically different across countries, and although supportive supervision is considered effective for identifying barriers to optimal service delivery and improving malaria case management in Sub-Saharan Africa, literature is limited, if not non-existent, on the topic of quality improvement of facility based ITN services. Quantitatively, it is unknown which barriers most impede optimal performance of these channels. PMI VectorLink has supported NMCPs to conduct supportive supervision of facility based ITN distribution and will showcase different measures used to assess the quality of these channels and share common findings. For example, different measures in Ghana and Niger all show that logistics management is the lowest performing aspect of these channels, and that provider adherence and data quality may not be as problematic as some insinuate. (E-mail: lnunez@psi.org)

P020

Using a complex data management system to deploy and monitor ATSBs (Attractive Targeted Sugar Baits) in Siaya County, Kenya

Caroline Ogwang, KEMRI Center for Global Health Research, Liverpool School of Tropical Medicine, Kenya

ATSB 'bait stations' are A4-sized panels containing thickened fruit syrup laced with dinotefuran, a neonicotinoid insecticide, which are designed to attract and kill mosquitoes. A cluster-randomised trial to evaluate ATSB for malaria control is currently ongoing in Kenya, Zambia, and Mali. In Kenya, 66,000 ATSBs were deployed in March 2022, covering 9,000 compounds in 79 villages. Approximately 300 staff are required to deploy the ATSBs, which are replaced every 6 months. Each ATSB has a unique QR code, and all households have been mapped. QGIS software is used to ensure that the ATSB stations are deployed within the cluster boundaries. ATSBs are monitored every 2 months by a team of field monitors who evaluate and replace ATSBs, if needed. This complex data management system has ensured adequate ATSB coverage and assessment of their status during the trial period. We will review the data management system and discuss lessons learnt. Other authors: Oliver Towett, Margaret Muchoki, Brian Polo, Daniel McDermott, Brian Seda, Feiko ter Kuile, Sarah Staedke. (E-mail: caroline.ogwang@lstmed.ac.uk)

P021**Reflecting back on implementation of facility based ITN distribution in Ghana using 7 years of DHIS2 data**

Prince Owusu, Population Services International (PSI), Ghana

Analyses of routine DHIS2 data revealed that Ghana is successfully implementing facility based ITN distribution. In 2016, 40% of pregnant women at ANC and 53% of children at EPI received an ITN. In 2022, this increased to 94% at ANC and 93% at CWC, 15 of the 16 regions maintained the national 80% strategic target, all health facility levels (e.g., hospitals, health centers, CHPS) performed at or above 80%, and both public and private facilities performed at or above 80%. Odds ratios further demonstrated there exist statistically significant differences in the likelihood of meeting the 80% strategic goal within facility types and ownership. In a country where 98% of pregnant women attend at least one ANC visit, these results reinforce the importance and necessity of routine distribution of ITNs through health facilities to prevent malaria among some of society's most vulnerable populations. E-mail: powusu@psighana.org)

P022**Role of *Anopheles stephensi* in urban malaria and it's control in India**

Sharma Rajander, UNIDO, India

Till 1950s malaria in urban areas was considered to be a marginal problem restricted to mega towns only. The phenomenon of urbanization has in recent past assumed a highly challenging status particularly with reference to malaria dynamics so much so that urbanization is being feared to transform malaria from a historically rural disease to that of an urban form. By 1970s, incidence of rural malaria came down drastically but the urban towns reported a rising trend. There is so much of difference between the rural and urban housing settings and environments that the urban malaria warrants to be dealt with distinctive intervention strategies. Unlike the rural India where as many as nine malaria vectors occur, in the urban agglomerations only *Anopheles stephensi* is the vector.

Before the launching of the National Malaria Control Programme in 1953, urban malaria was a problem in Bombay (now Mumbai) and a few more towns but its control was managed largely by source reduction and biological control. Historically, in India, urban malaria was the problem in port cities and later invasion of *An. stephensi* in towns along the rivers or excessive digging of wells introduced malaria in other towns e.g. Delhi, Lucknow, and Hyderabad etc. Malaria entered most of the Indian cities along with the piped water supply and the process is leading to the invasion of *An. stephensi* in the urban areas followed by the *Aedes aegypti*.

The rapid urbanization and deficient water supply necessitated the water storage practices, malaria in urban settings favoring creation of more mosquitogenic conditions, thereby resulting in increased transmission of vector borne diseases. *Anopheles stephensi* transmitted Urban Malaria started in 1971 in India and at present Urban malaria programme functioning in 131 towns covering a population of 142.9 million. The total malaria case load is though steady around 0.1 million cases annually since 2005 in Urban Malaria towns. There, has shown a declining trend since 2014. When interpreting API, it is important to evaluate the level of surveillance activity indicated by the annual blood examination rate. At low levels of surveillance in urban areas, the Slide Positivity Rate (SPR) may be a better indicator. The SPR has also shown gradual decline from 2.25 in 2005 to 0.06 in 2020. The

reported Pf cases declined from 14905 in 2005 to 1938 cases in 2020. The Pf % has gradually increased from 11.02 in 2005 to 0.49 in 2020.

This paper will highlight the existing health and governance structures, strategies and vector control intervention for urban malaria and its vector, *Anopheles stephensi*. (E-mail: ranjandersharma@gmail.com)

P023

The value of hydrological indicators towards understanding malaria transmission in a remaining malaria burden region: Limpopo Province, South Africa.

Megan Riddin, University of Pretoria, South Africa.

Malaria control strategies have contributed to an estimated averted 1.5 billion cases and 7.6 million deaths since 2000, however, progress has slowed in many regions. Limpopo Province is the region with the greatest remaining malaria burden in South Africa (SA). Sharing borders with Mozambique, Zimbabwe and Botswana, this province continues to experience persistent malaria despite active control efforts. As malaria presence is inextricably tied to water, it is apparent that this factor is a vital part of malaria epidemiological assessment. In Limpopo, a region where water availability is known to limit mosquito breeding, hydrological indicators may provide or contribute towards understanding and predictive tools. Such understanding of transmission, vector dynamics and hydrology allows a deeper insight into malaria force of infection, and may assist towards addressing persistent and remaining malaria burden in the region.

This study aimed to identify the value of surface hydrology, specifically river discharge, in understanding and addressing malaria persistence in Limpopo Province. Data was obtained from hydrological gauging stations which form part of river monitoring systems in SA monitored by Department of Water Affairs & Sanitation (DWS). The five components of a flow regime including magnitude, frequency, duration, timing and rate of change, were assessed against historical malaria case incidence (1999 – 2022) obtained from the Limpopo Provincial Malaria Control Programme, for identification of determining factors. Additional assessment was performed against water quality constituent data deemed important to aquatic health and obtained from DWS water quality sampling networks.

Investigations showed apparent statistical relationships between malaria incidence and surface flow in river systems across selective case study sites, including uncontrolled reference catchments (no impoundments) and controlled systems (with impoundments). Physiochemical parameters are deemed important to aquatic health, and therefore vector presence and malaria transmission. Preliminary evidence suggests that while concentrations of certain conservative constituents increased with a decrease in flow, there is little evidence to suggest an influence in malaria incidence due to rise during low flow periods.

The identification of such contributing measurable and monitored surface hydrological parameters will assist towards epidemiological understanding and form an integral component of future predictive and decision-making tools. (E-mail: megan.riddin@up.ac.za)

P024

Over-spraying in IRS trials: a real or imagined problem for IRS assessment?

Mark Rowland, LSHTM, UK

Assessment of insecticide application rate on walls by means of filter paper discs is critical to evaluation of IRS products. If the insecticide concentration on sprayed discs falls significantly above or below the target concentration, authorities reviewing the efficacy data may question its validity or reject the findings. Over-spraying of filter paper discs is a consistent trend in experimental hut and community trials. We examined the problem by taking three approaches: chemical analysis of filter paper discs, qualitative analysis of spray operator behaviour, assessment of volume of solution sprayed per unit area in sentinel houses. The filter paper discs were persistently over-sprayed despite instructions and training; spray operators unconsciously or consciously over-sprayed discs encountered. However, the volume sprayed per unit area in sentinel rooms was mostly on-target, and therefore the problem exaggerated. Focus groups with operators revealed several reasons for over-spraying discs. Taking a multi-disciplinary approach may get closer to the 'real truth'. (E-mail: Mark.rowland@lshtm.ac.uk)

P025**Crystalline insecticides and their presentation in VC products**

Svetlana Ryazanskaya, IVCC, UK

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P026**Overcoming Insecticide Resistance in Anopheles Mosquitoes by using Faster-acting Solid Forms of Deltamethrin**

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P027**Strengthening Systems for Improved Vector Control Data Management, Analysis and Use**

Kate Stillman, PMI VectorLink Project (Abt Associates), USA

Over the past five years, the U.S. President's Malaria Initiative (PMI) VectorLink project has demonstrated the utility of DHIS2 software for standardized collection and management of integrated vector control data. PMI investments in the project's central DHIS2-based system, VectorLink Collect, have generated important lessons on the use-case of DHIS2 for malaria vector control and contributed directly to strengthening government-owned data management systems and digital tools for vector control data. PMI VectorLink has worked in close collaboration with the World Health Organization (WHO) to align vector control and entomological DHIS2 metadata packages that are available as digital public goods and serve as an accessible starting point for national malaria programs to integrate this data into national systems. This presentation will highlight successful use of DHIS2 for vector control and entomological data and synthesize implementation experiences. (E-mail: kathryn_stillman@abtassoc.com)

P028**Implementation of larval source management to control *Anopheles stephensi* in Ethiopia**

Gashu Zegeye, Abt Associates-PMI VectorLink, Ethiopia

Anopheles stephensi, an invasive malaria vector, has been identified in 48 urban/peri-urban and rural sites across Ethiopia since 2016. The U.S President's Malaria Initiative (PMI) supports the Ethiopian National Malaria Elimination Program (NMEP) through PMI VectorLink Project to pilot implementation of larval source management (LSM) in six towns to control this vector and mitigate disease impacts. In 2022, the project developed a standardized implementation guide, recruited, and trained over 360 community-based technicians to implement LSM and conduct entomological monitoring activities. The initial larval habitat enumeration exercise identified a total of 839,174 habitats within 73,765 properties. Over four weeks of baseline entomological data collection, consolidated *Anopheles* larval densities from 229 tracked larval habitats were 13.83 and 5.73 *Anopheles* larvae/20 dips/day for early and late larval stages, respectively. Since August 2022 larval habitats of five towns and three high-burden neighborhoods in Dire Dawa have been either treated with larvicide or source reduced. (E-mail: gashu_zegeye@pmivectorlink.com)

P29**WHOPES methods holding back LLIN improvement, a suggested improvement**

Ole Skovmand, Vegro Aps Denmark

Regeneration time is a key parameter in evaluation of LLIN because it is used to define wash intervals in lab and semifield tests. Insecticides are not soluble in the polymers or coatings so they migrate to the surface in a never ending blooming process. Therefore, the longer wash interval, the more is washed off. Regeneration time as measured in mortality tests is limited by the 100 % threshold often reached day 1. Chemical analysis of surface concentration from solvents like cold acetone include recrystallized that has little biological effect. Therefore, bioassays and chemical methods must be combined to understand the regeneration process and thus make better predictions of chemical durability. We introduce a new wash resistance index WRI_{0,1-5} that we combine with MKDT determination to provide methods that better predict LLIN efficacy. Alternatively, resistant mosquitoes can be used. (E-mail: ole@insectcontrol.net)