Meeting Summary

Entomology and Vector Control for Malaria Elimination
Regional Meeting & Workshop

Kasetsart University, Bangkok, Thailand
November 7-10, 2016
Executive Summary

A two-part, four-day regional workshop on entomology and vector control was convened at Kasetsart University, from 7-10 November, 2016. Participants included representatives from nine national malaria control programs, ranging from Pakistan to Papua New Guinea, as well as from academia, development partners, non-governmental, bilateral and international organizations and the private sector.

The first two days focused on the strategic shift from ‘control’ to ‘elimination’, and comprised three major focus areas commencing with sharing of best practices for vector control, such as bed net durability, preference and use studies and insecticide resistance monitoring. A second major theme was the reorientation of entomological surveillance, from trapping, identification and mapping, to community-based systems for vector surveillance. The third major focus area was capacity-building for public health entomology, which explored approaches to strengthen Human Resource (HR) capacity, and technical skills in epidemiology and Geographic Information Systems (GIS). Discussions focused on HR needs and career development; information and knowledge sharing; training needs at national and subnational levels; and institutional, infrastructure and operational research needs.

The second part of the meeting comprised the “Mekong Outdoor Malaria Transmission Network” workshop, with participants expanded to include partners from Industry and private sector vector control services, and additional academic and research institutions. Discussions began with entomological aspects of outdoor transmission in the region. Country updates were provided and the evidence and driving forces of residual and outdoor transmission were discussed. Sessions covered the anthropological aspects of outdoor transmission, including human spatial ecology and available tools, including use of GPS tools, spatial and topical repellents and treated clothing. A panel discussion with the private sector explored the development and market entry of new tools, including needs from the public sector in terms of product testing, market projections, and regulatory issues. The final sessions and group work further explored new tool development, the role of large private employers, the WHO framework for moving from proof of concept to implementation; and review of regional and national regulatory processes.

Overall, the 3 ½ days of presentation and discussions offered a wealth of information on technical and scientific developments as well as best practices and lessons learned for effective field implementation. The gathering of entomology program leaders from such diverse countries and partners enabled programs to learn from each other about the necessary shifts in entomological surveillance and vector control strategies to move from malaria ‘control’ to ‘elimination’ and strategies to address outdoor transmission. Inclusion of product development partners provided a unique opportunity to discuss the challenges of innovation to address outdoor and residual malaria transmission: from vectors, human behavior and measuring public health impact, to market size and stability, intellectual property rights, and national regulatory issues.

A common theme throughout both segments of the meeting was the value of networks and mechanisms to allow programs and partners to communicate, share best practices and learn from each other – and the necessity to work across sectors to meet vector control needs. The concluding discussion emphasized the roles of different partners and programs to ensure continued learning and advancement of entomology and vector control, as essential components for malaria elimination in the Asia Pacific region. Priority areas of need and action identified by participants are summarized in the following section.
Priority areas of need and recommended actions:

The following key areas of need, and suggested actions, were identified by participants through facilitated group work sessions across both parts of the workshop:

Part 1: Strengthening tools and entomological capacity for vector control programs shifting to elimination

Actions for National Malaria Control Programs, with support from regional partners:

A. Improve Human Resource development and career pathways for entomology and vector control cadre.
   1. Conduct assessment of vector control personnel needs to gauge how many entomology and vector control staff are needed, at what skill levels, where they should go, what support is needed and what training they need to carry out their work.
   2. Provide some level entomology orientation and training to other cadre involved with malaria control and elimination, including the community.
   3. Support career development of entomologists, with clearly defined roles and responsibilities, and a broad scope of work to ensure ongoing value and employment.
   4. Promote understanding that “Public Health entomologists are needed to eliminate malaria”. Programs should clearly advocate this message in one voice.

B. Provide epidemiology-centered entomology and vector control training
   1. Conduct needs assessment of training requirements at different country levels and sectors, including entomological and epidemiological surveillance, data management (including GIS) and program management training.
   2. Link training needs to development of new job descriptions and/or new skills needed by existing staff or community volunteers.

C. Strengthen infrastructural and institutional support for entomology and vector control
   1. Ensure coordination and alignment of efforts between national, sub-national and regional bodies supporting entomology and vector control including support to reference laboratories, GIS platforms and insectaries.
   2. Engage regional universities and research institutions to support program-driven training and operational research activities.
   3. Improve linkages with public (educational, government) and private (industry) sectors for skills-strengthening, data sharing and operational research.

Actions for regional/international elimination partners:

A. Advocate for increased vector control capacity
   1. In concert with the WHO Global Vector Control Response, advocate for the essential role of entomology and public health entomologists within integrated strategies for malaria elimination, especially through bodies like APLMA, APMEN, RBM as well as the bi-lateral partners and WHO.
   2. Highlight that malaria elimination will require a shift in strategies, empowering staff at the peripheral levels to detect transmission foci, analyze the entomological and human behavior as well as the epidemiological aspects, and take appropriate action.
B. Improve vector control knowledge & information sharing
   1. Develop a standardized template to allow counties to share geo-referenced entomological information and data, using a platform that is understandable, easily harmonized and collatable.
   2. Establish a clearinghouse to collate vector control best-practices and SOPS, noting ACTMalaria’s previous efforts to do this.

C. Strengthen infrastructural and institutional support for vector control
   1. Ensure coordination and alignment of efforts between national and regional bodies supporting vector control.
   2. Support regional training opportunities to improve entomological surveillance, targeting and vector control/personal protection response.
   3. Stimulate Asia Pacific vector ecology research, and vector control tool development, especially to address the shift to elimination and the challenges of residual and outdoor transmission.
   4. Establish a resource person/clearing house within APMEN to assist in:
   - sharing and harmonizing of regional vector control best practices
   - collating and disseminating research
   - collating and disseminating regional entomology data
   - facilitating advocacy to governments, distilling WHO guidance
   - facilitate provision or exchange of regional technical advice to fill gaps, and ensure entomologists are engaged in elimination efforts.
   5. Engage regional universities and research institutions to support program-driven training and operational research activities.
   6. Improve linkages with public (educational, government) and private (industry) sectors for skills-strengthening, data sharing and operational research.
   7. Establish regional Reference Centers/Centers of Excellence for entomology and vector control.

Part II: Mekong Outdoor Malaria Transmission Network (MOMTN)

Priorities for the MOMTN to support:

A. Strengthen vector biology research, and vector control tool development
   1. Identify mechanism to share best practices for development of, and research on, personal protection and vector control methods.
   2. Compile list and define characteristics of potential tools to address outdoor transmission, including tools and strategies for monitoring and evaluation.
   3. Develop manual/Standard Operating Procedures to examine the role of outdoor/residual transmission, with precise indicators.
   4. Facilitate robust and comprehensive research on regional vector bionomics.

B. Enhance integration of anthropological approaches, community participation and engagement
   1. Enhance social sciences, participatory approaches and user-centered design to develop practices and processes adapted to the specific local context that will ensure greater “ownership” and sustainability.
2. Establish mechanism to give those at policy-making level a greater understanding of needs and issues of the at-risk population to better adapt procurement and implementation.
3. Empower peripheral staff to adapt national public health approaches to the local social, cultural and ecological context.
4. Leverage existing social networks and community structures, including the private and commercial sector for implementation of public health strategies.

C. **Enable access to necessary tools and capacity**
   1. Share best practices, study designs and protocols for entomological evaluation of both existing tools and new tool development.
   2. Ensure the appraisal pathway includes, in addition to entomological and epidemiological endpoints, user acceptance, manufacturability and other market and regulatory-related parameters.
   3. Facilitate knowledge sharing, identify immediate actions, avoid duplication and maximise synergies.
   4. Coordinate action to develop long-lasting, environmentally and user-friendly tools, with local specificity and acceptable within community and cultural practices; ideally, fitting in with current life styles, with no behaviour change needed by the end-user.

D. **Address market and regulatory challenges**
   1. Advocate for reform and harmonization of national regulatory processes to facilitate the timely national registration of proven tools needed for malaria elimination.
   2. Provide background technical documentation to National Regulatory Authority who may lack technical capacity and subject-matter experts to evaluate vector control tools.
   3. Develop international standard data packages and easier collaboration/access to information about target markets.
   4. Provide market-size projections to innovators, and explore mechanisms to support feasibility of supply, including linking to larger markets, reducing tariff barriers, and incentivizing product development.
   5. Engage regulators in discussion to promote understanding of needs and priorities, to streamline processes without compromising safety.
Summary of sessions

Opening session

Welcome: Dr. Sutkheth Nakasathien, Dean of Faculty of Agriculture, Kasetsart University; Dr. Siree Chaiseri, Acting Vice President for Research, Kasetsart University;

Opening remarks: Former Minister His Excellency Yongyuth Yuthavong, BIOTEC & RBM Board Member.

Opening presentations:
Global Vector Control Response: Tessa Knox, World Health Organization Global Malaria Programme (WHO GMP), Switzerland
Vector control in the Asia Pacific region - shifting from control to elimination: Bill Hawley, Centers for Disease Control and Prevention (CDC), USA

- Prof. Yongyuth noted that this workshop was an opportunity to learn from each other and from the past, including our program mistakes and successes.
- There is an opportunity to succeed in our hopes for malaria elimination.
- Improvements must be made not only to vector control, but also our understanding of entomology and the biological, ecological and social interactions underlying malaria transmission.
- An overview of the meeting agenda and objectives were provided.
- Moving from ‘control’ to ‘elimination’ requires a profound shift in entomological surveillance – a shift from implementing traditional “solutions” toward problem-solving the challenges of vector control.
- Dr Knox introduced the draft Global Vector Control Response (GVCR) for comments;
- The GVCR aim is to ensure all countries can achieve success, irrespective of their current capacities and resources. Emphasis is on country leadership, and integrated, evidence-based community-based approaches.
- Dr Hawley described differences in entomological surveillance and vector control in the shift from control to elimination, and the need to understand human as well as vector behavior to eliminate malaria.
- The elimination strategy is to reduce transmission to the extent that individual human cases can be mapped and treated before onward transmission to mosquitoes. However, preventing infection of mosquitoes through prompt diagnosis and treatment is possible only if mosquito populations have been sufficiently suppressed.

Part 1. Strengthening tools and capacity for vector control programs

Session 1. Entomological Surveillance
Chair: Prof. Indra Vythilingam, University of Malaya, Malaysia
Presenters:
Rahmad Isa & Budi Pramono, MoH Indonesia
John Gimnig, CDC USA
Neil Lobo, University of Notre Dame, USA
Vu Duc Chinh, NIMPR, Vietnam
Theeraphap Chareonviriyanaph, Kasetsart University
Dr’s Isa and Pramono described collection, identification and mapping as three essential steps for entomological surveillance, and provided an example of their Indonesian surveillance system with threshold indicators and an on-line geo-referenced data base.

Examples of more efficient collection methods were presented, but the efficiencies for each vary with species and context, with the recommendation to do many collections well and don’t over-interpret.

Programs will need to broaden and decentralize entomological surveillance in the shift towards elimination. An example from Zambia showed how community health workers could manage CDC light traps, sort mosquitoes by genus and package samples for identification and analysis by central-level staff.

Accurate identification remains the foundation of all entomological surveillance. Dr Chinh provided Vietnam’s examples of a strong system for mosquito identification and specimen preservation for training and voucher verification.

Many vectors in the region are part of morphologically similar complexes and in certain locations where sympatric sibling species exist should be identified through molecular techniques. Thailand provided an example of identification and mapping of species complexes in the Dirus, Minimus, Maculatus and Sundaicus Complexes. Examples were also shown of identification errors between vector and non-vector species that led to programs targeting the wrong locations and wrong mosquitoes.

Session 2. Vector Control
Chair: Muhammad Mukhtar, NMCP Pakistan
Presenters:
Prayuth Sudathip, MoPH, Thailand
Elijah Filip, PSK Cambodia
Si Thu Thien, PSI Myanmar
Hans Overgaard, Khon Kaen University, Thailand
Le Trung Kien, NIMPE Vietnam
Senarath Bandara, MoH Sri Lanka

Dr Sudathip from Thailand shared actions for surveillance and targeting to bring interventions in line with available funding. Prioritization and advocacy to increase domestic funding are key.

LLINs are essential. Programs are challenged with sustained funding monitoring durability, net preference and use vs untreated nets, and monitoring insecticide resistance.

Durability and actual preference and use of the LLINs we freely distribute are critical for best use of available funds. PSI offered a protocol for durability from Myanmar, as well as data from Cambodia on what types of nets actually meet community needs, and important ‘value for money’ data for procurement.

For the large number of untreated nets still being used, Dr Kien explained Vietnam’s successful strategy of community net re-treatment campaigns.

While insecticide resistance in the major vectors is not yet a severe problem the Thai/Lao MAL-VEC project provided an update on insecticide resistance monitoring and management in the region.

Dr Bandara described surveillance and control systems from Sri Lanka for preventing reintroduction of malaria transmission in their country.
Session 3. Capacity Building
Chair: Marvi Rebueno, Pilipinas Shell Foundation, Philippines
Presenters:
Michael Macdonald, WHO/ERAR, GMS
Christina Rundi, Sabah Department of Health, Malaysia
Moh Seng Chang, UNIMAS Malaysia
Cecilia Hugo, ACTMalaria, Philippines
Silas Davidson, AFRIMS, Thailand
Felix Holl, UCSF Global Health Group, USA
Amanda Murphy, APMEN, Australia
Paul Zoborowski & Melinda Susapu, NHD Papua New Guinea

- Shifting from malaria control to malaria elimination requires a realignment of medical entomology to public health entomology with greater capacity and linkage for epidemiology, GIS and program management and the empowerment of periphery staff to collect and analyze data and eliminate local transmission foci.
- Equally important to training are jobs and career structures for entomologists and assistant entomologists at sub-national levels.
- Universities are key partners for both pre-service and in-service training. Students can be mentored through internship and class projects attached to the NMCPs.
- Materials are available through ACTMalaria including both technical and managerial aspects of entomology and vector control.
- AFRIMS provides an excellent reference to build national capacities for insectaries and reference laboratory support.
- Advances in GIS technology and spatial analysis will greatly help in both surveillance and program management of vector control operations.
- Regional networks can support elimination efforts through enabling partnerships, allowing exchange of information and experience; and building technical evidence/capacity.
- Examples of comprehensive, community-based vector control were provided by initiatives in Papua New Guinea.
- Group work discussed needs and priorities in 3 areas: 1) human resources & career development, 2) information sharing, and 3) training needs. The outcomes are incorporated within the Priority areas of need and recommended actions, or see the full meeting report for more detail.
Part 2. The Mekong Outdoor Malaria Transmission regional workshop

### Session 1. Entomological aspects of Outdoor Malaria Transmission

**Chairs:** Tessa Knox, WHO GMP, Switzerland, John Gimnig, CDC, USA  
**Speakers:**  
Theeraphap Chareonviriyaphap, Kasetsart University, Thailand  
Pradya Somboon, Chiang Mai University, Thailand  
Indra Vythilingam, University of Malaysia  
Wannapa Suwonkerd, Office of Disease Prevention & Control, Ministry of Public Health, Thailand  

**Panel discussion:** Evidence and driving forces of residual and outdoor transmission  
**Panel members:** Representatives from Bangladesh, Cambodia, Malaysia, Pakistan, PNG, Sri Lanka, Thailand, and Vietnam

- The speakers reviewed the entomological aspects of outdoor transmission for both human and monkey malaria, and emphasized the importance of understanding species identification, and related transmission ecologies.  
- Precise identification of malaria vector species is needed in order to define efficient vector control programs targeting the right vectors.  
- Diverse mosquito behaviors and human activities are the key factors influencing the residual transmission. Better understanding of behavioral plasticity is needed.  
- Existing interventions cannot break the outdoor transmission cycle, especially early biting behavior, as observed in studies of *P. knowlesi* in Malaysia. Unclear how to address this; more investment and collaboration required to map and find solutions to outdoor and early biting vectors.  
- An example from the Thai-Myanmar border suggested that differences in mosquito biting behavior might be related to human activity; a better understanding of vector bionomics may assist vector control.  
- A panel discussion with country program representatives explored the different ecological settings for outdoor transmission, and how this impacts control strategies. See the [full meeting report](#) for more detail.

### Session 2. Anthropological and ecological aspects of Outdoor Malaria Transmission

**Chair:** Muhammad Shafique, Malaria Consortium, Thailand  
**Speakers:**  
Hannah Edwards, Malaria Consortium, Thailand  
Dan Parker, Shoklo Malaria Research Unit, Thailand  
Gloria Luz M. Nelson, University of the Philippines, Laguna, Philippines

- Varied ecological environments and human/vector behaviors create different transmission foci to be targeted.  
- Understanding individual movement from the village to the farm to the forest is a critical factor in for addressing outdoor malaria transmission. Better understanding of these factors influencing at-risk populations could inform improved approaches to elimination.
Likewise, programs need to understand how perceptions on social risks affect malaria infection using new social science methodologies for better client interaction.

Session 3. Current personal protection tools
Chair: Bill Hawley, CDC, USA
Speakers:
Neil Lobo, University of Notre Dame, USA
Jeffrey Hii, Malaria Consortium, Thailand
Mao Sokny, MoH Cambodia

Current tools including spatial repellents and insecticide treated clothing were presented, as well as studies investigating the effectiveness of these.

Protocols were presented on treated clothing, acceptability, durability and entomological efficacy based upon “moving landing collections” that simulates the movement of rubber tappers when working.

The entomological impact of a large randomized control trial of topical repellents was described examining both density and parity rates.

Session 4. Tools under development
Panel discussion: Approaches for development of outdoor transmission tools
Chair: Aekthada Chivakanit, WellTech Healthcare, Thailand
Panel discussion members: representatives from BASF-DFI, Bayer, InsectShield, Sumitomo Chemical Co., Syngenta, Tana Netting, Vestergaard

Panel members responded to 3 questions posed:
1. What does industry need from programs and other public sectors to proceed? For example, the market size. Are there any forecasting aspects that will guide industry?
2. What are the challenges of developing new products (including regulatory)?
3. Discuss other issues and processes affect distribution and utilization of vector control products; including solutions?

Product developers need more communication and transparency with health programs and other sectors; they need to know what is lacking and what is needed to implement the program, to understand the goals of programs.

Some companies already have nets that address pyrethroid resistance and some are working on non-pyrethroid treatments. But support of programs and partners (WHO) is required to bring them to market at a faster rate. There is also no evaluation criteria for treated clothing. Many companies are willing to invest, but need to improve communication to guide the development of new products.

A number of products are delayed by registration, especially when required to have efficacy-testing performed in the country; they need support to fast-track this process. This group could support industry by advocating for harmonization of registration processes across the region.

There must be a balance between ensuring testing and fast-tracking availability to ensure we reach elimination.
A number of products are no longer produced because the market is unstable or fragmented. It is essential to find a way to stabilize the market and give industry more reliable forecasting data to enable them to maintain production.

For more detail on the discussion, read the full meeting report, here.

Session 5. Market and regulatory aspects
Chair: Manesh Sharma, Vestergaard
Speakers:
Michael Bangs, Kasetsart University, Thailand
Michael Macdonald, WHO ERAR, GMS
Aekthada Chivakanit, WellTech Healthcare, Thailand

Regional regulatory forms are needed. The regulatory structure needs to be streamlined to make business sense. The opportunity costs are not just for the company but also for the end users of these potentially life-saving tools needed by programs.

Session 6. Study protocols for efficacy and effectiveness
Moderator: Amanda Murphy, APMEN

This session entailed group work aimed at identifying the requirements to address outdoor and residual malaria transmission, including relevant guidelines, necessary methodology, indicators, and common protocols. Four break out groups focused on discussing needs and priorities for four key areas: 1) Entomology, 2) Anthropology, 3) Tool development and 4) Market and regulatory. Group work outcomes are summarized under Priority areas of need and recommended actions, or see the full meeting report for more detail.

Session 7. Monitoring and evaluating progress

Dr. Theeraphap presented the proposed roles and structure and function of the MOMTN network, to be coordinated from Kasetsart University (KU), Thailand.
The MOMTN Secretariat will request nominations for country-level focal points to be engaged with the network on issues related to outdoor malaria transmission.
The KU Secretariat will take forward the recommendations and outcomes of this MOMTN workshop, and incorporate them within planning of future meetings;
The KU Secretariat will initiate or further develop partnerships with other regional networks, including ACTMalaria, the APMEN VcWG, the RBM VCWG and WHO.