MEETING REPORT

2023 Annual Conference, Asia Pacific Malaria Elimination Network (APMEN) Vector Control Working Group (VCWG)

23 & 24 November 2023, Lancaster Hotel, Bangkok, Thailand

Malaria Elimination: Emerging Challenges and Opportunities

Introduction

The Asia-Pacific Malaria Elimination Network (APMEN) was founded in 2009 as an outflow of high-level motivation by the then-Prime Minister of Australia, Kevin Rudd, who identified the need for coordinating and supporting structure to support the malaria elimination objectives of malaria-endemic nations in the Asia-Pacific Region. In 2013 the Asia-Pacific Leaders Malaria Alliance was established (APLMA), with the Prime Ministers of Australia and Viet Nam as co-Chairs. Since those early years APMEN and APLMA have worked closely together to complement their respective mandates towards supporting the current 22 Member States in their various malaria-reduction endeavours, with APMEN having a primarily technical mandate and APLMA more focused on Advocacy and facilitating opportunities for networking and coordination between member states. APMEN achieves much of its technical support through its three technical working groups, these being the Vivax Working Group, the Surveillance & Response Working Group, and the Vector Control Working Group. Each of these Working Groups has a separate Annual Conference each year to provide a platform for members of those specific working groups to convene and discuss thematic areas, receive input on Workplans, and have presentations for updates on international trends and state of the art. Due to funding limitations, APMEN provides funding support for only working group to convene an in-person conference each year, while the other two hold virtual conferences. This year it was the turn of the Vector Control Working Group to host an in-person annual conference.

The conference was held over one and a half days, that being Thursday 23rd November and Friday 24th November. The dates were chosen to fall between the 22nd RAI RSC Meeting in Siem Reap (Cambodia) and The Asia Pacific Conference on Mosquito and Vector Control (AMV)-2023 organized by Kasetsart University in Chiang Mai, to capitalize on country representatives already being in the region and easily moving from one meeting to the other.

The APMEN VCWG Annual Conference was attended by 54 persons on-site, of which 20 were senior National Malaria Control Programme and government staff (37%), plus many representatives from research/academic institutions (17%), multi-lateral institutions, donor organizations (e.g Gates Foundation) (2%), Technical Partners (e.g IVCC), Commercial Partners (e.g Mitsui, Sumitomo) (19%) and NGOs (26%), see Figure 1 for participants' demography. An additional 74 online participants listened in to the event and actively participated by way of Zoom Q&A. In terms of sector wise, the online attendees were majority from academic/research institutions (37%), followed by government agencies (29%), NGOs (12%) and private sectors (12%).

The conference was centred around three thematic areas that we had identified for specific inputs, discussion, and outputs. These were:

1. New tools and approaches against Outdoor-Biting mosquitoes (six presentations and a Group Discussion);
2. Capacity shortfalls in Medical Entomology and identifying specific needs and solutions (three presentations and a Group Discussion);
3. Creation of dedicated workstreams within the APMEN VCWG (two presentations and a Group Discussion).

In addition to the above-mentioned focused discussions on particular themes, there were also a number of Learning Talks to provide insights on various vector control-related topics, as well as country updates from NMCP Managers/Directors to give update on malaria status in their countries. A total of 23 presentations were given by subject specialists from around the world, some presented on-site but some online.

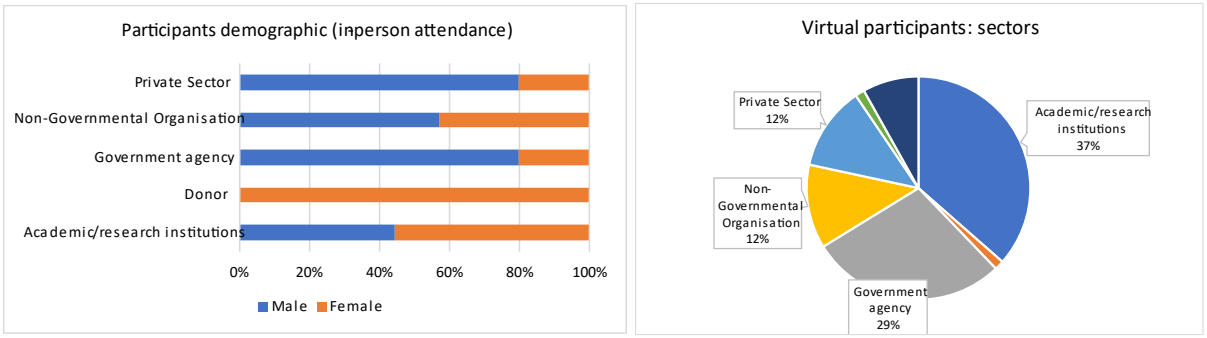


Figure 1 In-person and virtual attendees' demography: sector wise

The Conference Programme is attached herewith as Appendix 1.

Figure 2 Group photo of participants and speakers of the 2023 APMEN VCWG Annual Conference

SUMMARY OF CONFERENCE PRESENTATIONS

1. Report on APMEN VCWG activities during 2023 *(Leo Braack, Co-Chair APMEN VCWG)*

Leo spent ten minutes giving an overview of the APMEN VCWG activities during 2023, which can be summarized as follows:

- The annual two-week intensive in-person "Malaria Vector Surveillance for Elimination (MVSE)" course, which was very successfully held between 3-14 July in Salatiga, central Java, Indonesia, in collaboration with the Indonesian Institute for Vector & Reservoir Control Research & Development and the Indonesian Institute for Parasitic Diseases Control; 22 national nominees from Malaysia, PNG, Indonesia, Timor Leste, and Pakistan received training, funded by the USA Centres for Disease Control & Prevention;
- A four-day online training course on "Strategic Planning for Malaria Vector Surveillance & Control", presented by Dr Pradeep Srivastava, during August;
- Four APMEN TechTalk and two APMEN Xchange webinars;

- An ongoing "Country Capacity Situation for Malaria Vector Control & Surveillance", led by James Cook University in Cairns, Australia, in collaboration with APMEN VCWG;
- Ongoing maintenance of the Online Resource Exchange Network for Entomologists (ORENE)" website;
- Our APMEN VCWG Annual Conference.

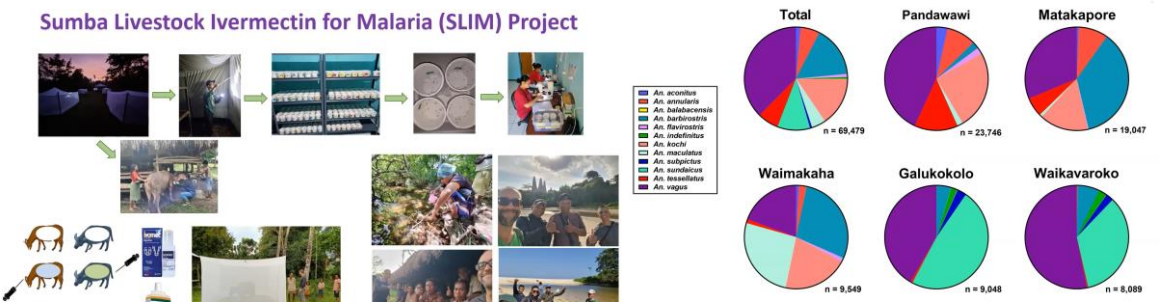
Leo then outlined the anticipated activities for 2024, which comprise:

- The 5th MVSE course which is scheduled for June in Madang, PNG;
- A four-day online training course on "Developing an effective malaria vector surveillance programme"
- A five day on-site in-person training course on PCR identification of malaria vectors;
- A South-South Exchange visit between *Anopheles stephensi* experts from South Asia and African colleagues;
- A research project on new vector tools against outdoor-biting mosquitoes;
- Continuation of the APMEN TechTalk webinar series;
- Maintenance of the ORENE website;
- Online Annual Conference.

2. Impact of standard and long-lasting ivermectin formulations on wild *Anopheles* in cattle and buffalo on Sumba Island, Indonesia *(Kevin Kobylinski, Mahidol Oxford Tropical Medicine Research Unit (MORU)*

Sumba Island has some of the highest diversity of *Anopheles* species in Indonesia, contributing to its disproportionately high malaria incidence. Southwestern Sumba, the area with highest malaria burden on the island, has small livestock holder systems where the animals (*e.g.* cattle, buffalo, horses, and pigs) are kept near the owners' house at night time, often underneath the house. *Anopheles* mosquitoes frequently blood-feed on livestock providing an opportunity for vector control by treating the animals with insecticides. Ivermectin is a systemic endectocide used to control helminth and ectoparasites in livestock, and ivermectin-treated hosts are lethal to *Anopheles* vectors. Both standard (Ivomec®) and long-lasting (Ivergen® Platinum) commercial formulations of ivermectin were investigated in cattle and buffalo in this study. Five villages were selected to maximize the diversity of *Anopheles* species. In each village, three cattle and three buffalo were treated with either standard (200 µg/kg), long-lasting ivermectin (630 µg/kg), or kept untreated as controls. Study animals were placed in net traps, which allowed mosquitoes to enter and blood feed on the animals. Mosquitoes were collected by mouth aspiration. Animals were exposed to mosquitoes before treatment and up to 72 days post treatment. Blood-fed *Anopheles* were transported to a field insectary where their survival was monitored daily, dead mosquitoes removed and identified, and ten days later the mosquitoes were frozen and counted as alive. Ten *Anopheles* species were frequently collected including: *An. aconitus*, *An. annularis*, *An. barbirostris*, *An. flavirostris*, *An. kochi*, *An. maculatus*, *An. subpictus*, *An. sundaicus*, *An. tessellatus*, and *An. vagus*. Cattle and buffalo treated with standard ivermectin (Ivomec®) were lethal to all *Anopheles* species for 16 and 8 days post-treatment, respectively. While cattle and buffalo treated with long-lasting ivermectin (Ivergen® Platinum) were lethal to all *Anopheles* species for 72 and 56 days post-treatment, respectively. This is the first time a commercially available, long-lasting ivermectin formulation has been evaluated against *Anopheles* survival, and the first time this potential vector control measure has been evaluated in buffalo. Long-

lasting ivermectin provides superior mosquito-lethal effect to wild blood-feeding *Anopheles* compared to standard ivermectin and could be considered for mass deployment as a malaria control intervention.



3. Building capacity for evaluation and implementation of alternative vector control tools in Papua New Guinea: Spatial emanators and larval source management *(Stephan Karl, Principal Research Fellow, James Cook University)*

The malaria burden in Papua New Guinea is equivalent to almost 90% of the malaria burden in the Western Pacific Region. It is here where regional malaria elimination will be decided. Malaria cases in PNG have been increasing since 2015, and incidence has doubled. The reasons for this increase are believed to be multifactorial, including quality issues with bed net products being the mainstay of malaria vector control in the country, but also sustained outdoor transmission that may be further intensified by behavioural changes of humans and mosquitoes. The confirmed emergence of pyrethroid resistance in local Anopheline populations is a further threat to the malaria vector control effort in PNG.

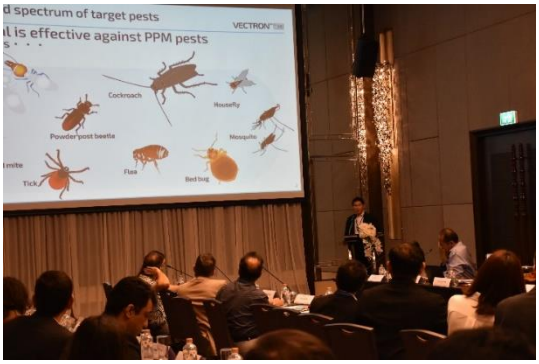
Bed nets in PNG are the only vector control tool distributed at the national level, financed predominantly by multilateral donor funding. There is currently only a very small vector surveillance and control workforce in PNG that is sustained within the national malaria control program, and very few resources to expand the vector control effort. There is also little evidence on the effectiveness and acceptability of alternative VCTs such as indoor residual spraying, larval source management and volatile pyrethroid spatial emanators.

Over the last 4 years, funded by the Innovative Vector Control Consortium, the PNG Institute of Medical Research and partner organisations have been working under the guidance of the PNG National Malaria Control Program to generate the evidence and build the capacity to enable the implementation of alternative vector control tools in the PNG setting. This has included building the research capacity to test alternative VCTs, several pilot implementation trials and the formation of a national Vector Control Stakeholder Network to leverage multisectorial vector control resources. My presentation will provide an update about these efforts.

4. **New IRS Compounds (Clothianidin, Vectron T500, etc)** *(Dr Christen Fornadel, Senior Technical Coordinator, Innovative Vector Control Consortium IVCC)*

This talk focused on 3rd generation IRS products, which are non-pyrethroid products lasting for at least 6 months on various surfaces. These products make up the vast majority of IRS conducted across sub-Saharan Africa today due to resistance and residuality issues. The first 3rd generation IRS product to come to market was Actellic 300CS, the organophosphate pirimiphos-methyl, which was recommended by WHOPES in 2013. In 2017 a second class of 3rd generation IRS product, containing the neonicotinoid clothianidin, was recommended, beginning with Sumishield in 2017 and Fludora Fusion in 2018. Two generic competitors for Sumishield and Fludora were approved in 2021, and the most recent addition to the IRS marketplace, Vectron T500, the meta-diamide broflanilide, was recommended in 2023. Sumishield and Fludora Fusion have shown 6-12 months of residuality on various surfaces, with Vectron T500 providing at least 18 months of protection in Benin. There are currently 3 additional IRS products in the WHO prequalification pipeline. Unfortunately, there has been an approximately 25% market drop in IRS procurement volume between 2022 and 2023, and this decreasing trend is expected to continue through 2026 even with the introduction of VectronT500 and potential other new IRS compounds due to higher LLIN prices and distribution costs impacting overall vector control budgets, leading to decreased support for IRS from donors. On the other hand, there is an increasing trend of national or institutional public-private partnership IRS procurement, but it is yet unknown how much that will increase demand in the medium term. To encourage the trends being seen in public/private partnerships for IRS, IVCC in its New Routes to Market work has been supporting National Malaria Programs in select countries to increase funding and expand coverage of IRS and eventually other Vector Control tools through public private partnerships.

5. **Introduction of VECTRON T500: Novel IRS Product with new mode of action** *(Takeo Maezawa, Director: Vector Control Group, Mitsui Chemicals, Japan)*



Rotation of insecticides with different modes of action for indoor residual spraying (IRS) is recommended for improving malaria vector control and managing insecticide resistance in vector populations. At present, there are only products with two modes of action available for implementation of insecticide resistance management, limiting options for countries on product choice, and making the emergence of resistance more likely. Therefore, novel products containing insecticides with new modes of action must be developed, registered, and deployed.

VECTRON T500, new IRS product recently prequalified by WHO, containing the novel meta-diamide insecticide TENEBENAL™ (common name: Broflanilide) with new mode of action, would contribute as a new tool of insecticide rotation. VECTRON T500 could be a game-changing product for malaria control.

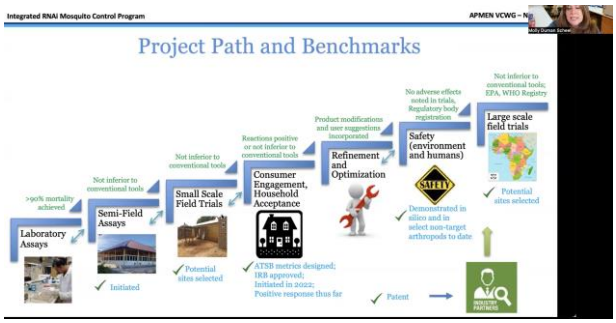
The presentation will explain characteristics of VECTRON T500, its efficacy against vector mosquitoes with trial results, and proposed positioning within the insecticide resistance management.

6. **Gene drive for mosquito-borne diseases** *(Prasad Paradkar, Group Leader: Human Health Programme, CSIRO, Australia)*

With increasing vector-borne diseases around the world, there is a need to explore novel approaches to reduce the impact of these diseases. Gene drives are selfish genetic elements which are transmitted to their progeny at super-mendelian frequencies. Advances in genetic manipulations, via CRISPR-Cas9 technology, provides a scalable and efficient way to introduce phenotypes in a population. This can be used for mosquito population suppression via causing female lethality, male sterility or introducing phenotypes such as flightless, reducing host attractiveness. Mosquito population replacement can be achieved by targeting vector competence of mosquitoes or directly targeting pathogen. Although laboratory studies have shown promise, there are some limitations to its field use. Given self-spread, there are concerns regarding containment of this gene drive technology. The gene drive sustainability is also dependent on the target gene. Therefore, there is a need to be social licence to use this technology in the field, backed by extensive risk analysis. Gene drive provides a novel approach to combat the vector-borne diseases to protect the vulnerable population.

7. **RNAi Yeast: A second-generation ATSB** *(Molly Scheel, Professor: Dept of Medical & Molecular Genetics, Indiana University School of Medicine)*

Molly briefly introduced the recorded presentation by explaining that Attractive Targeted Sugar Baits (ATSB's) are a relatively new tool primarily aimed at outdoor-biting mosquitoes, where a sugar-based bait is combined with a toxic substance within a membrane-covered bag that is hung on outdoor walls of dwellings in areas subjected to mosquito-borne disease. This methodology is still undergoing Phase 3 field trials in Kenya, Mali and Zambia, using dinotefuran as active ingredient, and has yet to receive WHO endorsement, but it holds much promise and the experimental findings are highly encouraging. The group led by Molly has developed a new generation insecticide based on RNA interference (RNAi) for selective gene targeting. You pick a sequence in any gene of interest and based on that sequence you can try to silence or to turn off the gene. What Molly's group has done is to use genes that are required for the survival of mosquitoes, but looking for sequences that are not conserved in non-target organisms such as honeybees; this way one can be narrowly selective in targeting the host organism, and so one can pick sequences that are only found in mosquitoes. Molly elaborated on the work she and her group have been doing in refining this technique. They have been conducting field trials in Trinidad and are now partnering with others to produce large-scale yeast mixtures for field trials.



8. Group discussion and recommendation for APMEN to conduct experimental trial on one new tool for Outdoor Biting *(Facilitated by Michael Macdonald and Leo Braack)*

Leo explained that APMEN has made available some funding for conducting a trail on a tool for reducing outdoor biting. Having listened to the six presentations on different vector control tools primarily aimed at outdoor biting, Leo requested the collective wisdom of the conference participants to recommend which tool would be most appropriate for doing trials on and in which country. Forty-two participants contributed to the web-based Slido survey and the results are summarized below:

1. Which country are you from?
   Eighty one percent of respondents recorded themselves as being from one of the 22 Member States of APMEN (Asia-Pacific), whereas 19% recorded themselves as "Other".
2. Which tool would you suggest is the most practical for small-scale trial?
   The top two vector control tools recommended were Outdoor Residual Spraying followed closely by Attractive Targeted Sugar Baits.
3. Which country do you recommend as most appropriate (high transmission, good local research support)?
   The top recommendation was Papua New Guinea closely followed by Indonesia.

9. Current status of malaria in Pakistan, with reflections on the floods of 2022 and Climate Change consideration *(Muhammad Mukhtar, Director: Directorate of Malaria Control, Pakistan)*

Dr Mukhtar introduced his presentation by explaining that malaria is the second most prevalent disease in Pakistan, after Acute Respiratory Infections. There are approximately 300-400 thousand cases of malaria confirmed annually, of which 76% are due to *Plasmodium vivax* and 23% to *Plasmodium falciparum*. Pakistan is ranked 2nd highest burden for *P. vivax* in the world, after India. However, Pakistan has made a remarkable reduction in malaria burden (40% estimated caseload) as compared to 2015 (WHO report). Dr Mukhtar then showed a map with malaria stratification across Pakistan. The goal for malaria is a reduction of the malaria burden by 20% in 2023 compared to 2019 in the high-endemic stratum-1 Districts (API > 5/1,000 population). The strategies to combat malaria include:

- Early Diagnosis & Effective Treatment
- Multiple Preventions (LLINs, and IRS)
- Strengthening of Malaria Surveillance System (through DHIS-2)
- Improve Health Seeking Behavior through BCC and community mobilization
- Capacity Building of MCPs & HCPs

With regard to Climate Change and malaria transmission, he mentioned that:

- Between 2000-2020, Pakistan ranked as the 5th most affected country by climate change
- Pakistan total contribution to GHG emission is 0.8%
- In the last 50 years, Annual Mean Temp in Pakistan has increased by 0.8°C – 1.0°C.
- The number of heatwave days/year has increased by a factor of 5 in the last 30 years.
- During recent (2016-2022) heatwaves, the temperature exceeded 50°C in some parts of the county.
- Predictions are that by the end of this century temperature rise will be 3°C - 4°C
- Annual R/F has historically shown high variability but has slightly increased in the last 50 years.
- 190% increase in rainfall leading to devastating floods (Sindh: 340% & Balochistan: 370%)
- Affected >65% of country and almost 30 M people had to live in temporary shelters
- 1740 including 648 people died
- Due to floods there was a marked rise in malaria cases in Sindh & Balochistan in July 2022
- In August country reached to a “State of Emergency”
- NMCP and WHO expert expected an extended and intense transmission season beyond December 2022 after the recession of flood water
- This outbreak is recognized as the heaviest resurgence in past 50 years.

With regard to vector mosquitoes in Pakistan:

- Of 24 Anopheline species, ONLY *An. culicifacies* has been reported as confirm/primary malaria vectors in Indo-Pak subcontinent since 1900's
- *An. stephensi* is secondary vector
- During field investigation in flood affected areas, surprisingly NOT A SINGLE specimen of *An culicifacies* was recorded; 20 times more malaria cases in these areas
- 97% mosquito samples were positive with *An. pulcherrimus*
- This situation raised some very important questions;
    1. In the ABSENCE of main malaria vector (*An. culicifacies*), which mosquito species is spreading malaria in flood affected areas?
    2. Is the flood water washed away the *An. culicifacies* and/or replaced with other species like *An. pulcherrimus*?
    3. What is the role of *An. pulcherrimus* in malaria transmission in Pakistan. Note: *An. pulcherrimus* is confirmed vector spp. in Iran and Afghanistan
    4. Is this replacement of *An. culicifacies* with *An. pulcherrimus* temporary or permanent? CLIMATE CHANGE??
    5. Questions are under investigation. If proven, might be the entire strategy for malaria control has to be revised.

The major interventions for vector control in Pakistan are:

1. **Core Interventions**
    - Insecticide-treated nets (ITNs/LLINs)
    - Indoor residual spraying (IRS) Mainly used for *Malaria Mosquito Control* in Pakistan

2. **Supplementary Interventions**
    - In specific settings, core interventions are supplemented by Larval Source Management (LSM)
    - Include the use of chemical-based Larvicides
    - Use of Bio-larvicides i.e. *Bacillus thrurengiensis* (BTI) and Spinocids since 2018
    - LSM is mainly used for *Dengue Mosquito Control* in Pakistan

3. **Outbreak Response**
    - Space Spraying (Thermal/Cold Fogging)
    - Only used for *Dengue Mosquito Control* in Pakistan

Challenges experienced by the programme include:

- Climate Change and its impact on Malaria VBDs
- Time and Target-Specific interventions
- Low Coverage of Interventions and acceptance (Rate of utilization 34%)
- Low domestic resources and over-reliance of donor support
- Quality of insecticides/ITNs (Non-WHO PQ Listed)
- Cross Border Collaboration (Pak-Iran-Afghanistan Malaria Network PIAM-Network)
- Up-gradation of data on Resistance in local vector species
- Promotion of IRS as campaign intervention 2024 onward

10. Status of malaria in Papua New Guinea *(Leo Makita, National Programme Manager, PNG)*

Mr Makita started his presentation with a quick overview of case numbers in PNG, stating that more than 90% of its >10 million population is at risk of infection. Malaria remains one of the leading causes of hospital admission and of recorded deaths. Around 1-1.5 million clinical "malaria" cases are reported annually (OPD + inpatients). Malaria mortalities reported are about 88 confirmed and 192 unconfirmed in 2022. All four species of human malaria parasites are present in PNG, with *P. falciparum*: 75%, especially in the coastal areas, islands and lowlands, while *P. vivax*: 25%, dominates in the highlands, *P. malariae* is identified occasionally., and *P. ovale* is also identified occasionally.

The most important vectors belong to the *Anopheles punctulatus* group: *An. farauti :* lowlands, coastal areas and others ; *An. punctulatus*: highlands, hills and mountains, and *An. Koliensis:* intermediate between lowlands and highlands. However, the genetic complexity of the group remains unresolved, with the following already clear: *An. koliensis* is at least 2 species; *An. farauti* is at least 6 species (No.1, No.2, No.3, No.4, No.5, No. 6); distinguishable only by genetic typing of chromosomes (no visible markings on body). Therefore, at least 9 known malaria vectors in PNG.

With regard to vector biting and feeding behaviour: *An. punctulatus* and *An. koliensis* are anthropophilic, feeding mostly indoors after midnight and mostly rest indoors after feeding. *An. farauti 1, is* an indiscriminate feeder, most active in evening and feed indoor and outdoor, may not rest indoor after feeding. The IMR research showed important behavioural differences associated with age of *An farauti* females: Early evening biters are younger females. Middle of night biters are older females.

Regarding the epidemiology of malaria in PNG: Complex epidemiology. Holoendemic (islands and coasts). Endemic (hills). Unstable epidemic (highlands). Complex host response. Strong protective genetic traits (G6PD deficiency, Duffy polymorphism, a and ß-thalassaemia). In the island and cost areas, both the prevalence of malaria infection and morbidity and mortality are highest in young children (<10 yrs old) and pregnant women. High level severe maternal anaemia and low birth weight among pregnant women and high level of splenomegaly and anaemia among children in the islands and coastal areas. Malaria attacks all age-groups in the highlands area, cause substantial high mortality during outbreaks.

Regarding programme objectives: Vision is a malaria-free Papua New Guinea (PNG) by 2030. The Mission is to ¡mprove, transform and provide quality malaria prevention and case management services through innovative approaches supporting primary health care and health system development and good governance at all levels. The malaria control and elimination programme will help to alleviate poverty amongst PNG's most marginalized people. Goals are to reduce malaria morbidity by 63 percent by 2025 (i.e. from 66.3 per 1,000 in 2019 to ≤ 25.8 per 1,000 in 2025); Reduce malaria mortality by 90 percent by 2025 (i.e. from 1.697 per 100,000 [146 deaths] in 2019 to ≤ 0.165 per 100,000 [16 deaths] in 2025); Eliminate malaria in the Autonomous Region of Bougainville by the end of 2025 and prevent reestablishment of transmission once malaria-free. There were 639,048 confirmed cases in 2019 (NHIS). NDoH will introduce subnational certification of elimination from 2028 based on zero indigenous cases for 3 consecutive years.

The major challenges of the programme include sustainable resourcing, capacity at implementation level, program management, health systems strengthening issues, new tools and strategies, human resource issues, and partner recruitment and maintenance.

11. Entomology courses in Thailand *(Theeraphap Chareonviriyaphap, Director: Graduate Programme, Dept of Entomology, Kasetsart University, Bangkok).*

Prof Theeraphap explained that the Faculty of Agriculture at Kasetsart in its Graduate Programme, offers a Master of Science Degree in Entomology and also a Doctor of Philosophy degree in Entomology, each of which offers either a "Research Programme" or a "Regular Programme". Each Programme covers a range of different options and topics. To qualify for an MSc degree, in addition to the coursework and thesis work, the candidate must also have published one scientific article, or at least have one accepted for publication, while for a PhD the candidate must have two published or accepted. Research areas at Kasetsart cover a wide range of topics, but fundamentally straddle the two fields of mosquito biology and vector control. Prof Theeraphap explained the different laboratory studies and facilities at KU and then showed the impressive range of field facilities available at their field station near Kanchanaburi.

12. The ArcTech/WHO TDR training in Medical Entomology initiative *(Freya Spencer; ArcTech Innovation, London School of Hygiene & Tropical Medicine)*

Training and innovation in the field of medical entomology are essential to mitigate the burden of vector-borne diseases globally. However, there is a significant shortage of medical entomologists worldwide, particularly in low- and middle-income countries most affected by vector-borne diseases. Mapping in 2016 draw attention to this shortage, highlighting that the majority of Medical Entomology training courses are focused in the Americas, are hosted in English with very few were available online, limiting the access globally.

To help bridge this gap, TDR has supported the development of a Global Atlas of Medical Entomology Schooling (GAMES), which lists a total of 126 medical entomology courses offered both on-campus and through distance learning in 32 countries across all WHO regions, covering seven languages. The online directory is hosted by the Global Vector Hub (GVH). GVH is an exciting new open-access online platform developed by the London School of Hygiene & Tropical Medicine (LSHTM) and Arctech Innovation, a spin-out company from the LSHTM. The GVH focusses on the surveillance and control of arthropod disease vectors. The Global Vector Hub is a community-led online platform to allow access to and exchange of information and data on vector control and vector biology. GVH hosts a worldwide **network** of vector researchers and people working in vector control, with organisations and individuals findable through a searchable registry.

During this talk at the Asia Pacific Malaria Elimination Network – Vector Control Working Group (APMEN VCWG) Annual Conference, I will explore the features of both the GVH network and the GVH-TDR Games directory, and the work we are doing to building capacity in medical entomology training.

13. Status of Entomological Training in Malaysia *(Khadri Sahar, Head: Unit Medical Entomology, Infectious Diseases Research Centre, and Dean of Applied Parasitology and Entomology, Institute for Medical Research, National Institute of Health, Malaysia).*

Training on Entomological continue relevant and important to Malaysia and regional countries. IMR has been constantly conducted Diploma in Applied Parasitology and Entomology (DAP&E) since 1970 (except in year 2020 & 2021 due to COVID-19). To date 695 graduates of DAP&E from 53 countries were trained. Four local universities provide few entomological subjects in their BSc. At the universities, focus on entomological have been carried at MSc and PhD levels based on request of collaboration and student needs. Malaysian Qualification Agency (MQA) is going to establish BSc in Entomology standard requirement for the universities. Three associations i.e., PEKA, ENTOMA and MSPTM have consistently offer entomological training to their members nationally and internationally.

DAP&E course is facing budget deficiency to continue train science or health officers/workers in entomological and parasitological works for participants from regional countries and worldwide. The fee for DAP&E course is still RM18,500 (US3950) since 2012. Source of funding from MOH (Ministry of Health Malaysia) is limited to our local academic lecturers, trainer's emolument, and free hostel for all DAP&E participants for 6 months. Whereas SEAMEO Trop Med has limited budget to 3 participants bench fee, books and meals allowance for their sponsorships. WHO recently sponsored a participant from Samoa which normally sponsored few participants every year. APMEN last sponsorship for participant was 2019 for three Indonesian participants. European Countries (EC), Asia Development Bank (ADB) have stopped sponsoring DAP&E participants since 2015. Malaysia Technical Cooperation Program (MTCP) has stop sponsoring participant for long course since 2015.

In relation to entomological training Government of Malaysia had endorsed Allied Health Profession Act 774 and be enforced since 2020 and thus all entomological works in the country have been regulated to provide its professional outcomes for the public and clients. Thus DAP&E, MSc, PhD, short courses of entomological training become more relevant, needed, updated, effective and accredited.

(DAP&E Application - https://imr.nih.gov.my/my/collaborations/1107-regional-centre-for-microbiology-parasitology-and-entomology)

14. Group discussion and recommendations for needs and expanded training for medical entomology in Asia-Pacific *(Facilitated by Leo Braack and Michael Macdonald)*

Leo explained that there is a global acknowledgement of the shortfall in medical entomology skills and capacity, and showed some of the peer-reviewed publications that reflect the findings of international surveys to demonstrate the high levels of capacity shortfalls. In order to get some additional insight into the situation in Asia-Pacific, APMEN VCWG requests participants to complete a quick online survey, outlined below:

Question 1: Which country are you from?

77% of the 47 survey participants indicated they were from one of the 22 APMEN Member States, and 23% “Other”.

Question 2: What are the fundamental public health entomology Human Resource shortfalls?

The majority of participants ranked “Too few field-level entomology staff” as highest priority shortfall, followed by “Too few basic-degree level graduates” and last was “Too few qualified PhD level graduates”.

Question 3: What are the basic skills gaps?

“Vector surveillance skills” was ranked as the most critical and highest priority capacity shortfall, followed by “Broad public health entomology understanding, all aspects”, followed by “Vector Control skills” and then “Malaria entomology skills” and finally “Arbovirus

Question 4: What kind of courses would best bridge these gaps?

The most highly ranked option was “Two-week specialized in-person training courses”, followed by “Six-month Diploma courses”, followed by "One-year Diploma courses”, then “Multi-year Degree courses” and surprisingly very last came “Online short courses”.

Question 5: What should be done to incentivize or make public health entomology a more attractive career?

The majority of participants selected “More job opportunities” as the most important, followed by “Better career advancement opportunities” and “better salaries” while “Make funding available for entomology bursaries” was lowest priority.

The direction provided by the Asia-Pacific vector community is therefore very clear, they identify improved vector surveillance skills as the most critical need, and they want it remedied by short, two-week, in-person courses.

15. Challenges by zoonotic malaria to Elimination Certification and the need for new policy guidelines (*Kimberly Fornace, Senior Research Fellow, Saw Swee Hock School of Public Health and National University Health System, National University of Singapore)*

Zoonotic malaria from wild non-human primates is increasingly recognised as a public health threat. Zoonotic malaria is caused by a diverse range of Plasmodium parasites found in different wildlife reservoirs across malaria endemic regions globally. However, the highest human malaria burden is caused by the zoonotic malaria parasite *Plasmodium knowlesi*; *P. knowlesi* is now the only indigenous cause of human malaria in Malaysia with thousands of clinical cases reported every year. Increasing evidence suggests land use change, such as deforestation and forest fragmentation, is driving the emergence of *P. knowlesi* by changing contact between humans, mosquito vectors and macaque hosts at the forest edges. Although nonzoonotic transmission of *P. knowlesi* has been demonstrated once in experimental conditions, current evidence suggests *P. knowlesi* transmission remains primarily driven by zoonotic spillover.

In 2022, World Health Organisation guidelines for malaria elimination certification changed to require countries to demonstrate elimination of *P. falciparum*, *P. vivax*, *P. malariae* and *P. ovale* and non-negligible risks of other Plasmodium species. Despite successes in malaria elimination, current control measures are not able to stop zoonotic transmission from wildlife reservoirs. This leaves countries reporting only zoonotic malaria with no way forward to achieve malaria elimination certification. New approaches to elimination certification are required to address differences by transmission mode. With no effective interventions addressing zoonotic spillover risks, zoonotic malaria can only be a target for elimination as a public health problem. Zoonotic malaria also requires novel control measures and additional surveillance to both monitor zoonotic malaria burdens and any future changes in transmission pathways. Without new policies and increased investment, zoonotic malaria poses a major threat to malaria elimination across Southeast Asia and globally.

16. Evaluation of "Caserotek", a low-cost and effective artificial blood-feeding device for mosquitoes *(Amy Morrison, University of California, Davis)*

Amy started off her recorded presentation by indicating that the talk is based on a recent publication "Astete H, Briesemeister V, Campos C, Puertas A, Scott TW, López-Sifuentes V, Larson R, Fisher M, Vásquez GM, Escobedo-Vargas K, Morrison AC. Evaluation of "Caserotek" a low cost and effective artificial blood-feeding device for mosquitoes. PLoS Neglected Tropical Diseases. 2023 Aug 25;17(8):e0011563.". The Abstract is as follows: Entomological research studies on mosquito vector biology, vector competence, insecticide resistance, dispersal, and survival (using mark-release-recapture techniques) often rely on laboratory-reared mosquito colonies to produce large numbers of consistently reared, aged, and sized mosquitoes. We developed a low-cost blood feeding apparatus that supports temperatures consistent with warm blooded animals, using commonly available materials found in low resource environments. We compare our system ("Caserotek") to Hemotek and glass/membrane feeding methods. Two experiments were conducted with *Aedes aegypti* (Linnaeus 1762) and one with *Anopheles darlingi* (Root 1926) (Diptera: Culicidae); 3 replicates were conducted for each experiment. *Aedes aegypti* female mosquitoes were provided chicken blood once per week for 30 min (Experiment #1) for 14 days or 1 hour (Experiment #2) for 21 days. *Anopheles darlingi* were fed once for 1 hour (Experiment #3). Blood-feeding rates, survival rates, and egg production were calculated across replicates. Caserotek had a significantly higher 30-min engorgement rate (91.1%) than Hemotek (47.7%), and the glass feeder (29.3%) whereas for 1-hour feeding, Hemotek had a significantly lower engorgement rate than either of the other two devices (78% versus 91%). Thirty-day survival was similar among the feeding devices, ranging from 86% to 99%. Mean egg production was highest for the Caserotek feeder (32 eggs per female) compared to the glass feeder and Hemotek device (21–22 eggs per female). Our new artificial feeding system had significantly higher blood feeding rates than for more expensive artificial systems and was equivalent to other fitness parameters. Caserotek only requires the ability to boil water to maintain blood temperatures using a Styrofoam liner. It can be easily scaled up to large production facilities and used under austere conditions.

17. How important is *Anopheles stephensi* in India, and how does India combat it? *(Susanta Kumar Ghosh, Formerly ICMR-National Institute of Malaria Research, Bangalore, Adjunct Faculty, Manipal Academy of Higher Education, Manipal, Karnataka, India)*

Anopheles stephensi, generally known as the Asian Malaria Mosquito, is native to Southeast Asia and the Arabian Peninsula and has emerged as a potential invasive malaria vector. Since it was reported invasion in Djibouti in 2012, horn of Africa, the global invasion range of *An. stephensi* has been expanding owing to its high adaptability to the environment. Many African nations extending from eastern to western regions, this species is expanding at a faster pace. In India, this is the main urban malaria vector representing three variants based on the number ridges on the eggs. These are type, intermediate and *mysorensis*. Till now, there is no proper molecular method to identify each variant. Also there is no information on distribution of these variants. However, type variant is found in urban, intermediate in semi-urban, and *mysorensis* in rural areas. *Xeric* trait is found in desert areas. Type variant plays as vector in India while *mysorensis* in rural Iran. Open dug wells are the main breeding

ground but they also breed in overhead tanks, water storing tanks, curing waters in the building construction sites, flower pots in plant nurseries, *tanka* (rainwater harvesting tanks in the hot arid zones) small road side water collections and ponds (in villages). In India, urban malaria scheme was launched in 1971 covering 131 towns and cities. The main control strategy is larval source management using larvivorous fish (Guppy; *Poecilia reticulata)* anti-larval insecticides ranging from insect growth regulators, bio-larvicides, and source reduction. There are limited uses of insecticide-treated bet nets since the biting time of *An. stephensi* is found in the early evening hours. Imposition of civic by-laws, mosquito-proofing mechanism and community action additionally support vector reduction efforts. The smart digital hand-held device of Malaria Control System in the southwestern Mangaluru city in the state of Karnataka is supporting effectively recording real-time malaria cases, treatment and vector control. Such devices should be deployed in all the endemic areas when we are aiming to eliminate malaria by 2030.

18. Pacific Mosquito Surveillance Strengthening for Impact (PacMOSSI): *(Amanda Murphy, James Cook University, Australia)*

Amanda showed a slide to illustrate the geographic scope of this DFAT-funded programme, which covers numerous islands clustered into 21 Pacific Island countries in the Melanesia, Micronesia, and Polynesia regions. Aedes-borne arbovirus transmission occurs widespread across the region, and includes all 4 serotypes of dengue, as well as Chikungunya and Zika. Malaria transmission is also problematic in Papua New Guinea, Solomon Islands, and Vanuatu. "PacMOSSI" is a regional consortium of 14 partners working to combat mosquito-borne diseases in 21 Pacific Island Countries and Territories (PICTs).

Their goal is to strengthen vector surveillance and control programs of PICTs to prevent and contain mosquito-borne diseases and improve the wellbeing of Pacific communities. Their philosophy is to empower Pacific Islanders to implement effective, locally-adapted vector surveillance and control and to share best practices between countries. She showed a slide that summarized their activities (Needs Assessment; Training; Data Management & Use; Expand Surveillance & Control; and Operational Research) and the foundations upon which these activities rest (Capacity Building and Community Engagement). She showed the various guideline documents that have been developed by PacMOSSI, outlined the face-to-face workshops, the Online Training facility, and other outputs. Clearly, this has been a productive and highly efficient initiative. More information about the PacMOSSI programme is available at www.pacmossi.org .

19. Addressing the vector monitoring needs of Pakistan – The new State-of-the-Art laboratory facilities (Muhammad Mukhtar, Director of the Directorate of Malaria Control, Pakistan)

Dr Mukhtar started off by showing a slide that displays the diverse range of malaria vector species in Pakistan, and the behavioural traits of each. Malaria transmission is most intense in the south-western parts of the country, and lowest in the northeast Punjab region. Dengue is the most rapidly-spreading of the arboviral mosquito-borne diseases in Pakistan. Pakistan recently established a National Entomological Reference Insectory (NERL) in collaboration with the Arid University-Rawalpindi The NERL has the following key roles and responsibilities:

- Act as a "*Center of Excellence*" to fulfill the research & capacity building needs of the country for sustainable management of VBDs

- Provision of policy and strategic directions to government and other stakeholders
- Monitoring vector fauna of the country
- Monitoring of susceptibility level resistance development trends of local vector species
- Monitoring the efficacy of interventions (IRS, LLINs, Larviciding etc)
- Serve as a Center for Public Health Pesticides Management
- Also act as a "Bank for Vectors (mosquitoes, sandfly, ticks, fleas, cockroaches, housefly, midges etc) of Public Health Importance" / Reference collection
- To ensure its sustainability the NMCP & University have an official MoU i.e equipment for research and capacity building by NMCP while University contributed Infrastructure and HR (Students).
- Students will complete their PhD, Master and Bachelor thesis /studies.
- Currently 2 PhD students and 3 Master level are conducting their research at NERL

Pakistan is now also making use of drones for detection of breeding sites of Aedes mosquitoes, such as massive accumulations of plastic bottles. These bottles are one of the identified factors for large outbreaks of dengue in Islamabad. Plastic bottles are dramatically increasing and unregulated. For example, just one five-start hotel that was studies uses about 31,000 mineral bottles per month. A survey showed that 67% of discarded bottles were populated with Aedes larvae.

Next steps include ensuring that Vector Surveillance always provides directions for "*Evidence-Based Programmatic Decision Making*" i.e. Policy making and Strategy and guideline development. To ensure its sustainability, Provincial Entomological Reference Laboratories (PERL) and District level Insectories (Sentinel Sites) must be established. Punjab Province has already established its PERL (IPH). Establishment of Experimental Huts is required. Accreditation of facilities needs to happen. Partners (Vegro aps-Denmark, UNICEF, WHO and GFATM) have shown their commitment for further strengthening.

20. Myanmar status of malaria *(Dr Aung Aung Myo, Assistant Director, National Malaria Control Programme, Myanmar)*

Dr Myo opened with a slide to show the annual malaria case numbers between 2012 (481,204 diagnosed cases) and 2022 (158,004 cases), during which period the lowest number (56,411) had been reached in 2019 but an increasing trend since that time. This trend is confirmed by the Annual Parasite Incidence (API) as determined by examination of blood-smears. In the initial years of the decade under review, *Plasmodium falciparum* was the dominant parasite, but since 2019 *Plasmodium vivax* has become more abundant and is now the overwhelming majority. Vector control is based on Indoor Residual Spraying in high-risk areas, and distribution of LLIN's elsewhere. This is supplemented with environmental management to reduce mosquito breeding sites, personal protective measures such as repellents, and education and awareness campaigns. Challenges include limited access to remote and conflict-affected areas, resistance of mosquitoes to conventional insecticides, seasonal and geographic variations affecting control efforts, and lack of community engagement and awareness in some areas. He spoke about innovations in vector control such as use of repellents, use of GIS for improved targeting of interventions, community-based participatory approaches and research on new vector control tools. Dr Myo then gave an overview on Surveillance and Case Management, including

the challenges being experienced such as Limited access to healthcare facilities in remote regions, Underreporting and misdiagnosis of malaria cases, Insufficient trained personnel and resources for comprehensive surveillance, Delays in data collection, analysis, and response in certain areas and also Surveillance gaps in border regions and conflict zones. He spoke about key achievements in malaria control in Myanmar over the preceding decade, including:

1. Reduction in Malaria Cases and Deaths:
    - 70% decrease in reported malaria cases over the past decade
    - 60% decline in malaria-related deaths due to effective interventions
2. Successful Initiatives and Programs:
    - Implementation of the National Strategic Plan for Malaria Control
    - Integration of community-based health volunteers for early case detection
    - Scaling up of LLIN distribution and IRS campaigns in high-risk areas
3. Collaborative Efforts and Partnerships:
    - Collaboration with international organizations like WHO and UN
    - Partnerships with local NGOs and community-based organizations for outreach
4. Impact of Key Achievements on the Overall Healthcare System:
    - Strengthening of healthcare infrastructure and capacity building
    - Improved community health outcomes and reduced burden on healthcare facilities

Dr Myo provided more detail on the challenges being experienced regarding malaria control, such as:

- Complex political and administrative landscape affecting program implementation.
- Cultural and language barriers influencing community engagement and health-seeking behaviors.
- Disparities in access to healthcare services between urban and rural areas
- Socioeconomic factors contributing to the persistence of malaria in marginalized communities.
- Difficulties in reaching remote and hard-to-access regions for surveillance and intervention.
- Security concerns and logistical constraints hindering effective malaria control efforts in conflict-affected zones.

21. Current status of malaria in Indonesia *(Iqbal Elyazar, Programme Manager OUCRU, Indonesia, and Ms Nurul Muhafilah, Medical Entomologist, Ministry of Health Indonesia)*

Dr Iqbal showed a graph which depicted the annual malaria cases between 2014 to 2023, with 443,530 cases in 2022 (most recent complete records). The most heavily affected Province is Papua Barat, with 264,392 cases in 2023 thus far. Another slide showed the projected malaria elimination objectives per region in Indonesia. Following slides expanded on the activities associated with the various phases of malaria control, specifically Acceleration, Intensification, Elimination, and Maintenance. He explained that five of the main challenges are that in high endemic areas, residential and environmental conditions are very receptive to malaria transmission and gave examples of the factors involved, and secondly that mosquitoes in Papua

Province are mostly anthropophilic and that the proportions of indoor and outdoor biting are similar, this complicating control. Thirdly, preventive actions by communities are inadequate; fourthly, challenges relating to reaching elimination and this includes several varied factors such as budget issues, human movement, and malaria in special groups such as miners and forest workers; and the fifth issue related to vector surveillance implementation and reporting. Another slide depicted the very high diversity of mosquito vectors present in Indonesia.

22. **Effectiveness of dual active ingredient insecticide-treated nets.** *(Timothy Barker, Research Fellow, School of Public Health, The University of Adelaide, Australia)*

The WHO currently recommends that insecticide-treated nets (ITNs) treated with a pyrethroid-based insecticide be used for large-scale deployment in malaria endemic regions. However, recent findings have demonstrated that prominent malaria vectors are becoming resistant to this insecticide, and the effectiveness of these ITNs to prevent malaria is beginning to diminish. In order to investigate possible solutions to this issue of resistance, the Vector Control & Insecticide Resistance Unit within the Global Malaria Programme of the World Health Organisation began a collaboration with the JBI Adelaide GRADE Centre and the University of Adelaide to conduct some systematic reviews into the effectiveness of two new ITN alternatives. This presentation presents the results of this systematic review and the recommendations made by the WHO regarding two new formulations of ITN to be deployed in malaria endemic regions where insecticide resistance has been documented.

23. **The Pan-African Mosquito Control Association (PAMCA): An overview**. *(Dr El Hadji Amadou Niang, Interim Director of Scientific Programmes, PAMCA)*

PAMCA is an African led collaborative network that brings together key stakeholders in the field of vectors and vector-borne diseases (VBDs) control. It offers a safe space where they can think, create, learn together, share, and adopt best practices to control and eliminate vector-borne diseases in Africa and worldwide. PAMCA core mandate is to create that enabling environment for entomologists, public health professionals, researchers and other stakeholders in the vector control and elimination in Africa to collaborate and drive synergies, disseminate related knowledge, promote new interventions, and advance integrated vector management programs.

PAMCA operates through a pyramidal model that consists of a secretariat at the head quarter, regional centers of excellence overlapping the main African regions and chapters in registered countries serving as a comprehensive and integrated platform with specific role supporting the design, implementation, and M&E of the organization's Global Program Portfolio and cross-cutting thematic areas.

PAMCA partners with global and regional agencies, donors and technical partners, and country technical working group in a structured approach to collaborate towards reducing and ending the burden and threat of vector-borne diseases.

The PAMCA's annual conference is the organization flagship that attracts over 800 delegates and provides a premier platform for diverse stakeholders in the VBDs control and elimination ecosystem to revitalize or form new working networks and share experiences and advances in VBDs management spanning surveillance, interventions, research, emerging risks, best practices.

24. Alliance for Malaria Prevention: What we do. *(Miko Thomas & Marcy Erskine)*

The Alliance for Malaria Prevention (AMP) is a global partnership housed and chaired by the International Federation of Red Cross and Red Crescent Societies (IFRC), focused on three core activities:

1. Coordination of partners involved in insecticide-treated net (ITN) campaign and continuous distribution (CD) activities.
2. Development and dissemination of operational guidance for planning and implementation of ITN distribution based on iterative learning and identified gaps.
3. Supporting national malaria programmes and partners with technical assistance for planning and implementation of ITN distribution based on country requests.

AMP's efforts support achievement of the WHO Global Technical Strategy (GTS) targets for high coverage and use of ITNs. AMP is a core member of the RBM Partnership to End Malaria's Country Regional Support Partner Committee (CRSPC). The alliance has a core AMP staff (technical and administrative core roles for AMP partnership management), and an AMP Core Group – "steering committee" that monitors AMP workplan and outputs. AMP has a weekly coordination call with partners.

AMP has several Working Groups, as follows:

- Emerging Issues
- Continuous Distribution
- Humanitarian and At-Risk Populations
- Toolkit and Training

Some AMP activities and functions is listed below:

- AMP has an Annual Partners Meeting and a Campaign Digitalization Meeting.
- AMP houses the Net Mapping Project, which tracks all WHO PQ-approved ITN shipments from all suppliers.
- AMP maintains the ITN Campaign Tracker that feeds into the RBM updates.
- AMP provides technical assistance (TA) to national malaria programs and their partners for over 15 years based on requests from national programs. The bulk of the support provided is in AFRO due to the malaria burden.
- AMP has a team of Technical Assistance providers built over the past 15 years, +80% based in malaria-endemic countries (primarily Africa). The areas of expertise typically requested are for ITN campaigns (e.g. strategy/operations, logistics, social and behaviour change, M&E, digitalization). For areas of expertise requested outside the "typical" technical skills, they either recruit new TA providers or facilitate linkages between the national programme and specialist organizations . These include Anglophone, Francophone and Lusophone consultants.

25. Group discussion and recommendations for thematic Workstreams within the APMEN VCWG
(Facilitated by Dr Muhammad Mukhtar)

Dr Mukhtar explained that several other vector control platforms, such as the RBM VCWG, have Workstreams that enable them to cluster experts on particular thematic areas to concentrate and coordinate their efforts, thus optimizing efforts and resources and enabling the VCWG to achieve more productive levels of stronger impact. He suggested that the APMEN VCWG should adopt a similar approach, and put together a set of survey questions for consideration by the conference participants. Thirty six participants took part in this survey, and of these 75% were from APMEN Member States. The survey questions were:

Question 1: What sub-groups would you suggest?
The following thematic groups were proposed, in order of ranking:

- New tools
- Intervention efficacy (ITN's, IRS, Insecticide Resistance Monitoring etc)
- Climate Change/Humanitarian. Displaced Populations group
- Outdoor transmission (Forest Goers etc.)
- Monitoring and evaluation

Question 2: What are the Opportunities, Benefits and Challenges for the different groups to collaborate? Many were raised, from Cross-fertilization, focus, targeted evaluation, evidence, lessons, and many others.

Question 3: Volunteers to lead the groups.
Some confusion exists here, because it is clear that many participants were suggesting names of people that had not themselves volunteered, and it is therefore not appropriate to give a list of names here when it is not certain whether these persons had in fact volunteered. However, in subsequent plenary discussion, Dr Kimberley Fornace did volunteer to lead a group on Climate, Environment and Health, and Dr Iqbal Elyazar volunteered to lead a group on Outdoor Transmission.

Conference Conclusion

As Chairman of the APMEN VCWG, Dr Mukhtar expressed gratitude to the participants who had travelled to attend the conference, as well as the Online participants, and handed over to the APLMA Chief Executive, Dr Sartak Das, who gave a closing speech.

The full conference was recorded and are available here

APPENDIX 1

Conference Programme

Day 1: Thursday 23 November 2023			
Introductory Opening and Welcoming Session Moderator: Dr Leo Braack			
08:00-08:30	30 mins	Registration	APMEN VCWG
08:30-08:35	5 mins	Brief welcome and opening address by APMEN VCWG Chair and introduction of APLMA Vice President	Dr Muhammad Mukhtar Director of the Directorate of Malaria Control, Pakistan
08:35 – 08:40	5 mins	Plenary welcome from APLMA Executive Vice President: Advocacy and Programs	Amita Chebbi APLMA Executive Vice President: Advocacy and Programs
08:40 - 08:50	10 mins	Update on APMEN VCWG 2023 activities	Dr Leo Braack Co-Chair: APMEN VCWG
Conference Session 1: New Tools and approaches against Outdoor Biting Moderator: Dr Muhammad Mukhtar Chair: Dr Champa Aluthweera			
08:50-09:00	10 mins	Sumba Livestock Ivermectin for Malaria Control Project.	Dr Kevin Kobylinski Senior Scientist at Mahidol-Oxford Research Unit
09:00-09:10	10 mins	Building capacity for evaluation and implementation of alternative vector control tools in Papua New Guinea: Spatial Emanators and Larval Source Management	Dr Stephan Karl Principal Research Fellow, James Cook University
09:10-09:20	10 mins	New IRS compounds (Clothianidin, Vectron, etc)	Dr Christen Fornadel (Senior Technical Coordinator: Innovative Vector Control Consortium-IVCC)
09:20 – 09:30	10 mins	Vectron T500: a new class of insecticide for IRS and potential for outdoor spraying	Takeo Maezawa Director: Vector Control Group MITSUI CHEMICALS
09:30 – 09:40	10 mins	Gene-drive for mosquito population control	Dr Prasad Paradkar Group Leader, Human Health Program, CSIRO, Australia
09:40 – 09:50	10 mins	Attractive Targeted Sugar Baits for Integrated Vector Management	Dr Molly Scheel Professor; Dept. of Medical and Molecular Genetics Indiana University School of Medicine
09:50– 10:05	15 mins	Q&A on morning session	
10:05– 10:35	30 mins	**Tea/Refreshment break**	
10:35– 11:15	40 mins	Breakout Group 1 and Group 2: Which new outdoor tool to trial by APMEN, and where	Facilitators 1. M MacDonald (Gp 1)

			2. L Braack (Online)
11:15–11:45	30 mins	Plenary feedback & discussion	
11:45 – 12:00	15 mins	Current status of malaria in Pakistan, with reflections on the floods of 2022 and Climate Change considerations	Dr Muhammad Mukhtar Director of the Directorate of Malaria Control, Pakistan
12:00-13:00	60 mins	**Lunch**	
13:00-13:15	15 mins	Malaria status in Papua New Guinea: Current status, Hotspots, Challenges, and effectiveness of vector control.	Mr Leo Makita National Program Manager, Papua New Guinea Virtual
13:15-13:45	30 mins	Question time	
13:45-13:50	5 mins	Group photo	
Session Conference Session 2: Medical Entomology Training Moderator: Dr Leo Braack Chair: Dr Rudra Prasad Marasini (Nepal)			
13:50-14:00	10 mins	Background and guidance for Break-out discussion	APMEN VCWG
14:00-14:10	10 mins	The ArcTech/WHO TDR training in medical entomology initiative	Dr Freya Spencer ArcTech Innovation, London School of Hygiene & Tropical Medicine
14:10-14:20	10 mins	Status of entomological training in Malaysia	Dr Khadri Sahar Head: Medical Entomology Unit; Institute for Medical Research, Malaysia
14:20–14:30	10 mins	Entomology courses in Thailand: which institutions offer courses, what kind of courses, how long, and what are the gaps and needs?	Professor Theeraphap Chareonviriyaphap Dept of Entomology, Kasetsart University, Thailand
14:30-15:15	45 mins	Break-out group discussion: Expanded training for Medical Entomology, priority needs: (Undergraduate course; 6-month Diploma; short courses?; what topics should be covered and prioritized?)	Facilitators 1. M MacDonald (Gp 1) 2. L Braack (Online)
15:15-15:45	30 mins	**Tea/Refreshment break**	
15:45-16:15	30 mins	Plenary feedback	
16:15	5 mins	Closing Day 1	Dr Muhammad Mukhtar Director of the Directorate of Malaria Control, Pakistan
Day 2: Friday, 24 November 2023			
Conference Session 3: Learning Primer Talks and Bringing Together Global Mosquito Control Forums Moderator: Dr Muhammad Mukhtar			

Chair Dr Ngo Duc Thang (Vietnam)			
08:30-08:40	10 mins	Introduction: Summary overview of findings of Day 1, and objectives for today	Leo Braack
08:40-08:55	15 mins	Challenges posed by zoonotic malaria to Elimination Certification and the need for new policy guidelines	Dr Kimberly Fornace Senior Research Fellow, National University of Singapore.
08:55-09:05	10 mins	Evaluation of "Caserotek" a low cost and effective artificial blood-feeding device for mosquitoes	Amy Morrison University of California (Davis)
09:05-09:20	15 mins	How important is *Anopheles stephensi* in India, and how does India combat it?	Dr Susanta Ghosh Former Head : National Institute of Malaria Research (ICMR) India
09:20–09:35	15 mins	PACMOSSI and need assessment in Asia Pacific	Dr Amanda Murphy James Cook University
09:35–10:05	30 mins	**Tea/Refreshment break**	
10:05–10:20	15 mins	Addressing the vector monitoring needs of Pakistan – The new State-of-the-Art laboratory facilities	Dr Muhammad Mukhtar Director of the Directorate of Malaria Control, Pakistan
10:20–10:35	15 mins	Myanmar status of malaria and its new strategy for malaria control and innovative stratification	Dr Aung Aung Myo Assistant Director, National Malaria Control Program, Myanmar
10:35-10:50	15 mins	Current status of malaria in Indonesia: Challenges in vector control and surveillance	Dr Iqbal Elyazar (Programme Manager) and Ms Nurul Muhafilah (Medical Entomologist) OUCRU
10:50-11:05	15 mins	Effectiveness of dual active ingredient insecticide-treated nets	Dr Timothy Barker Research Fellow, School of Public Health, The University of Adelaide, Australia
11:05-11:40	35 mins	Q & A session	
11:40-11:50	10 mins	Vector control platforms, how they work: PAMCA	Dr El Hadji Amadou Niang Interim Director of Scientific Programs Pan-African Mosquito Control Association - PAMCA
11:50-12:00	10 mins	Vector control platforms, how they work: Alliance for Malaria Prevention	Dr Giovanni Dusabe & Dr Marcy Erskine On behalf of Alliance for Malaria Prevention
12:00-13:00	60 mins	**Lunch**	
13:00-13:40	40 mins	Plenary discussion on:	Moderator Dr Muhammad Mukhtar

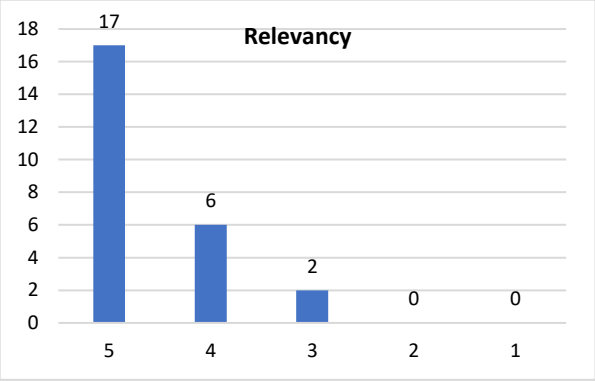
		1. Should APMEN VCWG have specialist sub-groups? (*Innovative tool subgroup*: repellent, LSM; *Intervention efficacy subgroup*: ITN, IRS, insecticide resistance monitoring; *M&E subgroup*; *Outdoor transmission subgroup:* Forest goers; *Climate change/displaced population subgroup*) 2. Opportunities, benefits, and challenges for different groups to collaborate. 3. Volunteers for subgroup leaders.	
13:40-13:50	10 mins	Expression of thanks to all	Dr Muhammad Mukhtar Director of the Directorate of Malaria Control, Pakistan
13:50-14:00	10 mins	Meeting Closure	Dr Sarthak Das
		Departure	

APPENDIX 2

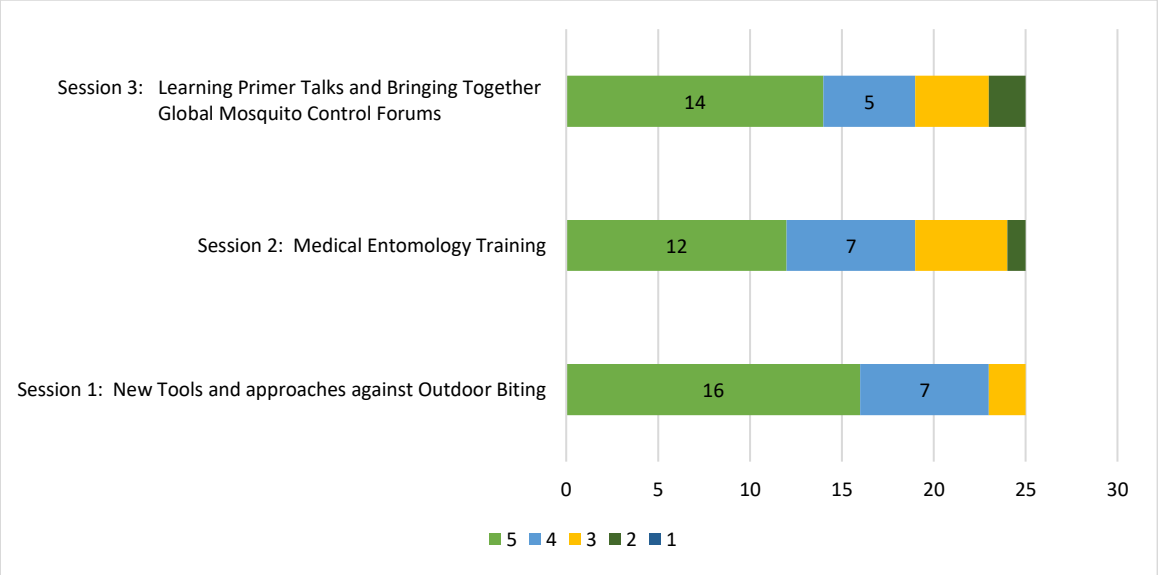
Conference Evaluation Feedback

Satisfaction and relevancy of the conference (N= 25)

Majority of participants (92%, Likert scale 4 and 5) who given feedback satisfied with the Annual Conference. Ninety-two percent of participants felt that the Annual Conference was relevant to them.



The most relevant session for attendance (N-25)



Generally, more than 80% of participants satisfied with the 2-day sessions and expressed that all sessions were relevant to them.