Institute of Tropical Medicine
Antwerp, Belgium

National Institute for Malariology,
Parasitology and Entomology,
Hanoi, Vietnam

INTERNATIONAL COLLOQUIUM

Malaria control in the Mekong Region: challenges and opportunities

Hanoi
3 - 5 December 2007

Abstract book

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International Colloquium
ITM / NIMPE

Malaria control in the Mekong Region: challenges and opportunities

The Colloquium

The National Institute of Malariology, Parasitology and Entomology (NIMPE), founded by Dr Dang Van Ngu, celebrates this year its 50th anniversary. Over the past decades, the NIMPE has acquired a solid national and international reputation by bringing malaria under control in a very large part of Vietnam. The anniversary presents a unique opportunity to bring together an interdisciplinary audience of scientists, experts and professionals from the Mekong Region with the international malaria community, to provide an updated overview of malaria control in the region, and to formulate recommendations for improved practices and policies. The colloquium is co-organised by the Institute of Tropical Medicine of Antwerp Belgium (ITM), which collaborates with NIMPE and the National Control Programmes of Cambodia, Laos and Thailand since 1994.

Background

During the last decade, the Mekong countries have been very successful in reducing the burden of malaria. Strong political commitment, technical expertise and the integration of malaria control in the community-based health system were key elements to success. The main strategies included prompt diagnosis and treatment, wide coverage and targeted vector control through insecticide-treated nets (ITNs), and indoor residual spraying (IRS). In addition, socio-economic development has substantially contributed to the decline of malaria in the region.

Malaria has not yet disappeared, however. In remote and forest settings the transmission rates are still high, as a result of complex interactions between vectors, parasites and humans. Forest vectors typically feed in the early night, making ITNs less effective; moreover, bed nets are not easily adaptable to the lifestyle of forest workers. Migration between endemic and malaria-free areas leads to upsurges of malaria; in border areas, access and compliance to prevention and treatment are complicated by social, cultural and political factors. Environmental modifications that affect the distribution and abundance of vectors lead to changes in malaria transmission. Multi-drug parasite resistance has become a regional and global emergency, complicated by the widespread marketing of substandard and counterfeit drugs. The effectiveness of ITNs is compromised by the emerging resistance of mosquitoes to pyrethroids, particularly in southern Vietnam.

Objective

The colloquium will review these experiences and challenges, with the following objectives:

- review the current situation
- identify remaining knowledge gaps
- formulate strategies for the consolidation and extension of the achievements
- optimize measures to roll back forest and border malaria
- examine ways to contain the spread of multi-drug and insecticide resistance.

Scientific programme

The colloquium will cover the following topics:

- Current malaria situation in the countries (Vietnam, Cambodia, Laos, Thailand)
- Vectors:
    - Biodiversity, behaviour, distribution
    - Insecticide resistance
    - Control methods and strategies
- Forest and border malaria:
    - Risk factors
    - Intervention strategies
    - Migration and mobility patterns
    - Cross-border problems
- Case management:
    - Drug resistance
    - Community-based approaches
    - Quality of antimalaria drugs
- Socio-cultural aspects:
    - Perception of malaria, its treatment and prevention
    - Compliance and health seeking behaviour
- Monitoring and evaluation
    - The role of the private sector
    - Health information systems
    - Key indicators

Organising Committee

Ho Dinh Trung (NIMPE, Hanoi)
Marc Coosemans (ITM, Antwerp)
Le Xuan Hung (NIMPE, Hanoi)
Umberto D'Alessandro (ITM, Antwerp)
Nguyen Manh Hung (NIMPE, Hanoi)
Wim Van Bortel (ITM, Antwerp)
Ta Van Thong (NIMPE, Hanoi)
Tran Minh Tien (NIMPE, Hanoi)
Annette Erhart (ITM, Antwerp)

Scientific Committee

Awa Coll Seck (Roll Back Malaria, Geneva)
Arata Kochi (Global Malaria Programme WHO, Geneva)
Le Khanh Thuan (NIMPE, Hanoi)
Bruno Gryseels (ITM, Antwerp)
Duong Socheat (National Center for Malaria Control, Phnom Penh)
Phompida Samlane (Center of Malariology, Vientiane)
Wichai Satimai (Bureau of Vector Borne Diseases, Bangkok)
Charles Delacollette (Mekong Malaria WHO, Bangkok)
Pierre Guillet (Global Malaria Programme WHO, Geneva)

Website

http://www.itg.be/colloq2007

SCIENTIFIC PROGRAMME

MONDAY 3 DECEMBER 2007

8:00 - 9:00 **REGISTRATION**

9:00 - 10:45 **OPENING CEREMONY**

Welcome address
Prof. Le Khanh Thuan, Director NIMPE, Hanoi, Vietnam.
Prof. Bruno Gryseels, Director ITM, Antwerp, Belgium.
H.E. The Minister of Health of Vietnam.

Malaria in Africa and Asia: the same Battle?
Prof. Marc Coosemans, ITM, Antwerp, Belgium.

Scaling up Malaria interventions for Impact: Lessons learnt from Africa and Asia.
Prof. Awa Coll Seck, Executive Director of the Roll Back Malaria (RBM) Partnership, Geneva.

Malaria control, elimination or eradication?
Dr Arata Kochi, Director of the WHO Global Malaria Programme, Geneva.

10:45 -11:15 *Coffee break*

11.15 - 12:00 **SESSION 1: ACHIEVEMENTS AND CHALLENGES**
Chairs: Dr Pricha Petlueng & Prof. Bruno Gryseels

Page 19

The malaria situation in Vietnam and perspectives for the next decade.
Prof. Le Khanh Thuan, Director of the National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam.

Border malaria: a serious concern for Cambodia.
Dr Duong Socheat, Director of the National Center for Parasitology, Entomology and Malaria Control, Phnom Penh, Cambodia.

12:00 - 13:30 *Lunch break*

13:30 - 14:30 **SESSION 1: ACHIEVEMENTS AND CHALLENGES**

Chairs: Dr Pricha Petlueng & Prof. Bruno Gryseels

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Achievements and challenges to control malaria in Thailand.
Dr Wichai Satimai, Director, Bureau of Vector Borne Disease, Department of Disease Control, Ministry of Public Health. Thailand

The current malaria situation and its control in Lao PDR.
Dr Phompida Samlane, Director, Centre of Malariology Parasitology and Entomology, Vientiane, Lao PDR

Malaria trends in the Greater Mekong Sub region.
Dr Charles Delacollette, Coordinator, WHO-Mekong Malaria Programme, Bangkok

Discussion

14:30 - 15:45 **SESSION 2: BIODIVERSITY OF MALARIA VECTORS**

Chairs: Dr Tho Sochantha & Dr Wim Van BorteL

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Malaria vector biodiversity in Southeast Asia.
Dr Ho Dinh Trung, Hanoi, Vietnam

Molecular assays for identifying malaria vectors in Asia: importance of correct species identification.
Dr Sylvie Manguin, Montpellier, France

Surveillance and control of malaria transmission in Thailand using remotely sensed meteorological and environmental parameters.
Dr Richard Kiang, Maryland, USA

Environmental factors and malaria vectors in South East Asia: from data integration to specific analysis.
Mrs Valérie Obsomer, Antwerp, Belgium

Discussion

15:45 - 16:00 ***Poster session on vectors***

Page 33

- Accessing, utilizing and visualizing NASA remote sensing data for malaria modelling.
Dr Richard Kiang, Maryland, USA
- Biological characteristics of *Anopheles dirus* in Khanh Phu Commune, Khanh Vinh District, Khanh Hoa Province.
Dr Pham Thi Khoa, Hanoi, Vietnam
- Karyotype of *Anopheles Leucosphyrus Conson* form from Vietnam.
Dr. Nguyen Duc Manh, Hanoi, Vietnam
- Random Amplified Polymorphic DNA (RADP) analysis of *Anopheles Maculatus* Group (Diptera/Culicidea) in Vietnam.
Dr Nguyen Thi Huong Binh, Hanoi, Vietnam
- Evaluation on the sensibility and resistance of Anopheles to insecticides in the central-highland.
Dr Truong Van Co, Quy Nhon, Vietnam
- Mosquito diversity and bionomics of medically important species in a rain forest ecosystem of North-East India.
Dr Dibya Ranjan Bhattacharyya, Dibrugarh, India
- Susceptibility of *Anopheles maculatus* and *Anopheles mimimus* to synthetic pyrethroids by WHO test and Biochemical Assay Technique.
Dr Piyaporn Wangroongsarb, Bangkok, Thailand

16:00 - 16:30 *Coffee break*

16:30 - 17:30 **SESSION 3: INSECTICIDE RESISTANCE OF MALARIA VECTORS**

Chairs: Dr Ho Dinh Trung & Prof. Marc Coosemans

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The insecticide resistance status of malaria vectors in Southeast Asia.
Dr Wim Van Bortel, Antwerp, Belgium

Impact of vector control tools on insecticide resistant *Anopheles epiroticus* in Southern Vietnam.
Dr Vu Duc Chinh, Hanoi, Vietnam

Multiple insecticide resistance mechanisms in the Southeast Asian Anopheles species.
Mrs Katrijn Verhaeghen, Antwerp, Belgium

Discussion

17:45 - 18:15 **Presentations of Private Companies**

8:30 - 10:00 SESSION 4: FOREST AND BORDER MALARIA

Chairs: Prof. Le Khanh Thuan & Prof. Umberto D'Alessandro

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Distance to forest as a determinant of individual-level malaria risk in Cambodia.
Dr Jonathan Cox, London, UK

The epidemiology of forest malaria in Khanh Phu.
Dr Nguyen Tuyen Quang, Hanoi, Vietnam

Malaria in migration and mobility patterns in Vietnam.
Dr Le Xuan Hung, Hanoi, Vietnam

Malaria Control in some forest fringe areas of Assam: A pilot study.
Dr Prafulla Dutta, Dibrugarh, India

Simian malaria in Malaysia.
Dr Indra Vythilingam, Kuala Lumpur, Malaysia

Discussion

10:00 - 10:15 *Poster session on forest and border malaria*

Page 51

- Epidemiological study in six forest villages in Cambodia.
Dr Tho Sochantha, Phnom Penh, Cambodia
- *Plasmodium knowlesi* malaria: an emerging zoonotic infection.
Dr Jennifer Luchavez, Muntinlupa City, Philippines
- Cambodia Malaria Baseline Survey.
Dr Ung Sam An, Phnom Penh, Cambodia
- Long Lasting Insecticidal Hammock nets for controlling forest malaria in Vietnam: baseline characteristics of study population.
Dr Ngo Duc Thang, Hanoi, Vietnam

Poster session on genotyping of P.vivax

Page 63

- Genotyping of *Plasmodium vivax* infections using microsatellite markers and MSP1.
Peter Van den Eede, Antwerp, Belgium
- Genetic Diversity of *P. vivax* in Phurieng rubber plantation, Binh Phuoc province
Dr Le Duc Dao, Hanoi, Vietnam.

10:15 - 10:45 *Coffee break*

10:45 - 12:00 **SESSION 5: EPIDEMIOLOGY OF MALARIA**

Chairs: Dr. Wichai Satimai & Dr. Bui Dai

Page 57

Early malaria epidemic detection model in Thailand.
Dr Supawadee Konchom, Bangkok, Thailand

Does serology represent a viable alternative for estimating malaria transmission intensity?
Dr Chris Drakeley, London, UK

Development of two antibody ELISA's for the diagnosis of *Plasmodium vivax* and *Plasmodium falciparum.*
Dr Filip Claes, Antwerp, Belgium

Malaria and HIV: a potential issue in Asia?
Dr Jean-Pierre Van geertruyden, Antwerp, Belgium

Discussion

12:00 - 13:30 *Lunch Break*

13:30 - 15:15 **SESSION 6: DRUG RESISTANCE**

Chairs: Dr. Tran Tinh Hien & Dr. Arata Kochi

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Intensity of transmission and spread of falciparum resistant malaria.
Dr Ambrose Talisuna, Kampala, Uganda

Nine years monitoring the first line treatment regimen for falciparum malaria.
Dr Saowanit Vijaykadga, Bangkok, Thailand

Molecular epidemiology of drug resistance markers.
Dr Kanungnit Congpuong, Bangkok, Thailand

Reviewing the monitoring of antimalarial drug efficacy and resistance in sentinel sites in Vietnam.
Dr Nong Thi Tien, Hanoi, Vietnam

Antigenic escape of a malaria vaccine candidate, AMA-1 in Vietnam.
Dr. Nguyen Duc Quang, Ehime, Japan

Discussion

15:15 -15:30 ***Poster session on drug resistance***

Page 73

- Sequence analysis of a rhoptry associated protein-1, rap-1, gene in *Plasmodium falciparum* and its applications.
Dr Harnyuttanakorn, Thailand
- Prevalence of polymorphisms in dhfr, dhps, pfmdrl and pdcrt genes of *Plasmodium falciparum* in Quang Tri province, Vietnam.
Dr Bui Quang Phuc, Vietnam

Poster session on vector control

Page 85

- Evaluation on the residual efficacy of Bistar TM 10 WP (bifenthrin) applied to various wall surfaces under laboratory conditions in Vietnam.
Dr Nguyen Anh Tuan, Hanoi, Vietnam
- Residual analysis, half-life time and residual effect on *An.dirus* of pyrethroid impregnated nets.
Dr Nguyen Anh Tuan, Hanoi, Vietnam
- Field evaluation of lambda-cyhalothrin micro-encapsulated formulation (Icon 2.5CS) impregnated bednets for malaria control in Nong district, Savannakhet Province, Lao PDR.
Dr Bounpong Sidayong, Vientiane, Laos

15:30 - 16:00 *Coffee break*

16:00 - 17:30 **SESSION 7: VECTOR CONTROL**

Chairs: Dr. Indra Vythilingam & Prof. Jo Lines

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Personal protection by long lasting insecticidal hammocks (LLIH) against forest malaria vectors in Cambodia.
Dr Tho Sochantha, Phnom Penh, Cambodia

Long-Lasting Insecticidal Hammock Nets (LLIHN) for controlling malaria in Vietnam: preliminary results.
Dr Ngo Duc Thang, Hanoi, Vietnam

Integrated pest and vector management: tool for adapting vector control to global change and local conditions.
Dr Hans J. Overgaard, Norway

Study on SupaTab use in 6 districts of 3 southern provinces of Laos (Saravane, Champassack and Sekong).
Dr Rattanaxay Phetsouvanh, Vientiane, Laos

Spatial targeted vector control in African highlands and its impact on malaria.
Dr Dismas Baza, Bujumbura, Burundi

Discussion

19:00 ***Mekong Dinner with traditional Vietnamese dances***
(only for registered participants)

Wednesday, 5 December 2007

8:30 - 9:45 SESSION 8: COVERAGE AND ACCEPTANCE OF ITN

Chairs: Dr. Duong Socheat & Dr. Koen Peeters

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National mosquito net coverage in malarious areas of Cambodia is surprisingly and uniformly high, but most nets are not treated.
Prof. Jo Lines, London, UK

Improving malaria control through the use of ITNs among the JARAY minority group in Rattanakiri province, Cambodia.
Dr Siv Sovannaroth, Phnom Penh, Cambodia

Acceptance studies of Long Lasting Insecticidal Nets (LLINs) among selected communities in Lao communities living in remote areas.
Dr Rattanaxay Phetsouvanh, Vientiane, Laos

Barriers for net-using among Bana people in K'Bang district, Gia Lai province.
Dr Phan Thi Thu Hien, Haoi, Vietnam

Discussion

9:45 – 10:00 *Poster session on rapid diagnostic tests*

Page 101

- The validation of the THMBC Malaria Pf./Pv. Rapid Diagnostic Device for the detection of falciparum and non falciparum malaria in Thailand 2006.
Dr Pongwit Bualombai, Nonthaburi, Thailand
- Producing monoclonal antibody against Plasmodium Glyceraldehyde-3- Phosphate Deshydrogenase (pGAPDH) to diagnose malaria parasites.
Dr Pongwit Bualombai, Nonthaburi, Thailand

Poster session on social approaches of malaria control

Page 113

- Low risk perception of contracting malaria among the Raglai ethnic minority group living in the forest and mountainous areas of Ninh Thuan province, Vietnam.
Dr Nguyen Xuan Xa, Hanoi, Vietnam
- Medical anthropology study on malaria control among Wa ethnic minority group in Ximeng County, Yunnan Province.
Dr Xu Jianwei, Yunnan, China

10:00 - 10:30 *Coffee break*

10:30 - 11:30 **SESSION 9: APPROACHES FOR BETTER CASE MANAGEMENT**

Chairs: Dr. Ambrose Talisuna and Dr. Annette Erhart

Page 95

The potential of village health workers for malaria control and how to realize it.
Dr Nguyen Tuyen Quang, Hoi, Vietnam

Village-based early diagnosis and appropriate treatment for malaria – The emergency strategy of choice for remote and hyperendemic villages in Cambodia.
Dr Chea Nguon, Phnom Penh Cambodia

Evidence of quality of care in primary health care system in rural Vietnam: A systematic review from studies managed by local NGO's and independent research institutions.
Dr Tran Tuan, Hanoi, Vietnam

Antimalaria drug quality monitoring in Viet Nam.
Dr Trinh Ngoc Hai, Hanoi, Vietnam

Discussion

11:30 - 12:00 **SESSION 10: SOCIAL APPROACH OF MALARIA CONTROL**

Chairs: Dr. Xuan Hung & Prof. Awa Coll Seck

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Health seeking behaviour models in malaria research.
Dr Joan Muela Ribera, Barcelona, Spain

Malaria baseline study with Kreng minority group in Rattanakiri Province
Dr Boukheng Thavrin, Phnom Penh, Cambodia

12:00 - 13:30 *Lunch Break*

13:30 - 14:30 **SESSION 10: SOCIAL APPROACH OF MALARIA CONTROL**

Chairs: Dr. Xuan Hung & Prof. Awa Coll Seck

The relevance of social science research in international health and malaria control in Vietnam and other settings.
Dr Koen Peeters Grietens, Barcelona, Spain

Addressing the challenge of malaria control in ethnic minority communities: a Mekong perspective.
Dr Pricha Petlueng, WHO, Laos

Social factors relative to the persistence of malaria transmission in Dak Rong and Huong Hoa districts in Quang Tri province.
Dr Doan Hanh Nhan, Hanoi, Vietnam

Discussion

14:30 - 16:00 **SESSION 11: MONITORING AND EVALUATION, COMMUNICATION**

Chairs: Dr Rattanaxay Phetsouvanh & Dr Charles Delacollette

Accuracy of the health information system on malaria surveillance in Vietnam.
Dr Annette Erhart, Antwerp, Belgium

Piloting of a strategy for collection of malaria information from the private sector in Cambodia.
Dr Kheng Sim, Phnom Penh, Cambodia

Private health sector in malaria control in Vietnam.
Dr Doan Hanh Nhan, Hanoi, Vietnam

Identifying key indicators for monitoring and evaluation of the activities and impact of the malaria control project in Vietnam.
Dr Le Xuan Hung, Hanoi, Vietnam

Resource sharing and communication: serving the needs of the malaria clientele.
Dr Joseph Yap, Phillipines

Discussion

16:00 - 16:30 *Coffee break*

16:30 - 17:00 **Closing session**

Final conclusions presented by the Directors of the National Malaria Control Programmes.

ABSTRACTS

MALARIA IN AFRICA AND ASIA: THE SAME BATTLE?

Prof. Marc Coosemans

Affiliation: Institute of Tropical Medicine of Antwerp, Belgium
E-mail: mcoosemans@itg.be

Malaria transmission in Sub-Saharan Africa occurs almost everywhere, while in Asia the transmission patterns are less homogeneous. This results in a variable disease burden. Surprisingly malaria control programs have a standard approach in both continents by using tools as indoor residual spraying, insecticide treated nets and malaria treatment, in a similar way.

In Sub-Saharan Africa, the main vector *An. gambiae sensu lato* breeds in sun exposed temporary habitats such as pools, puddles, hoof prints and borrow pits. *An.funestus* in more or less the same breeding places but only once vegetation has grown. The combination of these two vectors assures a prolonged or perennial transmission and explains the wide spread of malaria transmission in Africa. As a result, Africa 'hosts' 90% of the malaria burden in the world.

In Asia, and particularly in the Mekong Region, biodiversity of Anopheles species is considerably higher compared to Africa. Up to 20 different species can be found in a rural domestic environment, including several potential secondary vectors. Three major vectors are present. In forested and hilly areas, *An. minimus* s.l. and *An. dirus* s.l. are major vectors while *An. epiroticus* is the vector in the brackish coastal regions. *An. dirus* s.l. is certainly the most effective malaria vector in the world but is restricted to densely forested landscapes. Malaria is then mainly an occupational disease affecting people during their temporary stay in the forest. It concerns ethnic minority groups living in the forest and migrant forest workers.

Sub-Saharan Africa achieved, despite the socio-economic constraints, major progresses during the last four years by scaling up the control activities.
In Asia, due to a strong commitment of the Mekong countries and facilitated by an economic growth, the malaria situation improved a lot during the last decade. Unfortunately, there are still major challenges to tackle malaria and to sustain the achievements (e.g. drug and insecticide resistance, control of forest and border malaria, the control of vivax malaria, health system and the private sector).
Control approaches should depend on the biodiversity of malaria vectors, the socio-economic situation, the health infrastructure, migration patterns. Intensifying exchanges of experiences between experts of both continents will be needed to achieve the targets in malaria control set by the millennium goal.

SCALING UP MALARIA INTERVENTIONS FOR IMPACT: LESSONS LEARNT FROM AFRICA AND ASIA.

Prof. Awa Marie Coll-Seck,

Executive Director of Roll Back Malaria Partnership
E-mail: collsecka@who.int

As increased funding becomes available for malaria control globally and policies and strategies clarified, success stories are more and more documented. However, some countries face operational challenges in scaling up implementation, which in return jeopardizes their opportunity to access continued funds and sustain their efforts. Packages of tailored support are being made available to countries to release operational and financial bottlenecks, improve the performance of malaria control programmes and secure continued funding.

Lessons learned from recent application of this approach by the RBM Partnership shows that thorough analysis to identify bottlenecks and targeted support is effective in the fight against malaria and shows also the critical role of partners coordination in supporting scale-up.

MALARIA CONTROL, ELIMINATION OR ERADICATION?

Dr Arata Kochi

Director of the WHO Global Malaria Programme, Geneva
E-mail: kochia@who.int

At the Bill & Melinda Gates Foundation Malaria Forum, 16-18 October 2007, an ambitious target for malaria eradication was proposed, and globally endorsed by major stakeholders. In theory, malaria eradication can be achieved following certain steps from control to elimination, then eradication.

A first step towards eradication entails accelerating malaria elimination in a number of countries already engaged in this process. New initiatives on elimination will be further encouraged, either at country or regional levels. At the same time, malaria control in endemic countries, especially in Africa, will be strengthened and scaled-up based on three pillars: 1) diagnosis of malaria cases and treatment with effective medicines;
(ACTs); 2) mass distribution of free or highly subsidized long-lasting insecticidal nets (LLINs), to achieve full coverage of populations at risk of malaria; and 3) indoor residual spraying (IRS) to reduce and eliminate malaria transmission where appropriate, especially in areas with unstable and epidemic malaria.

A prerequisite for malaria elimination is interruption of transmission. Effective control of parasites and vectors has been independently managed in the past. Eventual interruption of transmission, especially in Africa, would require a synchronized attack of both parasites (use of rapid diagnostic tests, treatment of all parasite carriers using combination therapies) and vectors (mainly LLINs and IRS). However, to sustain this approach, new tools such as improved rapid diagnostic tests, new combination therapies, 5 year long-lasting nets treated with a combination of unrelated insecticides, longer lasting formulations for IRS and, eventually, effective malaria vaccine(s) will be needed. New approaches, for instance, the use of genetically modified vectors that would no longer feed on humans or have lost their ability to transmit human pathogens may eventually emerge in future.

Phased elimination is possible. Moving towards eradication will be an ambitious and long-term goal that will require substantial investment in strengthening capacity of national health services in endemic countries. This would also require strong and sustained political commitment of countries engaged in this effort. Finally, this would also require mobilization and a massive effort of the international community as well as innovative partnerships and approaches.

SESSION 1:

Achievements and challenges of malaria control in the Mekong region

THE MALARIA SITUATION IN VIETNAM AND PERSPECTIVES FOR THE NEXT DECADE.

Prof. Le Khanh Thuan

Affiliation: Director of the National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam.
E-mail: lekhanhthuan@hn.vnn.vn

Situations

Over the last decade (1991-2002), the malaria has been reduced greatly in Vietnam: the mortality and morbidity was reduced by 97% and 78% respectively. Reports in the first three years of this century (2001-2004) have showed that malaria continue to decline over the country. The morbidity and mortality decreased from 3.07/1,000 and 0.12/100,000 in 2001 to 1.90 and 0.06 respectively in 2004. No important malaria epidemic occurred during this period. This was beyond the expected goals defined for 2005, e.g. to reduce morbidity & mortality below 3.5/1,000 and 0.15/100,000 respectively).
The Government of Vietnam invests annually about 4 to 4.5 millions USD in the Malaria Control Programme (MPC). The annual number of persons protected by IRS and ITNs is 10-12 million (50-80% of population in the hyper-endemic areas) and more than 300,000 ITNs per year were distributed to the target population.
Although the MCP has been successful, the situation is still not consolidated: many places are still at risk for malaria resurgence and malaria mortality and morbidity is still high in some remote areas. Many factors account for this situation:

Gap, Constrains and Challenges

- The malaria endemic areas are large (42 of the 80 millions inhabitants are at risk)) but the coverage and quality of the intervention is limited.
- The morbidity and parasite carriers in some communities are still high, and is associated with illegal migration and forest activities overnight.
- In remote areas, health services are inadequately used due to a lack of knowledge and awareness of the community regarding malaria.
- Health staff and local authorities neglect the malaria problem where it has been considerably reduced.
- The limitation of resources for scaling up malaria control and roll back malaria.

Strategic directions to roll back malaria in Vietnam

Goals:
To continue to reduce the malaria morbidity, mortality and epidemics in order to make the disease no longer a major health problem in the community and to develop a sustainable approach for maintaining the obtained achievements of malaria control.

Objectives:
- To reduce malaria morbidity below 2.1/1,000 and mortality below 0.05/100,000 by the year 2004.
- To reduce malaria morbidity below 0.8/1,000 and mortality below 0.02/100,000 by the year 2010.

Solutions

- To develop good mechanisms for distribution of malaria supplies according to the national norms, focusing on priority areas.
- To improve the coverage and quality of the interventions, justification of drug policy and vector control strategy based on the micro-stratification in terms of efficacy and cost-effectiveness.
- To strengthen the health care system, increase access to early case detection and prompt treatment of malaria and management of private health sector.
- To strengthen the malaria surveillance system, including computerization and malaria information system.
- To improve control strategies taking into account migration patterns.
- To promote the implementation of the operational research, identifying research agenda and priorities.
- To socialize malaria control activities and to develop partnerships at the national, regional level, including cross-border and military-civilian collaborations.
- To mobilize all the resources and international supports.

BORDER MALARIA: A SERIOUS CONCERN FOR CAMBODIA.

Dr Duong Socheat

Affiliation: Director, National Center for Parasitology, Entomology and Malaria Control, Cambodia
E-mail: socheatd@cnm.gov.kh

In Cambodia, malaria continues affecting mostly the poorer communities living in the forested areas where approximately 2 millions people are at risk. It is not easy to estimate the real disease burden since about 80% people seek care from the private sector, which is not covered by Health Information System (HIS) report. Out of 24 Cambodian provinces/municipalities, 17 share the borders with Thailand, Laos and Vietnam where about 9.8 out of 14.4 millions populations reside. Among the 17 border provinces, 13 are endemic for malaria where about 6 million people live. Among those 2 millions people, who are living at high risk of malaria within 2km of forest, 1.5 millions of them are from these 13 border provinces.

Malaria situation in border provinces of Cambodia: according to the HIS data, a total of 100,943 malaria cases were treated in 2006 of which 78,696 were confirmed malaria. About 75% of all confirmed malaria cases were *P. falciparum* and 23% *P. vivax*. Around 65% of vivax malaria is observed at the Cambodia-Thai border areas (7 provinces). In remote, hyper-endemic areas, mostly in border provinces, Village Malaria Workers (VMW) have treated about 45,000 confirmed *P. falciparum* malaria cases in 2006.

Cambodia is right at the centre of the global multi-drug resistant malaria problem especially in western Cambodia. The efficacy of the current 1st line treatment (artesunate + mefloquine) of uncomplicated falciparum malaria has decreased in the western part though this regimen is still highly effective in the eastern part of Cambodia. To obtain further evidences, regular monitoring of drug quality and treatment efficacy must be continued in sentinel sites. Vivax malaria is an increasing public health problem, especially in western part of Cambodia.

According to MAVECASIA project, the main malaria vector (*An dirus* and *An. minimus*) in Cambodia and Vietnam is still sensitive to pyrethroids. However, insecticide resistance problems occur in southern Vietnam with *An. epiroticus (*formally *An.sundaicus)*. That may also impede the vector control activities in Cambodia. Recommendations to tackle this problem need to be discussed in the appropriate forum.
The overall prevalence of counterfeit and substandard drugs in the Mekong region is estimated at about 40% for some anti-malaria drugs (e.g. artesunate) purchased from private retail outlets. At least 14 different types of fake Artesunate are sold in the mainland of South-East Asia, most of which are also available in Cambodia because of the flourishing cross-border trade between Cambodia and its neighbours. However, despite the governmental efforts of promoting anti-malarials of good quality at a subsidized price, also in the private sector (e.g. Malarine), many people, particular the poor living in remote and border areas, continue to buy anti-malarial other than “Malarine".

There are numbers of formal and informal checkpoints along the borders of Thailand, Laos and Vietnam. Many people cross the borders for various purposes,

such as for temporary or longer-term jobs, business, family visits as well as tourists. The non-immune or partially-immune people are easy victims of malaria and severe malaria is not uncommon. Health facilities are often absent along the borders. The people are treated at private clinics with drugs of poor quality (counterfeit drugs), may cause even deaths among these malaria victims.

There is a need to intensify malaria control activities in border provinces by improving rational use of anti-malarial drugs, ensuring quality, combating counterfeit drugs and implementing a comprehensive malaria control measures in cooperation with other sectors to halt the spread and further development of multi-drug resistant of malaria.

In collaboration with the neighbouring countries, we want to strengthen the existing national border health committees, especially in the malaria endemic areas. Regular meetings and exchanges of the provincial and district health staff can be organized (e.g. quarterly) to discuss the malaria situation and the actions required, and to share experiences. Through the GFATM Round 6 project, Cambodia will address some of these issues, but there is need to explore the feasibility of properly designing and submitting joint proposals to the funding agencies to address seriously the cross-border malaria issues including the multi drug resistance.

ACHIEVEMENTS AND CHALLENGES TO CONTROL MALARIA IN THAILAND.

Dr Wichai Satimai and Kesanee Kladphuang, Saowanit Vijaykadga

Affiliation: Director, Bureau of Vector Borne Disease, Department of Disease Control, Ministry of Public Health. Thailand
E-mail: wichaisatimai@yahoo.co.th

Thailand's National Malaria Control Programme has successfully reduced malaria morbidity and mortality in most of the country using vector control measures and a large network of malaria clinics delivering diagnosis and treatment. Malaria transmission is now limited to the forested and hilly areas of the Eastern and Western border provinces and the Southern peninsula.
The success is so significant that the programme is currently facing different challenges of complacency, with a drastic domestic budget reduction, which threatens the country's ability to maintain the gains made over the past decade. Majority of confirmed cases are reported from and confined to provinces bordering neighbouring countries especially on the Thai-Myanmar border where there is a continuous influx of migrants and increasingly on the Thai-Malaysian border as a result of the unrest situation. The ongoing serious conflict in the south of Thailand is severely compromising the ability of the established health system to provide basic health care. However due to the success of the overall malaria programme in recent years, the national budget has been drastically reduced from US$ 23 million in 2002 to 12 million in 2006.

Although Thailand has a considerable achievement on malaria control program, collaborative mechanisms for the program still needs to be strengthened, especially for cross-border health collaboration with neighbouring countries in order to solve the problems more effectively and efficiently. More over the issue those are challenging the malaria multi-resistant falciparum malaria is one of the most severe challenges to malaria control in Thailand. To further reduce the malaria burden, the programme intends to scale up cost-effective interventions in all endemic villages targeting also the migrant population, which is not taken into account by the Thai national welfare policy. In the conflict zones of the southern provinces, Thailand, community based activities should be strengthened relying on local staff to perform quality interventions and in partnership with provincial and military authorities ensuring protection of national and provincial staff when on field supervision. Thailand has the decentralization of the health care services policy, especially National Malaria Control Programme services into the regular health service system at the provincial and local level. Therefore, capacity building of local health personnel on malaria control program is needed and will provide an opportunity for human resource development at the community or grass root level. Another issue that is challenging the impacted of Global warming is factors influence the problem to vector-borne disease (malaria dengue, leishmaniasis, Lyme disease, tick-borne encephalitis). The detection and measurement of the health effects of climate change are needed to provide evidence on which to base national and international policies related to adaptation and mitigation measures.

THE CURRENT MALARIA SITUATION AND ITS CONTROL IN LAO PDR.

Rattanaxay Phetsouvanh, Samlane Phompida, Bouasy Hongvanthong, Viengphone Sengsavath, Simone Nambanya, Viengsay Vanisaveth, Kongsay Louangphengsouk and Deyer Gopinath

Affiliation: Centre of Malariology Parasitology and Entomoly, Vientiane, Lao PDR.
E-mail: rattanaxay.phetsouvanh@theglobalfundlao.org, p.samlane@gmail.com

Malaria is always ranking among the top ten diseases reported by the Ministry of Health, Lao PDR. Hence, it has always been considered as a public health problem in Lao PDR, particularly the population living in very remote areas. Malaria control activities was initiated in the early sixties. However only after the liberation of the country, particularly since 1996 onward, malaria control programme has indeed been expanded to all provinces. It covers all 17 provinces of the country. Due to the success of the malaria interventions such as vector control using ITN/LLN and the early diagnosis and adequate treatment through ACT and RDT in recent years it has been observed that malaria morbidity and mortality has been gradually reduced country wide. There has been a significant reduction of malaria mortality and morbidity in the last 5 years.

All four malaria parasite species can be found in Laos. However *P. falciparum* is the most predominant species and accounted for 95% of all malaria cases in the country while *P. vivax*, *P. malaria* and *P. ovale* have been found in 4%, 0.8% and 0.2%. Four *Anopheles* species were recognized as main vectors: *An. minimus*, *An. maculatus*, *An. dirus*, and *An. jeyporiensis*.
Studies on anti-malarial drug monitoring in several sentinel sites have shown no resistance of P.f against the new ACT (CoArtem®) used in Laos.
Insecticide Treated Nets (ITN) and Long Lasting Treated Net (LLTN) are becoming the main intervention for vector control in the whole country.
Although malaria control in Laos has achieved a great progress in term of reduction of malaria mortality and morbidity, still tremendous efforts are needed to make the programme sustainable.

The NMCP should give particular attention to capacity strengthening of the health staffs from all level; more training (short and long-term training) is than essential to catch up the trend already achieved by other countries. Operational research is needed to elucidate questions encountered during the implementation of malaria control activities (knowledge on social approaches for malaria control in Laos is limited; the health economic aspects of the vertical programme versus the integrated system need to be explored, etc.) Therefore, more cooperation and collaboration are still needed for the NMCP to move forward with strong scientific evidence.

MALARIA TRENDS IN THE GREATER MEKONG SUB REGION.

By the WHO Mekong Malaria Programme

Presented by Dr Charles Delacollette
Coordinator, WHO-Mekong Malaria Programme Faculty of Tropical Medicine, Mahidol University
E-mail: Delacollette@searo.who.int

In 1999, the countries of the Greater Mekong Subregion (GMS) – Cambodia, Lao PDR, Myanmar, Thailand, Viet Nam and China's Yunnan province – committed to substantially reducing malaria morbidity and to halving the annual number of malaria deaths between 1998 and 2010. To date, as officially reported by national country programmes to WHO, the Mekong region has made considerable progress with regard to these goals. With a 55% drop in annual malaria deaths between 1998 and 2005, the region overall has already met its objective on malaria mortality. In terms of morbidity, the number of confirmed malaria cases across the region declined by 32.1% between 1998 (400,722 cases) and 2005 (272,184 cases). As of 2005, the Mekong region had a malaria incidence rate of 1.03 confirmed cases per 1,000 population (compared to 1.67 cases per 1,000 in 1998) and a malaria mortality rate of 0.87 deaths per 100,000 population (compared to 2.13 deaths per 1,000 in 1998).

Despite these significant improvements in the epidemiological situation, malaria continues to be a major public health problem in the Greater Mekong Subregion. Within the region, progress in malaria control has been varied and the current malaria situation is highly uneven. In 2005, malaria incidence ranged from 0.2 confirmed cases per 1,000 resident inhabitants in Yunnan province to 3.8 confirmed cases per 1,000 in Cambodia. Although Myanmar accounts for approximately one-fifth of the region's population, more than half of malaria cases and nearly three-quarters of malaria deaths in the GMS in 2005 occurred in this country, mostly in border areas.

The concentration of malaria along international borders is a common pattern across the GMS. These border areas are characterized by forest and forest fringe areas with high malaria transmission and poor geographical accessibility. Extensive population movements from endemic areas to low-prevalence areas have aggravated the malaria situation along the Yunnan border and in western Thailand. Antimalarial drug resistance has undermined malaria control efforts in the GMS, particularly along the Thai-Cambodian border.

This paper outlines the major epidemiological trends in malaria in the region between 1998 and 2005 and provides an overview of the current malaria situation. Areas of high malaria morbidity and mortality rates within the six countries of the GMS are further described.

SESSION 2:

Biodiversity of malaria vectors

MALARIA VECTOR BIODIVERSITY IN SOUTHEAST ASIA AND CONSEQUENCES IN A FAST CHANGING ENVIRONMENT.

Ho Dinh Trung[1], Wim Van Bortel[2], Tho Sochantha[3], Kalouna Keokenchanh[4], Le Khanh Thuan[1] and Marc Coosemans[2].

Affiliation: 1. National Institute of Malariology, Parasitology and Entomology, Vietnam (NIMPE); 2. Institute for Tropical Medicine Prince Leopold, Belgium (ITM); 3. National Center for Malaria Control, Parasitology and Entomology, Cambodia (NCM); 4. Centre of Malariology, Parasitology and Entomology, Laos (CMPE).
E-mail: hodinhtrung@nimpe.vn

In Southeast Asia, the biodiversity of *Anopheles* species in the domestic and forested environment is very high. Only few species are considered major vectors throughout the region, whereas the vector status of other species varies from area to area. Often it is difficult to identify an *Anopheles* species as a malaria vector in area with low malaria incidence. The behaviour of *Anopheles* species largely determines their vector status, and insights into their behaviour are essential to evaluate the appropriateness of vector control measures.

Below are the findings of long-term entomological studies conducted in ecologically different localities in Vietnam, Laos and Cambodia, from 1998 to 2006.

Spatial variation in biting and resting behaviour was observed within almost all *Anopheles* species. These heterogeneities may result in differences in transmission and in response to vector control of *Anopheles* species in different areas.

Anopheles dirus was highly anthropophilic at all investigated sites where it occurred and continued to play an important role in malaria transmission despite its low density. This is supported by sporozoite rate of 1.1 - 10.7% found in *An. dirus* at these sites. By contrast, the degree of anthropophily exhibited by *An. minimus* A depended on availability of cattle, and its role in malaria transmission varied between localities. This species was found to be highly anthropophilic at sites in Central Vietnam and Laos with human-cattle biting ratio of 8.1 and 10.1, respectively. At the sites in Northern Vietnam and Cambodia, *An. minimus* A was highly zoophilic with human-cattle biting ratio of 0.1 and 0.5, respectively. Only samples of *An. minimus* A collected at sites in Central Vietnam and Cambodia were found to be positive with sporozoite rates of 2.8% and 1.4%, respectively.

Late biting of *An. minimus* A and biting activity throughout the night of *An. epiroticus* (formerly *An. sundaicus*) favour bed-nets as a suitable control tool for these species, whilst exophilic and outdoor biting in combination with early feeding behaviour of *An. dirus* make both insecticide-impregnated bed-nets and indoor residual spraying less suitable for controlling this species.

Environmental changes and changes in human practices are expected to influence the abundance, behaviour, hence the role of difference *Anopheles* species in malaria transmission and malaria situation. The expansion of people into forest in a locality in Central Vietnam attracted a considerable number of *An. maculatus*, a secondary vector, to bite human (3.2 bites/man/night). The sporozoite rate of

0.4% found in samples of *An. maculatus* at this site indicated that this secondary vector obviously participated in malaria transmission. The recent changes in land use from rice cultivation to brackish shrimp farming in the Mekong delta probably leads to the increase of density of brackish water breeding species *An. epiroticus* (up to 190 bites/man/night). Moreover, the reappearance of *An. takasagoensis*, a member of *Dirus* species complex in some localities in Northern Vietnam is associated with the increase of forest coverage in recent years. This phenomenon may be a "signal" alarming the threat of come-back of malaria in free-malaria areas where the success of re-forestation program is obtained?

MOLECULAR ASSAYS FOR IDENTIFYING MALARIA VECTORS IN ASIA: IMPORTANCE OF CORRECT SPECIES IDENTIFICATION.

Sylvie Manguin[1], Claire Garros[1], Isabelle Dusfour[1] & Marc Coosemans[2].

Affiliation : 1. Institut de Recherche pour le Développement (IRD) France. 2. Institute for Tropical Medicine Prince Leopold, Antwerp, Belgium.
Email: manguin@mpl.ird.fr

Malaria vector system in Southeast Asia is complex due to the number of species potentially involved in transmission. All Oriental malaria vectors belong to species complexes which cannot be distinguished on the sole basis of morphology. The follow-up and evaluation of preventive control measures are therefore hampered by the potential misidentification of vectors.

Efforts have been made to develop efficient alternative techniques to morphology. For decades, the gold standard for anopheline species identification was isozyme electrophoresis which requires fresh or frozen samples. The large development of PCR-based methods that constitute efficient and powerful identification tools changed drastically the panel of molecular identification assays without such conservation requirements.

This talk aimed at presenting the PCR-based assays available to identify the main Oriental malaria vectors with a special focus on the Culicifacies, Dirus, Fluviatilis, Maculatus, Minimus, and Sundaicus Complexes. Moreover, the importance of using PCR-based assays in entomological surveys will be highlighted through two examples. In central Vietnam, a RFLP-PCR assay showed that an unusual morphotype of *Anopheles minimus* was actually *An. varuna*, a non-vector species. Within the Minimus Complex, the use of an allele-specific PCR over large temporal and geographic surveys demonstrated the unreliability of two morphological characters considered as diagnostic.

Molecular identification assays have proven to be the most efficient tools to differentiate unambiguously malaria vectors versus non-vector species when morphology finds its limits. Proper species identification is essential and mandatory in any relevant study on malaria vectors for improving our knowledge on species distribution and biology, as well as for the application of successful vector control strategies.

SURVEILLANCE AND CONTROL OF MALARIA TRANSMISSION IN THAILAND USING REMOTELY SENSED METEOROLOGICAL AND ENVIRONMENTAL PARAMETERS.

Richard Kiang

Affiliation: Nasa Goddard Space Center, Maryland, USA
E-mail: richard.kiang@nasa.gov

At 4,200 km, the Mekong River is the tenth longest river in the world. It directly and indirectly influences the lives of hundreds of millions of inhabitants in its basin. The riparian countries form the Greater Mekong Subregion. This geographical region has been the world's epicenter of *falciparum* malaria. Depending on the country, approximately 50 to 90% of all malaria cases are due to this species.

In the Malaria Modeling and Surveillance Project, which is part of the NASA Applied Sciences Public Health Applications Program, we have been developing techniques to enhance public health's decision capability for malaria risk assessments and controls. The main objectives are: 1) identification of the potential breeding sites for major vector species; 2) implementation of a risk algorithm to predict the occurrence of malaria and its transmission intensity; 3) implementation of a dynamic transmission model to identify the key factors that sustain or intensify malaria transmission. The potential benefits are: 1) increased warning time for public health organizations to respond to malaria outbreaks; 2) optimized utilization of pesticide and chemoprophylaxis; 3) reduced likelihood of pesticide and drug resistance; and 4) reduced damage to environment.

Environmental parameters important to malaria transmission include temperature, relative humidity, precipitation, and vegetation conditions. The NASA Earth science data sets that have been used for malaria surveillance and risk assessment include AVHRR Pathfinder, TRMM, MODIS, NSIPP, and SIESIP.

Textural-contextual classifications are used to identify small larval habitats. Neural network methods are used to model malaria cases as a function of the remotely sensed parameters. Hindcastings based on these environmental parameters have shown good agreement to epidemiological records. Discrete event simulations are used for modeling the detailed interactions among the vector life cycle, sporogonic cycle and human infection cycle, under the explicit influences of selected extrinsic and intrinsic factors. The output of the model includes the individual infection status and the quantities normally observed in field studies, such as mosquito biting rates, sporozoite infection rates, gametocyte prevalence and incidence. Results are in good agreement with mosquito vector and human malaria data acquired by Coleman et al. over 4.5 years in Kong Mong Tha, a remote village in western Thailand.

Application of our models is not restricted to the Greater Mekong Subregion. Our models have been applied to malaria in Indonesia, Korea, and other regions in the world with similar success.

ENVIRONMENTAL FACTORS AND MALARIA VECTORS IN SOUTH EAST ASIA: FROM DATA INTEGRATION TO SPECIFIC ANALYSIS.

Valérie Obsomer [1,2], Wim Van Bortel [1], Katrijn Verhaeghen[1] ,Le Khanh Thuan[3], Ho Dinh Trung[3], Phompida Samalane[4] , Keokenchanh Kalouna [4], Duong Socheat[5], Tho Sochantha[5], Pierre Defourny[2], Marc Coosemans[1]

Affiliation: 1. Institute for Tropical Medicine Prince Leopold, Belgium (ITM), 2. Universite catholique de Louvain, Belgium (UCL); 3. National Institute of Malariology, Parasitology and Entomology, Vietnam (NIMPE); 4. Centre of Malariology, Parasitology and Entomology, Laos (CMPE); 5. National Center for Malaria Control, Parasitology and Entomology, Cambodia (NCM)
E-mail: valerie.obsomer@uclouvain.be

Environmental factors are of up most importance for malaria transmission dynamics in Southeast Asia. Indeed, the diversity of vectors and anopheles species is particularly high in the region and the vector status might depend on the ability of a given landscape to provide the environmental conditions favourable for the mosquito development.

In the framework of the MALVECASIA EU funded project, a geographical information system was developed to integrate mosquito data with environmental factors. The data was collected, documented, organised and a data visualisation tool (SEAGIS) was developed to make the information available to the key person. Mosquito collection surveys cover a hundred sites throughout Laos, Cambodia and Vietnam with more than 30 species collected. The main malaria vectors in the region were tested for insecticide resistance. Environmental databases for the region include information derived from satellite imagery, detailed land cover, meteorological information and malaria indicators.

The interaction between the environment and the mosquitoes were investigated. The analysis focuses on species associations, development of risk maps for the major vectors and investigations on the persistence of *An. dirus* during the dry season (in dense forested areas). The analyses are performed using methodologies adapted to the specificity of the data. Different seasons and years of collection are inevitable in monitoring activities covering such an extended territory. The strong influence of seasonality and meteorological conditions on the presence of mosquito species makes it impossible to be sure that a particular species is absent in one area. Moreover, variation in behaviour according to mosquito species makes it impossible to compare quantitative mosquito population data. Adapted methods are implemented to first define habitat suitability maps based on presence data only, then analyse species resemblance using coefficient giving more weight to presence than to absence data and finally define species associations and habitat based on those asymmetric coefficients.

Poster session on malaria vectors

ACCESSING, UTILIZING AND VISUALIZING NASA REMOTE SENSING DATA FOR MALARIA MODELLING.

Richard Kiang

Affiliation: Nasa Goddard Space Center, Maryland, USA
E-mail: richard.kiang@nasa.gov

The transmission of malaria is influenced by a myriad of factors. Environmental, climatic, socioeconomic, public health, political, and wartime conditions have all been shown to contribute to malaria occurrence and outbreaks. Among these, the environmental conditions, especially rainfall, appears to be the most recognizable determinant. The geophysical parameters relevant to malaria transmission include precipitation, surface temperature, humidity, elevation, and vegetation type. Because these parameters can be routinely measured over large areas using remote sensing, remote sensing is an important technologic tool for predicting, preventing, and containing malaria epidemics.

A variety of NASA remote sensing data can be used to extract environmental information for modeling malaria transmission. We will discuss both the well known and less known remote sensing data, including Landsat, AVHRR (Advanced Very High Resolution Radiometer), MODIS (Moderate Resolution Imaging Spectroradiometer), TRMM (Tropical Rainfall Measuring Mission), ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer), EO-1 (Earth Observing One) ALI (Advanced Land Imager), and SIESIP (Seasonal to Interannual Earth Science Information Partner) dataset.

The precipitation data is from TRMM data product 3B43, which can be acquired using the Giovanni tool at the NASA Goddard Earth Sciences Data and Information Services Center (GES DISC) (http://disc2.nascom.nasa.gov/Giovanni/tovas). Giovanni is a Web-based application developed by the GES DISC that provides a simple and intuitive way to visualize, analyze, and access vast amounts of Earth science remote sensing data without having to download the data. The temperature and NDVI data are from MODIS products MOD11/MYD11 and MOD13/MYD13 respectively. These global monthly products are available for download from LPDAAC (Land Processes Distributed Active Archive Center) (http://lpdaac.usgs.gov). The MODIS water vapor product MOD05/MYD05, which can be used for deriving relative humidity, is distributed by the Level One and Atmosphere Archive and Distribution System (LADS) in MODIS Adaptive Processing System (MODAPS) (http://ladsweb.nascom.nasa.gov). Digital elevation data are from the Shuttle Radar Topography Mission (SRTM) (http://www2.jpl.nasa.gov/srtm). ASTER, ALI and Landsat data can be downloaded from the USGS Global Visualization Viewer (http://glovis.usgs.gov). This tool is capable of viewing basic images and certain products from sensors such as EO-1, ASTER, Landsat, and MODIS. Climate forecast data is available from NASA Goddard Modelling and Assimilation Office (GMAO) (http://gmao.gsfc.nasa.gov).

Examples for accessing, visualizing and analyzing the remote sensing data described above will be given. Examples for modelling the spatiotemporal malaria transmission risks in Thailand and other counties based on remotely sensed geophysical parameters will be discussed in another presentation.

BIOLOGICAL CHARACTERISTICS OF *ANOPHELES DIRUS* IN KHANH PHU COMMUNE, KHANH VINH DISTRICT, KHANH HOA PROVINCE.

Pham Thi Khoa

Affiliation: National Institute of Malariology, Parasitology and Entomology, Vietnam (NIMPE)
E-mail: htn@nimpe.vn

Blood fed *Anopheles dirus* mosquitoes collected in the Khanh Phu commune, Khanh Vinh district, Khanh Hoa province were reared and forced to lay eggs in the insectarium of NIMPE. The females could feed on man or on mice. The study shows that *An. dirus* are anthropophilic as it bites more frequently on man than on mice.

Mosquitoes fed by human blood were found to lay more eggs (45 - 258 eggs) than those fed on mice (15 - 145 eggs). It is suggested that man is the preferable host for rearing of *An. dirus* in the lab. The appropriate water level for the advanced development of larval stage should be 10 mm to 20mm. Mass death of larvae was observed while protozoa intensively developed in the rearing boils.
The typical karyotype (2n = 6) have 2 pairs of autosomes and one pair of sex chromosome is heteromorphic. Three types of X chromosomes (X1,X2,X3) chromosomes and 2 types of Y (Y1,Y2) chromosomes were identified. Analysis of 60 females of *An. dirus* collected in Khanh Phu commune, using specific PCR primers, showed that only *An. dirus A* is present in the areas. Products of 562 bp were produced.

KARYOTYPE OF *ANOPHELES LEUCOSPHYRUS CONSON* FORM FROM VIETNAM.

Nguyen Duc Manh, Ho Dinh Trung, Nguyen Thi Hong Ngoc, Nguyen Thi Huong Binh.

Affiliation: National Institute of Malariology, Parasitology and Entomology, Vietnam (NIMPE)
E-mail: ndmanhshpt@fpt.vn

In November 2005, specimens of *Anopheles leucosphyrus* conson form were collected in pigsties of the forested area of Con Dao Island, located in 8034' - 8049' North latitude, 105031' - 106045' East longitude, about 100 sea miles South of Hochiminh City.

Fresh fed female mosquitoes were brought to NIMPE insectaria for laying eggs. Twelve broods were reared. Early 4th-instar larvae were treated with a 0.1% colchicin solution for 3-4h, after which their ganglia were removed and mitotic chromosome preparations were made following a modified method of Baimai (1975). Slides were stained with a 2% Giemsa solution and later examined under oil immersion using Olympus phase contrast microscope. Photomicrographs of the mitotic karyotype were taken with Kodak 100 film under oil immersion (6.7X100) with green filter.

The metaphase karyotype of *An.leucosphyrus* conson form (2n = 6) consists of one pair of metacentric (V shaped) autosome (II), one pair of submetacentric autosomes (III), and one pair of telocentric sex chromosomes. The term telocentric is used for both X and Y chromosomes because the small portion of the extremely short arm of centrometric heterochromatin generally is not observable using conventional preparation techniques. The karyotypic variation found in the X and Y chromosomes is mainly due to differences in amount and distribution of major blocks of heterochromatin. Two types of X and two type of Y chromosomes have been observed.

RANDOM AMPLIFIED POLYMORPHIC DNA (RADP) ANALYSIS OF *ANOPHELES MACULATUS* GROUP (DIPTERA / CULICIDEA) IN VIETNAM.

Nguyen Thi Huong Binh, Nguyen Duc Manh, Nguyen Hong Ngoc, Ho Dinh Trung, Tran Duc Hinh, Trinh Dinh Dat

Affiliation: National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam.
E-mail: binhngoc2002@yahoo.com

Anopheles maculatus group is widely distributed in Oriental region. They have overlapping morphological characteristics and some of the species bear no clear-cut diagnostic characteristics. Recent studies carried out in NIMPE showed that this group consists of at least ten members involving 6 known species and 4 undetermined forms. To assess the genetic diversity of An.maculatus group in Vietnam, our study make use of RADP analysis with 7 decamer primers. All the primers produced polymorphic amplification products. A total of 149 bands were generated with an average of 21 bands per primer. The genetic distance (Nei, 1983) between 0.1918 to 0.5613 shows the relationship between the members and forms of the Anopheles maculatus group.

EVALUATION ON THE SENSIBILITY AND RESISTANCE OF ANOPHELES TO INSECTICIDES IN THE CENTRAL-HIGHLAND.

Truong Van Co

Affiliation: Institute of Malariology-Parasitology and Entomology, Quy Nhon, Vietnam.

E-mail: contrungimpe@yahoo.com

The Anopheles species were tested in some provinces belonging to the Central-Highland in the period 2004-2007. The results showed that *An.dirus* is highly susceptible to Lambdacyhalothrine and Alpha-Cypermethrine. *An.minimus* is still susceptible against these two insecticides but was found to be tolerant in a limited number of study sites. Some species as *An.maculatus, An.annularis* and *An.jeyporiensis* are tolerant against Lambdacyhalothrine and Alpha-Cypermethrine. *An.vagus* and *An.sinensis* were identified to be resistant for both insecticides used in the national malarial control programme.

MOSQUITO DIVERSITY AND BIONOMICS OF MEDICALLY IMPORTANT SPECIES IN A RAIN FOREST ECOSYSTEM OF NORTH-EAST INDIA.

Dibya Ranjan Bhattacharyya, Anil Prakash, P K Mohapatra and J Mahanta

Affiliation: Regional Medical Research Centre, N.E. Region (ICMR) Dibrugarh
E-mail: drbhattacharyya@yahoo.com

Northeastern region of India is one of the known bio-diversity hotspot in the world. A large portion of the land area in the region is covered with tropical rain forest and is rich in mosquito fauna. The region is highly endemic for malaria (Pf % >75%) with high and widespread prevalence of antimalarial drug resistant Plasmodium falciparum species. The vectors responsible for transmission of malaria are mainly *Anopheles dirus*, *An. minimus* and *An. fluviatalis*. Besides, the region is also endemic for Japanese encephalitis, filariasis and sporadic outbreaks of Dengue is also reported. The presence of diverse vector borne diseases in the region is due to vector diversity and its abundance. We carried out entomological survey in a isolated forest fringed village as well as in a forest camp located inside the forest in a tropical evergreen rain forest known as Upper Dehing Reserve Forest (27o 3'N and 95 o4'E) in Dibrugarh district of Assam state. Larval surveys inside forest yielded 2 new mosquito species *viz. Uranotaenia dibrugarhensis*, *Verallina assamensis*, in addition we also found 5 mosquito species as new country occurrence record. Whole night human bait catches inside deep forest (forest camp) attracted only two species *Anopheles baimaii* (formerly known as *Anopheles dirus D*) and *Anopheles philippinensis*. Whereas in the fringe area (forest village) 11 species were recorded in human bait catches which includes *An. baimaii* and some potential JE vectors. However, intensive survey in the area failed to detect *An. minimus* and *An. fluviatalis*. Sporozoites were detected in the salivary gland of *Anopheles baimaii* whereas *An. philippinensis* was found to be only CSP ELISA positive. Bionomics of *An. baimaii*, *An. philippinensis* and some other potential JE vectors are discussed.

SUSCEPTIBILITY OF *ANOPHELES MACULATUS* AND *ANOPHELES MIMIMUS* TO SYNTHETIC PYRETHROIDS BY WHO TEST AND BIOCHEMICAL ASSAYS.

Piyaporn Wangroongsarb, Prasan KanKaew, Suchart Patipong, Veeraphol Phothijiti, Ratana Sithiprasasna

Affiliation: Bureau of Vector Borne Disease, Ministry of Health, Bangkok, Thailand.
E-mail: piyap@health.moph.go.th

Malaria is an important epidemic arthropod-borne disease, which is recognized as a public health problem by the Thai Ministry of Public Health (MOPH). Vector control by insecticides is considered to be effective for the prevention of malaria. Since 1996, Thai MOPH has been using Pyrethroids i.e. deltamethrin and permethrin for Anophelines mosquito control instead of organochlorine compounds. WHO test kits have always been routinely used to assess susceptibility of Anophelines mosquitoes to the insecticides by the Bureau of Vector Borne Disease, MOPH.

From May to July 2005 the susceptibility of four wild mosquito populations was assessed: *Anopheles maculates* population collected from UthaiThani and *Anopheles minimus* populations collected from Tak, Chumporn, and SuratThani during. WHO bioassays were performed and the applicability of biochemical assays was evaluated

The result of WHO bioassays on *An. maculatus* from UthaiThani and *An. minimus* from Tak and Chumporn showed that the mortality was up to 98 % and thus no resistance was found according to WHO standards. Results of the biochemical assay tests on *An. maculatus* from UthaiThani and *An.minimus* from SuratThani, and Chumporn, were compared with those obtained from 2 colonies of mosquitoes reared in the laboratory. No elevated esterase or oxidase activity was observed among the tested specimens. The biochemical assays confirmed the full susceptibility to pyrethroids in *An. maculatus* from UthaiThani and *An. minimus* from SuratThani and Chumporn. These biochemical assay method represents a promising new technique for the detection and assessment of insecticide resistance. However limited number of mosquitoes was tested, and more samples need to be analysed to provide a susceptibility threshold for routine monitoring.

SESSION 3:

Insecticide resistance in malaria vectors

THE INSECTICIDE RESISTANCE STATUS OF MALARIA VECTORS IN SOUTHEAST ASIA.

Wim Van Bortel[1], Ho Dinh Trung[2], Le Khanh Thuan[2] Tho Sochantha[3], Duong Socheat[3], C Sumrandee[4,] Visut Bamai[4], Kalouna Keokenchanh[5],Samlane Phompida[5], Janet Hemingway[6], Sylvie Manguin[7], Ralph Harbach[8], Marc Coosemans[1]

Affiliation: (1) Institute of Tropical Medicine, Antwerp, Belgium; (2) National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam; (3) National Center for Malaria Control, Parasitology and Entomology, Phnom Penh, Cambodia; (4) Mahidol University, Bangkok, Thailand; (5) Center of Malariology, Parasitology and Entomology, Vientiane, Laos; (6) Liverpool School of Tropical Medicine, Liverpool, UK; (7) Centre de Biology et Gestion des Populations, Montferrier, France; (8) The Natural History Museum, London, UK
E-mail: wvbortel@itg.be

Vector control, which played an essential role in the reduction of malaria in Southeast Asia, is of essential importance to control malaria in endemic foci. The available vector control methods rely on the use of insecticides for bed net impregnation or indoor spraying. Consequently, the development of insecticide resistance may jeopardise the vector control efforts. Hence, knowledge of vector resistance and changing trends of resistance in target species are basic requirements to guide insecticide use in malaria control programmes.

Therefore, a network for the monitoring of insecticide resistance, MALVECASIA, was set up in Southeast Asia in order to assess the insecticide resistance status of the major malaria vectors in different regions of Cambodia, Laos, Thailand, and Vietnam. From 2003 till 2005, bioassays were performed on adult mosquitoes using the standard WHO susceptibility test with diagnostic concentrations of permethrin 0.75% and DDT 4%. Additional test were done with insecticides applied by the different national malaria control programmes.
After three years of intense insecticide resistance monitoring in 116 study sites a clear picture of insecticide resistance status of malaria vectors was achieved. *Anopheles dirus s.s.*, the main vector in forested malaria foci, was susceptible to permethrin. In central Vietnam, *An. dirus s.s.* showed possible resistance to alpha-cypermethrin and one population was resistant against lambda-cyhalothrin. In the Mekong Delta, *An.epiroticus* was highly resistant to all pyrethroid insecticides tested. It was susceptible to DDT, however near Ho Chi Minh City An. epiroticus showed possible DDT resistance. In Vietnam, pyrethroid susceptible and tolerant *An. minimus s.l.* populations were found, whereas *An. minimus s.l.* from Cambodia, Laos and Thailand were susceptible. Only two *An. minimus s.l.* populations showed DDT tolerance, one in western Cambodia and one in northern Vietnam. *Anopheles vagus* was found resistant to DDT and to several pyrethroids in Vietnam and Cambodia.

In conclusion, in Laos, Cambodia and Thailand, insecticide resistance in the malaria vectors *An. dirus s.s., An. epiroticus* and *An. minimus s.l.* was almost absent. In Vietnam, insecticide resistance was mainly observed in low or transmission free areas and the network concluded in a list of recommendations that there is no need to actually change the malaria control strategy currently implemented in Vietnam. However, trends in resistance status should be carefully monitored, mainly in *An. dirus*. The impact of existing vector control tools on resistant populations of *An. epiroticus* in Southern Vietnam is now ongoing.

IMPACT OF VECTOR CONTROL TOOLS ON INSECTICIDE RESISTANT *ANOPHELES EPIROTICUS* IN SOUTHERN VIETNAM.

Vu Duc Chinh[1], Wim Van Bortel[2], Ho Dinh Trung[1], Nguyen Quoc Hung[3], Dirk Berkvens [2], Marc Coosemans[2]

Affiliation: (1) National Institute of Malariology, Parasitology and Entomology,, Hanoi, Vietnam; (2) Institute of Tropical Medicine, Antwerp, Belgium; (3) Institute of Malariology, Parasitology and Entomology, Ho Chi Minh City, Vietnam; E-mail: chinh_vu99@yahoo.com

After three years of intense insecticide monitoring in Southeast Asia by use of the standard WHO bioassays, a clear picture of the status of insecticide resistance of malaria vectors was achieved. In southern Vietnam, high levels of resistance in An. epiroticus were detected for all pyrethroids that were tested (permethrin, deltamethrin, á-cypermethrin, ë-cyhalothrin, and etofenprox) and a low level of DDT resistance in this species was found around Ho Chi Minh City. Studies on the mechanism of insecticide resistance revealed that target site resistance (kdr) does not occur in An. epiroticus, whereas biochemical assays indicated increased levels of esterase.

Six experimental huts were built in Bac Lieu province, Southern Vietnam to evaluate the impact of existing vector control tools in terms of mortality, deterrence, blood-feeding inhibition and induced exophily on wild resistant populations of Anopheles epiroticus. Five different treatments were evaluated in comparison to an untreated net that was used as negative control. Nets were treated with alpha-cypermethrin (25 mg a.i./m²), lambda-cyhalothrin (20 mg a.i./m²) and permethrin (500 mg a.i./m²). The Long Lasting Insecticidal Nets Olyset and Permanet were included as well. In each net six holes were made to mimic torn nets.

The impregnated bed nets had an important blood feeding inhibition effect on *An. epiroticus*, resulting in a more than 75% personal protection compared to the non-treated nets. Most of the treatments had a deterrent effect. Moreover, a higher morality was observed among mosquitoes collected in huts with treated nets. A detailed analysis is ongoing but it seems that pyrethroid impregnated bed nets still give a protection against mosquito bites, despite the fact that the mosquito vector is resistant to this class of insecticides.

MULTIPLE INSECTICIDE RESISTANCE MECHANISMS IN THE SOUTHEAST ASIAN ANOPHELES SPECIES.

Katrijn Verhaeghen[1], Wim Van Bortel[1], Trung Ho Dinh[2], Tho Sochantha[3], Thierry Backeljau[4], Marc Coosemans[1].

Affiliation: (1) Institute of Tropical Medicine, Antwerp, Belgium; (2) National Institute of Malariology, Parasitology and Entomology Hanoi, Vietnam; (3 National Center for Malaria Control, Parasitology and Entomology, Phnom Penh, Cambodia; (4, Royal Belgian Institute of Natural Sciences, Brussels, Belgium.
E-mail: kverhaeghen@itg.be

Insecticide resistance may jeopardize the successful malaria control programmes in Southeast Asia. Therefore, a large investigation was conducted in the Mekong countries to assess the susceptibility of different Anopheles species against pyrethroids and DDT. Amongst the main vectors, *Anopheles epiroticus* is highly pyrethroid resistant in the Mekong delta of Vietnam. An.minimus sensu lato was pyrethroid resistant at the Vietnamese border with China, whereas low pyrethroid resistance was found in *An. dirus* sensu stricto from central Vietnam. The potential vectors *An. vagus*, *An. sinensis*, *An. paraliae* and *An. peditaeniatus* were resistant to both DDT and pyrethroid in Vietnam and Cambodia. Knowledge on the different resistance mechanisms is necessary to guide the insecticide use in the vector control. An important resistance mechanism against DDT and pyrethroids, known as knockdown resistance (kdr), is caused by a mutation in a sodium channel gene. In this study, molecular techniques based on real-time PCR, allele specific PCR and PCR-RFLP were developed to detect possible kdr mutations in the Southeast Asian Anopheles species. However, in the main vectors, no kdr mutation was observed. Biochemical assays revealed a high esterase activity in the pyrethroid resistant *An. epiroticus* populations of the Mekong delta and a high esterase and P450 monooxygenase activity in the pyrethroid resistant *An. minimus* s.l. populations of northern Vietnam. Only in the potential vectors *An. vagus*, *An. sinensis*, *An. paraliae* and *An. peditaeniatus* kdr mutations were found in the populations of southern Vietnam and at the Cambodian border with Vietnam. At population level, the kdr frequencies could be correlated to the permethrin but not to the DDT survival rate. At individual level, the kdr genotypes were equally distributed among resistant and susceptible mosquitoes. This suggests that (I) posttranscriptional regulation mediates a correlation at individual level or (II) additional subsequent mutations in the sodium channel gene are necessary to survive the bioassay or (III) other metabolic resistance mechanism are involved. Biochemical assays suggest a GST mediated detoxification in DDT resistant *An. vagus* and *An. sinensis* populations and an esterase mediated detoxification in the pyrethroid resistant *An. vagus* and *An. sinensis* populations without kdr. Insecticidal pressures in interaction with the environment are likely to contribute to the selection of a resistance mechanism and leads in combination with the species' genetic predestination to a complex resistance pattern, varying between species and region, as found in Southeast Asia.

SESSION 4:

Forest and border malaria

DISTANCE TO FOREST AS A DETERMINANT OF INDIVIDUAL-LEVEL MALARIA RISK IN CAMBODIA.

Jonathan Cox[1,2], Jo Lines[1,2], Jane Bruce[2], Khol Vohith[3], Mao Bunsoth[3], Duong Socheat4, Sylvia Meek[2]

Affiliation: 1 London School of Hygiene and Tropical Medicine, UK. 2. Malaria Consortium, London, UK. 3. National Institute of Public Health, Phnom Penh, Cambodia. 4. National Center for Parasitology, Entomology and Malaria Control, Phnom Penh, Cambodia.
E-mail: Jonathan.Cox@lshtm.ac.uk

In Cambodia 'distance to forest' is an established means of stratifying malaria risk at the village level and hence for targeting specific malaria interventions. The use of forest distribution as a proxy for malaria risk is based on sound epidemiological inference but has never been tested formally. Previous attempts to describe relationships between risk of infection and exposure to forest have been generalized at the village level, but the validity of analysis at this spatial scale is questionable, since both data on mosquito flight-range and on risk-gradients elsewhere suggest that the risk of infection may decline very sharply (over hundreds of metres) with increasing distance from the forest edge.

The Cambodia Baseline Malaria Survey was conducted during the malaria transmission season of 2004 using a two-stage cluster sampling process. Villages were randomly selected by province from a national list of communities and sampling was stratified according to distance from village to forest. Household locations were recorded using global positioning system (GPS) receivers.

In this paper we analyse the association between malaria prevalence and distance to forest and other potential risk factors. We assess a range of measures and data sources for describing 'exposure' to forest and explore the relative utility of these different methodologies in terms of the operational assessment of village-level malaria risk. Results suggest that distance to forest (however measured) is an important determinant of risk at the individual level. Nevertheless, there is evidence that local transmission may extend further from the forest edge than has hitherto been supposed. The implications of these findings for deriving operational, village-levels estimates of malaria risk are discussed.

THE EPIDEMIOLOGY OF FOREST MALARIA IN KHANH PHU.

Nguyen Tuyen Quang, Nguyen Ngoc Duong, Nguyen Thi Bich Lien and Ron Marchand

Affiliation: NIMPE / Medical Committee Netherlands-Vietnam
E-mail: kpmalaria@hn.vnn.vn

Khanh Phu commune (Khanh Vinh district, Khanh Hoa province, Vietnam) was one of the most malaria endemic areas in the country before the universal use of Insecticide-trated bednets (ITN) in 1998. This strategy led to a more than five-fold, and since then sustained, reduction in malaria endemicity. At the same time the main vector species, *An. minimus* Species A, disappeared. The remaining malaria is transmitted by bites of the forest-dwelling mosquito *An. dirus* in the forest and in villages in the forest fringe zone (hence: “Forest Malaria”).

From 2002 until 2006, forest malaria continued to be studied in Khanh Phu through human-landing collections of the mosquito populations in the forest and forest fringe, mark-release-recapture experiments and by the detailed recording of forest-going activities and malaria cases in the human population.

We describe the characteristics of the epidemiology of forest malaria, compare it with the situation found before in the villages and discuss the difficulties for sustainable control.

MALARIA IN MIGRATION AND MOBILITY PATTERNS IN VIETNAM.

Le Xuan Hung

Affiliation: National Institute of Malariology, Parasitologuy and Entomology, Hanoi, Vietnam.
E-mail: lxhung1952@yahoo.com

Malaria and migration is a complex but common phenomenal occurring in Vietnam, and is one of the current challenges faced by the National Malaria Control Program. After 15 years of success in controlling malaria nationwide, however, there are still some difficulties in applying effective malaria control interventions for areas where important population movements occur due to recent fast economic development.

1. Every year in Vietnam, about two million people are identified as migrants and movements are mostly going towards Central Highlands. Most of the migrants are from ethnic minorities of the North going to settle as permanent residents in new lands of the Centre (98.8%). The main reason for migration is economic (95.5%). Migrants are exposed to malaria infections and lack protection means such bednets (83.0%) or anti-malaria drugs (17%). Usually newly established migrants are isolated and living near to/ or in the forest (97%). The malaria prevalence is usually higher in new migrants who arrived 1-2 years compared with those arrived longer time ago. The risk factors for malaria in migrants are working and sleeping over night in the forest (98%), and temporary houses made with poor quality material (86%). In addition, migrants are reluctant to use the public health facilities.
2. Migration to endemic areas of people never exposed to malaria continue to be a problem with a seasonal pattern (e.g. at coffee harvest time). It is estimated that the Northern provinces annually contribute to about 15,000 seasonal workers moving to other malaria endemic areas of the country. This results in the fact that over 50% of the malaria cases identified in the North are actually imported.

Poor living standards and educational level (on malaria and overall) of ethnic minorities together with their migration habits are also still problems. Especially during crop failure years, people migrate in search of food and income, sometimes to the forest, situations putting them more at risk of malaria.

In conclusion, most of the malaria burden in mobile people can be attributed to forest activities, low knowledge and non-active practices in malaria prevention. In this situation, the control measures should focus on the protection of migrants, and the impact of interventions such insecticide treated materials (bed nets, hammocks, sheets, etc.) should be evaluated. IEC campaigns should also accompany all these interventions.

MALARIA CONTROL IN SOME FOREST FRINGE AREAS OF ASSAM: A PILOT STUDY.

Prafulla Dutta, A.M. Khan, S.A. Khan and J. Mahanta

Affiliation: Regional Medical Research Centre, N.E. Region (ICMR) Dibrugarh
E-mail: duttaprafulla@yahoo.com

The study was carried out in Bokakhat PHC area of Golaghat District of bordering KarbiAnglong hill district of the state of Assam, India having forested-foothill ecosystems, which are endemic for malaria. The areas were divided into four sectors (A, B, C, D) covering a total population of nine thousand. In the initial year, malaria surveillance was done in all the four areas to get the true picture of incidence as well as the recognized vector prevalence pattern before implementing intervention measures. After one year of parasitological monitoring it was observed that all the four areas were endemic for persistent type of malaria the Slide Positivity Rate (SPR) ranged from 4.52 -42.19 in sector- A; 5.88-44.03 in Sector- B; 6.25-45.23 in Sector-C and 7.69-46.15 in Sector-D. In entomological monitoring, the prevalence of two major vectors viz. *Anopheles dirus (baimaii)* and *Anopheles minimus* was observed. The intervention measures were implemented in three sectors as earmarked. The sector A, the population was covered with ITMN+repellent; Sector B with ITMN alone; Sector C with repellent alone and Sector D kept without any intervention measures (control area). IEC activities were carried out in A, B and C sectors by organizing exhibition, lecture session in schools, community halls. From the present investigation, it is observed that the areas with coverage of Insecticide treated mosquito nets alone or with repellent can drastically reduce the malaria mortality and morbidity. In Sector A and B, the Slide positivity rate went down after implementation of ITMN coverage along with the IEC activities, the SPR value was as high as 17.07 and as low as 0 in Sector A and Sector B showed SPR as high as 10.81 and low as 0. In the subsequent year of observation also there was no rising of case incidence in these two sectors whereas in no intervention area, the malaria morbidity was quite high being the SPR in the range of 7.14-33.33 in the 1st year and 2.0-30.0 in the 2nd year of observation. Vector population of sector A and B also went down drastically in comparison to that of control sector-D. No significant reduction of vector population was observed in sector-C where only repellent was used. Health awareness activities help immensely the residents of these areas who are mostly tribal people to participate actively in this malaria control programme. During this period of study, no mortality as well as no serious malaria cases was detected. It is noteworthy that the intervention areas experienced only negligible incidence of *P. falciparum* malaria whereas in no intervention area, the incidence of *P. falciparum* was quite high. The Implementation of ITMN in Sector A and B drastically reduced the anopheline population. This finding of this pilot study is indicative of containment of high morbidity and mortality due to malaria in a highly endemic area of Northeastern part of India and this will be an effective module for implementation in inaccessible hardcore forest/forest fringe areas having great influence of the major vectors like *An dirus (baimaii)* and *An.minimus*.

SIMIAN MALARIA IN MALAYSIA.

Indra Vythilingam,

Affiliation: Parasitology Unit, Institute for Medical Research, Jalan Pahang 50588 Kuala Lumpur.
E-mail: indra@imr.gov.my

Malaria parasites in Malayan monkeys was first reported in 1908, but it gained interest in the 1960s after the accidental discovery that a species of simian malaria could be transmitted to humans in the laboratory. The first case of human Plasmodium knowlesi was reported from Pahang in Peninsular Malaysia in 1960s and the 2nd case from Johore in 1970s. In 2004 cases of P. malariae in Sarawak Malaysian Borneo was found to be *P. knowlesi* using molecular tools. From 2005 we are also seeing cases of P. knowlesi in humans in p. Malaysia. Cases are also reported from the Thailand and China. *Anopheles latens* has been incriminated as the vector of *P. knowlesi* in Sarawak Non human primates are now recognized as an important source of emerging human pathogens. It seems that we are now having zoonotic transmission in our midst and thus control measures have to change accordingly. Studies are on going to determine the intensity of transmission of simian malaria in humans and the prevalence of the parasites in non human primates and mosquitoes. This will be discussed.

Poster session on forest and border malaria

EPIDEMIOLOGICAL STUDY IN SIX FOREST VILLAGES IN CAMBODIA.

Tho Sochantha[1], Heng Somony[1], Siv Sovanarath[1], Wim Van Bortel[2], Patricia Roelants[2], Leen Denis[2], Annette Erhart[2], Mao Sokny[1], Umberto D'Alessandro[2], Marc Coosemans[2]

Affiliation (1)National Center for Malaria Control, Parasitology and Entomology, Dept. Entomology, Phnom Penh, Cambodia; (2) Institute of Tropical Medicine, Antwerp, Belgium.
E-mail: sochanthat@cnm.gov.kh

Forest malaria is nowadays the biggest challenge for National Malaria Control Programs in Southeast Asia and particularly in Cambodia. People living in villages at the edge of the forest or having forest activities are at high risk for malaria because of the presence of highly effective malaria vectors: *Anopheles dirus* and to a lesser extent *An. minimus*. Moreover, health facilities in these areas are rudimentary. In Cambodia, despite active and uncontrolled deforestation, about 40% of the total land (181,035 Km^2) is covered with forest. Most of these forested areas are located in provinces bordering Vietnam, Laos and Thailand. In Cambodia, a total of 2 million people are at risk of malaria (15% of the total population), and the 500,000 persons living in forested areas are at high risk for malaria infection. Indeed, each year about 80% of the malaria cases occur in the forested areas. We present here the preliminary results of an epidemiological study performed in twelve forest villages of Cambodia.

Material and Method: Six forest villages were selected in the eastern part of the country (Province of Rattanakiri with 3 in the district of O Chum and 3 in the district of Borkeo) and 6 other villages in the western part (3 in the Province of Pailin, and 3 in Pursat). After a census in each village, two surveys were organized (August September and November December). For each survey and village, outdoor human landing collections of mosquitoes were performed during 6 nights in three fixed points (in the village, the forest way and the forest camp). ELISA tests were performed to detect sporozoites in the salivary glands. Positive ELISA tests were checked by PCR. Thick films of 120 at random chosen individuals per village and per survey were analyzed by microscopy.

Results: In the eastern part of the country (Rattanakiri), *P.falciparum* is the predominant plasmodium species (above 50%), while *P.vivax* (more than 90%) is predominant near the Thai border (Pailin and Pursat). Malaria prevalence is the highest in the Burkeo district of Rattanakiri (around 20%) while it is only 5% in the O Chum district. In Pailin and in Pursat it varies between 1 and 16% according to village and survey. It is also in Borkeo that highest densities *An. dirus sensu stricto* was observed (up to 7.8 bites/man/night). In Borkeo, 13 of the 183 (7%) *An.dirus* analyzed were carriers of malaria sporozoites (mainly *P.falciparum*). The role of *An.dirus* was less important in the remaining 9 villages (4 positive out of 962 samples). In Pailin, high densities of *An.minimus* were observed during the second survey in the villages as well as in the forest camp (up to 27bites/man/night). Elsewhere, densities of this vector were often below 5 bites/man/night. Only 2 *An.minimus* out of 1747 samples were positive for sporozoite detection by ELISA. Both positive samples are coming from Pailin. In these forest villages, the density of both vectors is slightly higher in the forest camps compared to one in the villages. On the way to the forest camps very few vectors were collected. Positive ELISA tests on *An.maculatus*, *An. philippinesis* and *An. barbirostris* could not be confirmed by PCR.

Conclusions: The malaria endemicity is the highest in the remote forested area of Burkeo, where *P.falciparum* is dominant. The recent improvement of the road

infrastructure in the nearby district of O Chum seems to have considerable impact in decreasing the endemicity. In both districts, *An.dirus* is the main vector. In the western part of country (Pailin and Pursat), *P.vivax* is predominant and transmission is mainly ensured by *An. dirus* in Pursat and *An. minimus* in Pailin. Many false positive results were observed with the ELISA test, particular in zoophilic anophelines.

PLASMODIUM KNOWLESI MALARIA: AN EMERGING ZOONOTIC INFECTION.

Jennifer Luchavez[1], Ronald Espina[2], Peter Hew Curameng[2] and Fe Esperanza Espino[1]

Affiliation: 1 Department of Parasitology, Research Institute for Tropical Medicine, Alabang, Muntinlupa City, Phillipines. 2 Center for Health Development-MIMAROPA, Department of Health
E-mail: jluchavez@yahoo.com

Humans are known to encroach in forested areas inhabited by macaque monkeys, the natural host of the malaria parasite *Plasmodium knowlesi*, heightening the risk of cross-species transmission of this zoonotic infection. We report here a number of indigenous human cases of *P. knowlesi* malaria from Palawan, Philippines. This simian parasite morphologically resembles *P. malariae*, the initial species diagnosis made by microscopy. The cases were confirmed to be *P. knowlesi* by a polymerase chain reaction (PCR) assay in an overseas reference laboratory. Two of the cases were adult males engaged in forest-related livelihood activities with no history of travel outside a 50-kilometer radius from their residence in the province or outside the country, specifically to Malaysia, where a large focus of this zoonotic infection was previously reported. Both patients responded well to treatment with chloroquine and primaquine and no recurrence of symptoms were reported by either of them since their malaria episodes six months ago. On follow-up, the patients had normal physical examination results, as well as negative malaria rapid diagnostic tests and blood films.

Current control practices and policies should be strengthened and improved to take into account this emerging zoonotic infection, including use of bed nets every night for all family members in the endemic communities, strict implementation of policy on prophylaxis for non-immune travelers coming to the affected areas in conjunction with other personal protection measures, and microscopic detection of *P. malariae* cases for confirmation by PCR in a reference laboratory.

Gaps exist regarding *P. knowlesi* infections in humans - its geographic and temporal distribution, transmission patterns (monkeys to humans or human to human), mosquito vectors responsible for its spread, and clinical aspects. Studies to address these gaps are necessary for better and targeted control in the affected areas, as well as raising the awareness of the community and health workers on this emerging zoonotic infection.

CAMBODIA MALARIA BASELINE SURVEY.

Ung Sam An[1], Sylvia Meek[2], Socheat Doung[3] Tsuyuoka Reiko[4], Mark Fukuda[5]

Affiliation: 1 National Institute Public Health/MOH, Cambodia. 2 Malaria Consortium, UK. 3 National Malaria Control Program/Ministry of Health, Cambodia. 4 World Health Organization, Cambodia. 5 US Armed Forces Research Institute of Medical Sciences (AFRIM)

Background

Malaria is one of the leading public health problems in Cambodia, with an estimated annual incidence of 10.26/1000 population and a mortality rate of 3.7/100,000 population (HIS, 2003). Real figures would be much higher as most malaria cases are first treated through self-administration of drugs purchased in a variety of private outlets. Overall case fatality is 0.37% (HIS, 2003), but reaches almost 10% in some remote provinces. The National Malaria Control Programme (NMCP) in Cambodia gives critical importance to the conduct of a baseline survey, since the improvement of monitoring and evaluation (M&E) systems based on a rigorously conducted Baseline Survey could be of particular relevance in view of results-based disbursement of future GFATM trenches. The survey undertaken from November to December 2004 investigating the characteristics of target areas prior to the implementation of a project are presented.

Methods

The Cambodia Malaria Baseline Survey (CMBS) studied a sample of individuals in high-risk areas of Cambodia in order to measure their Knowledge, Attitude, Behaviour and Practice (KABP) towards malaria and obtain a baseline prevalence estimate. In addition, health facilities and providers were surveyed to obtain a measure of coverage of both public and private distribution of anti-malarial drugs and mosquito nets.

Results

Overall positive slide rate in sampled clusters, which focused on higher risk regions, was 2.7%. Positive rate of Rapid diagnostic tests in nearby clusters was 3.9% and spleen rate 2.9%. Positive rates were higher close to forest. Little difference was observed between 0 to 250 meters compared with 251 m to 1 kilometre but a sharp decline in positive rate occurred within a distance from 1 to 2 kilometres from the forest. This suggests that preventive measures should be targeted mainly to populations up to 1 kilometre of forest, which is a greater geographical range than the current strategy.

Conclusions

An important finding of the survey is the similarity of epidemiological and socioeconomic results between CMBS risk zone 1 (0-250 m from forest) and CMBS risk zone 2 (251 m to 1 km), whilst CMBS risk zone 3 (1 to 2 km) results are different. This applies to positive slide rate, RDT, spleen rate and socioeconomic status. There is, however, evidence of some low level transmission (based on data in children) in the 1 to 2 km zone. These findings can be used to reconsider intervention strategies. Decisions on malaria control strategy beyond 1 km need to take careful account of resource availability, prioritizing preventive interventions within 1 km. Decisions to provide preventive interventions beyond this distance would need to be weighed against investing in, for example, better access to effective anti-malarial diagnosis and treatment over broader geographical areas or programmes to address other non-malaria health problems. It would be important to assess which strategy is likely to save more lives.

LONG LASTING INSTECTICIDAL HAMMOCK NETS (LLIHN) FOR CONTROLLING FOREST MALARIA IN CENTRAL VIETNAM: BASELINE CHARACTERISTICS OF THE STUDY POPULATION.

Ngo Duc Thang[1], Annette Erhart[2], Le Xuan Hung[1], Marc Coosemans[2], Umberto D'Alessandro[2]

Affiliation: 1.National Institute for Malariology, Parasitology and Entomology, Hanoi, Vietnam. 2. Institute of Tropical Medicine, Antwerp, Belgium

Email: thangnimpevn@yahoo.com

Aim: To evaluate the effectiveness of LLIHN as a new strategy for malaria control in forested areas of central Vietnam.
Methods: A community based, clustered randomised trial on LLIHN was carried out in Central Vietnam. Twenty clusters (about 1000 inhabitants each) situated in a forested area in Ninh Thuan province were identified. During the year before the intervention a census of the study population was done. Passive detection of clinical cases was started and continued until the end of the study. In addition, two malariometric surveys (one at the beginning and one at the end of the transmission season) were done yearly before and after the intervention. After the distribution of LLIHN in 10 clusters, the population was followed for 2 additional years. We present here the results of the baseline year, before the distribution of LLIHN.
Results: The population comprised 18,646 people, median age was 19 years and the main ethnic group Raglai (88.5%), traditionally nomadic tribes living in the forest. Educational level as well as socio-economic status was generally low. The main activity was forest work (94% of the active population). In 2004, the malaria incidence rate was 69/1,000/year. People sleeping in the forest had a significantly higher risk of clinical malaria (OR=1.7; $p<0.01$). Gender, age, occupation, ethnics, education and socioeconomic status were also risk factors for malaria. Parasite prevalence varied between 14.2% in April and 17.8% in December. *P. falciparum* and *P. vivax* were the main parasite species, equally represented. However, 80% of clinical cases detected by passive surveillance were *P. falciparum*. While 86% of the population used to sleep under ITNs in the village, this proportion dropped to 12.5% among people sleeping in the forest.
Conclusions: Considering that forest work is a significant risk factor for malaria, LLIHN could have a protective effect against malaria infection.

SESSION 5:

Epidemiology of malaria

EARLY MALARIA EPIDEMIC DETECTION MODEL IN THAILAND.

Supawadee Konchom

Affiliation: Senior Technical Officer, Bureau of Vector Borne Disease, Department of Disease Control, Ministry of Public Health, Thailand.
E-mail: jiabk@yahoo.com , supawade@health.moph.go.th

A malaria epidemic warning system was established in 1984 using graphs displaying the median or mean incidence of malaria over the previous five years compiled from malaria surveillance data throughout the country. This reporting mechanism is not timely enough to detect the occurrence of a malaria epidemic which usually occurs at the district level over a short period of time. An alternative method for early detection of malaria epidemic employing the Poisson model has been proposed. The development of this early malaria epidemic detection model involved 3 steps model specification, model validation and model testing. The results of model testing reveal that the model can detect increasing numbers of case earlier, one to two weeks prior to reaching their highest peak of transmission. Results from model testing show the model can be used for monitoring the weekly malaria situation at the district level. The Poisson model was able to detect malaria early in highly endemic provinces with a satisfactory level of prediction. As the application is essential for malaria officers in monitoring of malaria epidemics, this early detection system was introduced into malaria epidemiological work. This model may be helpful in decision making process, planning and budget allocation for the Malaria Control Program.

DOES SEROLOGY REPRESENT A VIABLE ALTERNATIVE FOR ESTIMATING MALARIA TRANSMISSION INTENSITY?

Chris Drakeley

Affiliation: London School of Hygiene & Tropical Medicine
E-mail: Chris.drakeley@lshtm.ac.uk

Estimation of malaria transmission intensity is key for the successful deployment and assessment of malaria control methods. Current entomological and parasitological methods are subject to constraints particularly in areas of low transmission. Anti-malarial antibodies constitute a record of infection history and the age-specific prevalences of malaria-specific antibodies reflect cumulative exposure to malaria over increasing periods of time.
We have obtained data indirectly or directly on the prevalence of IgG antibodies to *P. falciparum* antigens from a variety of sites within Africa and other endemic areas and compared these with parasitological measures of transmission intensity. The prevalence of antibodies was significantly correlated with both estimated and actual measures of entomological inoculation rate.

Data will be presented on the use of this method in low transmission settings and from areas where both *P. vivax* and *P. falciparum* occur. Additionally, to optimise this approach for monitoring and evaluation, methods for participant recruitment and sample collection will be discussed.

DEVELOPMENT OF TWO ANTIBODY ELISA'S FOR THE DIAGNOSIS OF PLASMODIUM VIVAX AND PLASMODIUM FALCIPARUM.

Filip Claes[1], Annette Erhart[1], Nico Speybroeck[1], Ta Thi Thin[2], Le M.D. [2], Nguyen V.H. [2], Fatima Balharbi [1], Chantal Van Overmeir[1], Michael Theisen[3], Irene Soares[4], Dirk Berkvens[1], Philippe Buscher[1], Umberto D'Alessandro[1].

Affiliation: 1. Institute of Tropical Medicine Prince Leopold, Antwerp, Belgium; 2. National Institute for Malariology, Parasitology and Entomology, Hanoi, Viet Nam, 3. Statens Serum Institut, Copenhagen, Denmark, 4. Faculdade de Ciências Farmacêuticas Universidade de São Paulo, Brasil
E-mail: fclaes@itg.be

Two antibody detection ELISA systems were developed using specific antigens for *P. vivax* (MSP1) and *P. falciparum* (GLURP, conserved region R2), respectively. Subsequently these tests were evaluated in the laboratory using a library of specific human sera. Initial comparison to IFAT data (crude antigen) showed a sensitivity and specificity of 85% and 92% for the *P. falciparum* ELISA and 83% and 91% for the *P. vivax* ELISA, respectively. Further evaluation will be done by latent class analysis combining microscopy, ELISA and PCR results on a large data set: 4,000 blood samples collected during a cross sectional survey in rural district of Ninh Thuan province (Central Vietnam). This analysis will allow us to determine precisely the sensitivity and specificity of the ELISA tests, as well as the true prevalence of malaria in the study population. The two tests were transferred to the laboratory of Immunology at NIMPE, Vietnam, and a local training course was given to familiarize the local staff with the two tests. Currently the ELISA's are used to estimate the evolution of malaria sero-prevalence and the incidence of new infections in a cluster randomized trial evaluating the efficacy of long lasting insecticidal hammocks to control forest malaria in Central Vietnam. After full evaluation, these 2 tests could be used by the National Malaria Control Program as a surveillance tool for malaria in some sentinel sites, especially remote and forested areas where local minorities are often difficult to reach during the transmission season.

MALARIA AND HIV: A POTENTIAL ISSUE IN ASIA?

Van geertruyden Jean-Pierre

Affiliation: Institute of Tropical Medicine Prince Leopold, Antwerp, Belgium
E_mail: jpvangeertruyden@itg.be

Biological facts

The HIV-malaria biological interaction is driven by substantial immune suppression. A higher malaria burden with more symptomatic and severe malaria and a less-than-optimal response to treatment are observed among HIV infected individuals with low CD4 counts.
Conversely, malaria infection provokes a transient increase of the viral load and a transient decrease in CD4 cell counts. Hypothetically, HIV patients might progress more rapidly to full-blown AIDS. Currently, there is no direct and firm evidence that HIV modifies malaria transmission or malaria HIV transmission although modeling techniques suggest an increased transmission in areas where both diseases co-exist.
Unfortunately, there are no data regarding HIV-Plasmodium vivax malaria interaction; all data report HIV 'Plasmodium falciparum' interaction. This is a major concern as the hepatic stage of malaria is mainly controlled by cellular immune mechanisms which are the most affected in HIV infected individuals.

Epidemiology

Considering that an estimated 1 billion people in South-East Asia are exposed to unstable malaria, even small overlaps of malaria and HIV in these settings may have a large public health impact. Countries as Myanmar and Thailand have a generalized HIV epidemic but malaria distribution is heterogeneous in this region.
Deteriorating malaria indices in SEA are also associated with drug resistance. Multi drug resistance is a well known problem in SE Asian countries. Spurious, counterfeit and substandard drugs are common. The fact that HIV infected have more malaria attacks and react suboptimal to malaria treatment can only fuel further the spread of drug resistance. This problem is more pronounced in the border areas as multidrug resistant P. falciparum is highly prevalent on the Thai-Cambodia, Thai-Myanmar and Vietnamese border areas and HIV prevalence is highest amongst migrant workers.
At present the two diseases coincide in specific high-risk groups. These high-risk populations may act as bridging groups, facilitating transmission of HIV from high-risk groups to the general population.

Conclusion

Malaria and HIV are major public health problems in the South-East Asia Region. Although the rates are not as appealing as in Sub Saharan Africa, any percentage equals high numbers and high population densities favor a fast spread of any disease. Much remains to be discovered about the interaction between HIV and malaria especially vivax malaria. HIV and malaria (co-)exist in the areas with the less developed health surveillance systems, creating a potential risk for the whole region.


MEKONG MALARIA

Poster session on epidemiology and genotyping of P.vivax

GENOTYPING OF PLASMODIUM VIVAX INFECTIONS USING MICROSATELLITE MARKERS AND MSP1.

Peter Van den Eede[1], Gert Van der Auwera[1], Chantal Van Overmeir[1], Ngo Duc Thang[2], Annette Erhart[1], Le Xuan Hung[2], Joseph Anné[3], Umberto D'Alessandro[1].

Affiliation: 1.Institute of Tropical Medicine Prince Leopold, Antwerp, Belgium, 2. National Institute for Malariology, Parasitology and Entomology, Hanoi, Viet Nam, 3. Catholic university of Leuven, Leuven, Belgium
E-mail: pvandeneede@itg.be

Plasmodium vivax is the most widely spread of the four malaria species and the main cause of malaria outside sub-Saharan Africa. The difficulty of its control is mainly due to the relapsing liver forms that cannot be distinguished from new infections. A reliable genotyping technique is necessary to understand the dynamics of P. vivax transmission and its epidemiology. Microsatellites appear to be useful markers and are commonly used for genotyping several organisms and appear to be useful markers for a wide variety of studies. Recently, several different micro-satellites for *P. vivax* have been identified. Our objective is to compare new and already-known microsatellite regions with MSP1, the most commonly used P.falciparum marker, in order to develop a reliable genotyping method for *P. vivax*.

Methods: Five new microsatellites were identified in silico by analysing the P. vivax genome on plasmodb. Microsatellite repeats with more than 20 times a unit of 2-6 base pairs were selected. Oligonucleotide primers were developed against the flanking region of the microsatellite region.
The 5 new and the already-known microsatellites were compared to MSP1 on blood samples from P. vivax infected patients from a Central Vietnam.

Results: Parasite DNA amplification was obtained up to the concentration of 0.01-0.001fg DNA/µl with cloned PCR product and at a density of 1-5 parasites added to the reaction mix. No misamplification was detected using DNA from the other 3 human plasmodial species, from Anopheles stephensi and human pathogens like *Leishmaniasis donovani, Trypanosoma cruzi, Schistosoma mansoni, HIV, Mycobacterium ulcerans and Mycobacterium tuberculosis*. Preliminary results show that some microsatellites are more polymorphic and hence more suitable for *P.vivax* genotyping than MSP1. Thus, we hope to be able to select a minimum set of discriminant micro-satellites to accurately identify homologous and heterologous genotypes of P. vivax. Such a method could be combined to serological and epidemiological data in a mathematical model to estimate the probability of *P. vivax* new infections/relapses in a given area. If successful, such a tool will be a great relevance for the understanding of *P. vivax* epidemiology and the adaptation of its control measures.

GENETIC DIVERSITY OF *P. VIVAX* IN PHURIENG RUBBER PLANTATION, BINH PHUOC PROVINCE.

Le Duc Dao[1], Nakazawa,S.[2], Truong Van Hanh[1], Nguyen Duc Giang[1]

Affiliation: 1. National Institute of Malariology, Parasitology, Entomology, Hanoi, Vietnam. 2. Institute of Tropical Medicine, Nagasaki University, Japan

Plasmodium vivax malaria accounts for approximately 45% of malaria cases in Phu Rieng rubber plantation, Binh Phuoc province. There is no information on the genotypic polymorphism of *P. vivax* in this malaria endemic area. Two highly polymorphic genes (Pvcs, MSP1) were selected for a study of genetic diversity in Phu Rieng strains.

Blood from 45 patients with *P. vivax* infection were diagnosed by PCR between and genotyped at two polymorphic loci: the *P.vivax* circumsporozoite protein (Pvcs), the *P.vivax* merozoite surface protein 1 (Pvmsp1).

Analysis of these two genetic markers revealed that *P. vivax* populations in Binh Phuoc are highly diverse with mixed genotype infection found in 37,8% of the samples. Multiplicity of infection (MOI) = 1,47. Two major type VK210 and VK247 type have a worldwide distribution.

A large number of distinguishable alleles were found from two genetic markers: 10 for Pvcs, 12 for Pvmsp1. These were in general randomly distributed amongst the isolates.

These results indicate that the *P. vivax* parasite population is highly diverse in Binh Phuoc. The genotyping protocols used in this study may be useful for differentiating re-infection from relapse and recrudescence in studies assessing of malarial drug efficacy in *P. vivax* malaria.


MEKONG MALARIA

SESSION 6:

Drug resistance

INTENSITY OF TRANSMISSION AND SPREAD OF FALCIPARUM RESISTANT MALARIA.

Ambrose O. Talisuna[1], Paul E. Okello[2], Annette Erhart[3], Marc Coosemans[3], Umberto D'Alessandro[3].

Affiliation: 1. Uganda Ministry Of Health, Epidemiological Surveillance Division; 2. East African Network For Monitoring Antimalarial Treatment; 3.Institute of Tropical Medicine, Antwerp, Belgium
E-mail: atalisuna@yahoo.com

Malaria transmission intensity has been proposed, based on theoretical models, as an important factor for the spread of falciparum resistant malaria, but the predictions obtained vary according to the assumptions inherent in the model used. We have summarised the available field data on transmission intensity and the prevalence of malaria drug resistance. Resistance to chloroquine and sulphadoxine-pyrimethamine monotherapy was invariably higher where transmission was intense. Vector control interventions were associated with a better chloroquine and sulphadoxine-pyrimethamine efficacy. However, high resistance to chloroquine and also to combination therapy (chloroquine plus sulphadoxine-pyrimethamine and amodiaquine plus sulphadoxine-pyrimethamine) was also observed in very low transmission areas. Reducing transmission intensity is likely to slow the spread of drug resistance. Nevertheless, where transmission is extremely low, to limit the unnecessary use of antimalarials and a consequent paradoxical acceleration of the spread of resistance, patients should be treated only after laboratory confirmation of malaria.

NINE YEARS MONITORING THE FIRST LINE TREATMENT REGIMEN FOR *FALCIPARUM MALARIA.*

Saowanit Vijaykadga, Wichai Satimai, Kanungnit Congpuong, Sawat Cholpol, Aranya Pinyoratanachote, Dokrak Thongkong, Malee Chansawang, Argat Nakavet, and Thaiboonyong Phoungpeapichai

Affiliation: Bureau of Vector Borne Disease, Department of Disease Control, Ministry of Public Health. Thailand
E-mail: saowanit@health.moph.go.th

Malaria is one of the most common parasitic disease and major public health in many tropical and subtropical countries. In Thailand, malaria is endemic along the border areas, especially the Thai-Myanmar and Thai-Cambodia borders. Multidrug-resistant *falciparum malaria* has also been a major problem in these areas. Monitoring of drug resistance malaria is an important measure to forecast the trend in areas prone to resistance. This information is useful to early management to stop or delay the resistance such as the adjustment of dosages or changing drug regimens appropriate to areas and resistance level. As a part of on-going monitoring drug resistance in Thailand, we conducted a 28 and 42 days therapeutic study in 9 provinces along the international borders in 1997 - 2005 followed WHO protocol. Three regimens are as follow: 15 mg/kg of mefloquine single dose (M3), 15 mg/kg of mefloquine combined with 12mg/kg of artesunate (M3A) and 25 mg/kg of mefloquine combined with 12 mg/kg of artesunate (M5A). The results from long term monitoring revealed that high treatment failure occur in Trat (T/C border), Tak and Ranong (T/M border). This is an early warning for possible development or spread of ACT resistance to other areas. Thus, this situation is an urgently need to investigate parasite drug sensitivity, molecular marker, pharmacokinetics or any activities related to confirm parasite resistance in these areas.

MOLECULAR EPIDEMIOLOGY OF DRUG RESISTANCE MARKERS.

Kanungnit Congpuong, K. Na Bangchang, M. Mungthin, P. Bualombai and W. H. Wernsdorfer.

Affiliation: Bureau of Vector Borne Disease, Ministry of Health, Thailand
E_mail: nungnit@health.moph.go.th

Abstract: To determine differences in the distribution of drug resistance mutations in the Plasmodium falciparum chloroquine resistance transporter (pfcrt) and *P. falciparum* multi-drug resistance 1 (pfmdr1) genes of *P. falciparum* isolates in Thailand, a study was conducted using polymerase chain reaction-restriction fragment length polymorphism to detect mutations in P. falciparum isolates obtained from three areas with different levels of in vivo mefloquine (MQ) resistance. All isolates carried mutant allele T76 of the pfcrt gene and wild-type allele D1246 of the pfmdr1 gene except for one isolate, which showed the wild-type K76 allele. This isolate was obtained from Chanthaburi Province, an area with high MQ resistance.

Relatively low rates of the mutant alleles D1042 and Y86 of the pfmdr1 gene were found among Thai isolates of *P. falciparum*. However, a statistically significant difference in the distribution was noted. Most of the mutant isolates were found among isolates from areas with moderate or low MQ resistance.
Only one isolate with mixed mutant and wild-type N1042 and D1042 and two mutants of Y86 were found among the isolates from areas with high MQ resistance. The findings provide limited support for the hypothesis that mutant alleles of pfmdr1 may be associated with increased sensitivity to MQ.

REVIEWING THE MONITORING OF ANTIMALARIAL DRUG EFFICACY AND RESISTANCE IN SENTINEL SITES IN VIETNAM.

Nong Thi Tien

Affiliation: National Institute for Malariology, Parasitology and Entomology, Hanoi, Viet Nam.

From 2003 to 2007, the monitoring of antimalarial drug efficacy and resistance was carried out in Quang Tri, Dak Nong, Ninh Thuan and Binh Phuoc provinces.

We used *in vivo* test for assessing the therapeutic efficacy of antimalarial drugs used in the treatment of *P.falciparum* malaria. The level of treatment failure of chloroquine is 22.9%. The mono-therapy with artesunate for 7 days shows that the level of recrudescence is from 6.9% to 7.3%. The use of available combination therapies (ACTs) is actively encouraged and tested in Vietnam. Using of dihydroartemisinin-piperaquine (Arterakine, Obelix) for 3 day, we see that the level of adequate clinical and parasitological response (ACPR) on Day 28 is 100%.

We used *in vivo* test for assessing the therapeutic efficacy of chloroquine for the treatment of *P.vivax* malaria. The level of late parasite failure ranges from 0% to 5.7%. We used of dihydroartemisinin-piperaquine for 3 days for the treatment of *vivax* malaria, the level of ACPR is 100%.

We also used *in vitro* micro test to assess the sensibility of *Plasmodium falciparum* to chloroquine, mefloquine and artemisinin. The results from study sites for all fresh isolates of *P.falciparum* in the field revealed are as follows:

- With chloroquine: the level of resistance is from 28.6 % to 44.1%, and the IC50 value is from 37 nmol/L to 51 nmol/L.
- With mefloquine: the level of resistance is from 0 % to 8%, and the IC50 value is from 60 nmol/L to 69 nmol/L.
- With artemisinin: the IC50 value is from 14 nmol/L to 17 nmol/L.

According to molecular analysis for blood samples collected in the sentinel sites, the mutations in *P.falciparum* genes *dhfr, dhps Pfcrt and Pfmdr1* are as follows:

- Rate of mutation at codon 51, 59, 108 and 164 in gene *dhfr* are 25.6%, 76.7%, 79.1% and 11.6% respectively.
- Rate of mutation at codon 436, 437, 540, 581 and 613 in gene *dhps* are 16.3%, 32.6%, 4.7%, 6.9% and 4.7% respectively.
- Rate of mutation at codon 76 in gene *Pfcrt* range from 21.4% to 59.1%.
- Rate of mutation at codon 86 in gene *Pfmdr1* range from 0.9% to 16.5%.

At present, we are monitoring the antimalarial drug efficacy and resistance at the sentinel sites. The results from these studies play an important role to assess the efficacy of current recommended treatments. Then we could consider the necessary changes in drug policy to select the more appropriate and effective drug(s) for malaria treatment.

ANTIGENIC ESCAPE OF A MALARIA VACCINE CANDIDATE, AMA-1 IN VIETNAM.

Nguyen Duc Quang

Affiliation: Laboratory of Molecular Genetics, Ehime University, Japan
E-mail: quanghoa@agr.ehime-u.ac.jp

Malaria remains a major cause of disease and death worldwide, killing millions every year [1]. The unavailability of a suitable malaria vaccine and emergence of drug-resistant parasites are further complicating the situation in tropical areas [2]. Although several vaccine candidate antigens of *Plasmodium falciparum* have been identified and characterized, the availability of a universal malaria vaccine is still a remote possibility. One reason is the antigenic variation (a) of different geographic isolates of the parasite. Antigenic diversity (b) has been implicated in the failure of several licensed and test vaccines [3]. Apical membrane antigen-1 (AMA-1) is one of the leading malaria vaccine candidates; however, it has detected >60 polymorphic sites (c) on AMA-1 protein [3]. These polymorphisms could be resulted from both mutation (d) and recombination(e). In the rodent malaria challenge model, polymorphism of AMA-1 has been unequivocally linked to vaccine failure [4]. Characterizing the patterns of evolution of AMA-1 gene in local populations at different temporary times is therefore important for vaccine development. In this presentation, we characterize the patterns of molecular evolution in AMA-1 gene in 51 samples collected from Vietnam in July 2006. Our main finding is that the high level of polymorphism observed for this gene in the Vietnamese population was caused not only by balancing selection (f) but also by highly selectively advantageous recombination (g) which occurred during the diploid phase of the parasite life cycle taking place in the mosquito midgut. However, further researches on recombination of different regions of the parasite genome should be done to confirm this finding. The pattern of polymorphism of AMA-1 in the Vietnamese population is very important for malaria vaccine development.

Our practical recommendation is that it is far much better to find ways to kill mosquito rather than to kill parasites by drugs. As the adaptive evolution(h) of parasite mainly occurs during the diploid phase in the midgut of mosquito rather than the haploid phase in human blood and because drug-resistant genes and vaccine candidate antigens can accumulate genetic changes at high rates whereas the drug/vaccine technologies take time to develop.

Notes

(a) (b) antigenic variation, antigenic diversity: changes in amino acid residues on protein caused by non-synonymous substitutions at the corresponding codons on gene.

(c) polymorphic sites: the sites at which there is at least one nucleotide (amino acid) change.

(d) mutation: nucleotide substitutions and indels.

(e) recombination: formation in offspring of genetic combinations not present in parents; in this text the authors imply intragenic recombination, recombination occurring between nucleotides within a gene.

(f) balancing selection: natural selection that has the effect of preserving genetic variation in population.

(g) selectively advantageous recombination: recombinations that generate beneficial alleles for the evolution of population.

(h) adaptive evolution: population undergoes genetic changes adaptive to changes in environment.

Poster session on drug resistance

SEQUENCE ANALYSIS OF A RHOPTRY ASSOCIATED PROTEIN-1, RAP-1, GENE IN *PLASMODIUM FALCIPARUM* AND ITS APPLICATIONS.

Harnyuttanakorn P., Siripoon N., Seugorn A., Kanchanakarn N., Pumpaiboon T., Thaithong S.

Affiliation: Department of Biology, Faculty of Science, Chulalongkorn University and Institute of Health Research, Chulalongkorn University, Thailand.
E-mail: hpongcha@chula.ac.th

Malaria parasites have developed their genetic diversity through several genetic mechanisms such as point mutation, deletion, insertion and genetic recombination. Some of these diversified genetic patterns may limit in some areas while some of them may commonly found in several parts of the world. To elucidate the genetic pattern of malaria parasites in Thailand, 23 isolates of *Plasmodium falciparum* were collected from different parts of Thailand and their rhoptry associated protein-1, rap-1, genes were sequenced and compared to the sequences available in the GenBank database. From the point mutations analysis the P. falciparum isolates can be grouped according to their rap-1 gene sequence. Most of their genetic patterns were specific to the isolates from the South-East Asia region compared to other region of the world. Because few point mutations occur along its sequence, 2 KB, the rap-1 gene is, then, considered highly conserved and may be useful as a genetic marker for *P. falciparum*. If enough genetic patterns of the rap-1 gene and other conserved genes in *P. falciparum* from endemic areas were established, it would be possible to determine the parasite's genetic patterns or its identity with better accuracy. This knowledge could help to further develop other molecular techniques such as DNA microarray, amplified fragment length polymorphism (AFLP) in the future. These molecular techniques would then allow us to identify the parasite origins for epidemiology study, to distinguish between drug resistance and new infection parasites, to follow some phenotypic patterns, for example drug resistance status, and valuable information for a vaccine design.

PREVALENCE OF POLYMORPHISMS IN DHFR, DHPS, PFMDRL AND PDCRT GENES OF *PLASMODIUM FALCIPARUM* IN QUANG TRIP PROVINCE, VIETNAM.

Bui Quang Phuc, Sonia R. Caruana, Alan F. Cowman, Beverley-Ann Biggs, Ngo V. Thanh, Nong T. Tien & Le Khan Thuan

Affiliation: National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam
E-mail: phucnimpe@yahoo.com

In Vietnam, routine monitoring for antimalarial drug resistance is carried out by the National Institute of Malariology, Parasitology and Entomology. In 2002, 47 patients from Quang Tri Province presenting uncomplicated *Plasmodium falciparum* infection were enrolled in one such survey. Sulfadoxine/pyrimethamine was the standard treatment recommended for uncomplicated *P. falciparum* malaria in that area at the time. Early or late treatment failure as defined by WHO was observed in 14.9% (7/47) of patients. Molecular analysis of dhps and *dhfr* alleles associated with resistance to sulfadoxine (S) and pyrimethamine (P) respectively was performed. *Dhps* and *dhfr* mutations linked to SP resistance were found respectively in 35% (14/40) and 66.5% (31/40) of the isolates. In 6 patients with treatment failure, 5/6 isolates had two or more mutations for *dhfr* and four of these had two or more *dhps* mutations. *Pfcrt* and *pfmdr1* mutations, a chloroquine resistance-associated polymorphisms, occurred in 28.6% (11/39) and 25.6% (10/39) of isolates respectively.

SESSION 7:

Vector Control

PERSONAL PROTECTION BY LONG LASTING INSECTICIDAL HAMMOCKS (LLIH) AGAINST FOREST MALARIA VECTORS IN CAMBODIA.

Tho Sochantha[1], Wim Van Bortel[2], Siv. Savonnaroth[1], Tanguy Marcotty[2], Marc Coosemans[2]

Affiliation: 1. National Center for Malaria Control, Parasitology and Entomology, Dept. Entomology, Phnom Penh, Cambodia; 2. Institute of Tropical Medicine, Antwerp, Belgium.
E-mail: sochanthat@cnm.gov.kh

In Southeast Asia, forest malaria remains a big challenge for malaria control programmes. The main vector, *Anopheles dirus*, is mainly biting outside the houses and if biting inside it will not rest on the walls. Moreover regular forest activity is considered as an important risk factor for malaria infection. This means that traditional vector control methods are not effective in controlling forest malaria. Indoor spraying with residual insecticides will not be effective against the vector because of its exophilic behavior and insecticide treated nets are not used by forest workers during the night.
For this purpose long lasting insecticidal hammocks, using Olyset™ technology, were tested in two forest villages of Cambodia (in Pailin and Pursat). In each village, two entomological surveys, each 10 consecutive nights, were done. Human landing collections were performed during the whole night by people sitting in long lasting insecticidal hammocks and non-treated hammocks, installed outside.
In total 6449 mosquitoes were collected from control hammocks compared to 4481 in treated hammocks. A significant personal protection with the Olyset hammocks was only obtained against *An. minimus* ($p<0,01$). Impact on *Anopheles dirus* bites was only observed during the second survey and no effect was observed on *An.maculatus* and *Culicinae*. A more detailed analysis is still going on and will be presented during the meeting.
Current study will complete a community based intervention trial evaluating the impact of these Olyset hammocks on malaria incidence in central Vietnam.

LONG-LASTING INSECTICIDAL HAMMOCK NETS (LLIHN) FOR CONTROLLING MALARIA IN VIETNAM: PRELIMINARY RESULTS.

Ngo Duc Thang[1], Annette Erhart[2], Nico Speybroeck[2], Le Xuan Hung[1], Le Khanh Thuan[1], Nguyen Xuan Xa[1], Marc Coosemans[2], Umberto D'alessandro[2].

Affiliation: 1. National Institute for Malariology, Parasitology and Entomology, Luong The Vinh street, BC 10200 Tu Liem district, Hanoi, Vietnam 2. Institute of Tropical Medicine, Antwerp, Belgium
E-mail: thangnimpevn@yahoo.com

Aim:
To evaluate the effectiveness of LLIHN as a new strategy for malaria control in forested areas of central Vietnam.
Methods:
A community based, clustered randomised trial on LLIHN was carried out in a forested area in Ninh Thuan province, Central Vietnam. Before the intervention, a census was carried out and the study population divided in 20 clusters of about 1,000 people each. Moreover, baseline data on malaria morbidity were collected. LLIHN were distributed to 10 intervention clusters and the whole study population, including the 10 control clusters, was followed for 2 years. Malaria cases were identified by passive case detection. Each year, 2 malariometric surveys (one at the beginning and one at the end of the rainy season) were carried out.
Results:
The study population comprised 18,646 people, mostly from the Raglai ethnic group, with low educational and socio-economic level. Before the intervention, malaria prevalence was 14%, with almost equal distribution of *P.falciparum* and *P.vivax,* respectively 46% and 43%, most infections (88%) asymptomatic. Risk factor analysis showed that socio-economic status was the most important risk factor for malaria infection, with regular forest activity as a strong risk factor in the higher wealth group only. In the low-medium wealth group, the most important risk factor was ITN use, non-users being much more infected (27%) than users (15%).
After two years intervention, malaria prevalence had decreased more in the intervention (from 22% to 4%) than in the control group (from 14% to 4%). The reduction of malaria incidence was more pronounced in the intervention (88/1000 population to 17/1000, reduction by 80%) than in the control group (52/1000 to 23/1000, reduction by 56%). Direct comparisons between intervention and control groups will be made on the reduction of malaria sero-prevalence, and results will be discussed in the light of additional entomological and anthropological results.
Conclusion:
In the forested areas of Central Vietnam, LLIHNs offer a good protection against malaria and might have a significant impact on its transmission. This is the first large scale community trial on LLIHNs carried out in Vietnam and its findings should be confirmed by other studies in the Mekong region.

INTEGRATED PEST AND VECTOR MANAGEMENT: TOOL FOR ADAPTING VECTOR CONTROL TO GLOBAL CHANGE AND LOCAL CONDITIONS.

Hans J. Overgaard

Affiliation: Bioforsk - Norwegian Institute for Agricultural and Environmental Research, Norway
E_mail: hans.overgaard@bioforsk.no

Global change will likely affect the epidemiology of vector borne diseases (VBD). A changing climate may cause shifts in the prevalence and intensity of VBD's. Both direct effects (changes in temperature and rainfall) and indirect effects (changing local environmental conditions) of climate change influence disease vectors and the disease-causing organisms they carry. Substantial research efforts are required to predict the effects of future climate scenarios on changes in magnitude and spatial distribution of VBD's. Research is also needed to explore innovative locally-adapted solutions to control vectors and VBD's. Solutions that can be easily adapted to local situations and changing environmental and climatic conditions are more likely to be effective and sustainable. The Integrated Pest and Vector Management (IPVM) approach is a promising solution.

IPVM is a recently developed concept based on community participation and agroecosystem management aiming to control both agricultural pests and disease vectors in an environmentally friendly and sustainable manner. IPVM originates from the Integrated Pest Management (IPM) approach, which is commonly implemented through Farmer Field Schools (FFS). IPM is a crop protection strategy with focus on biological control aiming to reduce pesticide use for the benefit of human and environmental health. FFS is a participatory non-formal education approach teaching farmers the principles of biological control through agroecosystem analysis, field observations, and experimentation. IPM implemented through FFS has led to reduced crop losses, less pesticide input, increased profitability, and improved environmental management and farmer empowerment. By adding modules on vector ecology, vector control, disease cycle, etc. to the FFS curriculum local communities may contribute to improved vector control by implementing synergistic combinations of interventions based on knowledge of local vector biology and disease transmission (i.e. Integrated Vector Management, IVM). These approaches preserve beneficial organisms, lessen selection pressure for insecticide resistance, and ensure community empowerment for the benefit of health promotion, rural development, and preparedness for adverse global change effects.

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STUDY ON SUPATAB USE IN 6 DISTRICTS OF 3 SOUTHERN PROVINCES OF LAOS (SARAVANE, CHAMPASSACK AND SEKONG).

Rattanaxay Phetsouvanh, Samlane Phompida, Bouasy Hongvanthong, Bounpone Sidavong, Viengphone Sengsavath, Simone Nambanya, Sithong Nouangsengsy and Khamphou Phranakhone

Affiliation: Centre of Malariology Parasitology and Entomology, Vientiane, Laos
E-mail: rattanaxay.phetsouvanh@theglobalfundlao.org

Social marketing of Supatab as retreatment tablets for insecticide treated nets (ITNs) was first introduced in Laos in 2002. It was progressively applied to other provinces under the GFATM. Social marketing of ITNs and use of re-treatment tablets in Africa has demonstrated that it could increase the coverage of the ITNs and at the same time improve the impact on malaria if properly done.

From the 2683 householdes interviewed it was shown that only 18.33% knew about Supatab. In some target districts this proportion was even lower.

The best sources of information for the dissemination of Supatab seems to be through the village health workers, radio, district health staff and pharmacies, with 24.95%,17.79%, 18% and 9.20%, respectively.

Among those who know about Supatab, 96.69% understood the use of it. However among those who knew, only 51.64% bought it for the re-treatment of the nets. The highest percentage was found in Saravane where PSI had explored how to increase the buying rate.

The main reason for the low buying rate is the non-availability of these tablets near the userhome. Village health workers probably could be another option beside the existing retailer system to improve the re-treatment rate of the ITN at the community level. This finding was also supported by the fact that 67.31% of the householdes suggeste to have Supatab available near their home and the best places for distibuting them would be through pharmacies and village health workers (35.21% and 29.81% respectively).

Side effects of the tablet are uncommon. Supatab is developed for friendly use and 93.83% of the householdes confirmed it. Most of the households bought the tablets for the re-treatment of their old nets rather than for dipping a new net, which is in line with the NMCP policies.

SPATIAL TARGETED VECTOR CONTROL IN AFRICAN HIGHLANDS AND ITS IMPACT ON MALARIA.

Natacha Protopopoff[1,3], Dismas Baza[2], Wim Van Bortel[1], Tanguy Marcotty[1], Michel Van Herp[3], Peter Maes[3], Umberto D'Alessandro[1], Marc Coosemans[1]

Affiliation: 1. Institute of Tropical Medicine of Antwerp, Belgium. 2. Programme de Lutte contre les Maladies Transmissibles et Carentielles, Burundi. 3. Médecins Sans Frontières, Belgium.
E-mail: nprotopopoff@itg.be , bazadismas@yahoo.fr

Background: Prevention of malaria epidemics is a priority for African and Asian countries. The 2000 malaria epidemic in the highlands of Burundi prompted the government to implement measures for preventing future outbreaks. A vector control programme was initiated in one of the most affected highland provinces. The focal distribution of malaria vectors in the highlands was the starting point for designing a targeted vector control strategy. The objective of this study is to present the results of this strategy on malaria vectors, transmission and prevalence in an African highland region.

Methods: In Karuzi, vector control activities combining indoor residual spraying (IRS) and long lasting insecticidal nets (LLINs), were implemented between 2002 and 2005. The IRS interventions were done before the peak malaria transmission period and targeted the areas in the valleys of the hills, with the expectation that this would also protect the populations living at higher altitudes. The impact on the *Anopheles* population, malaria transmission and prevalence was determined by nine cross-sectional surveys carried out at regular intervals throughout the study period. The potential additional effect of long lasting insecticidal nets was evaluated.

Results: After the intervention and compared to the control valleys, *Anopheles* density was reduced by 82% (95%CI: 69-90). Similarly, transmission was decreased by 90% (95% CI: 63%-97%, p=0.001). Children 1-9 years old, in the treated valleys had a lower risk of malaria infection (OR: 0.55; 95%CI: 0.42-0.72, p<0.001) and less clinical malaria (OR0.57; 95%0.41-0.81) compared to the control valleys. Impact on malaria prevalence was even higher in infants (OR: 0.14, 95%CI: 0.04-0.52, p=0.005). No additional protective effect due to the nets was observed. No significant impact in vector density, malaria transmission and prevalence were observed on the less exposed hill tops. However the intervention focused on the high risk areas near the valley floor, where 90% of the transmission was found.

Conclusions: Spatial targeted vector control effectively reduced *Anopheles* density, malaria transmission, malaria prevalence and malaria attacks in African highlands. The absence of an additional protective effect of bed nets is probably due to high coverage (>90%) of the IRS. Despite the lack of protection on the hill tops, the programme successfully covered the areas most at risk. Investment in targeted and regular control measures associated with effective case management should be able to control malaria in the highlands. Exchange of experience and expertise between Africa and Asia would be very useful for the National Control Programmes.

Poster session on vector control

EVALUATION ON THE RESIDUAL EFFICACY OF BISTAR ™ 10 WP (BIFENTHRIN) APPLIED TO VARIOUS WALL SURFACES UNDER LABORATORY CONDITIONS IN VIETNAM.

Nguyen Anh Tuan, Nguyen Thi Phuc, Le Khanh Thuan, Ho Dinh Trung, et. al

Affiliation: National Institute of Malariology, Parasitology & Entomology, Hanoi, Viet Nam.

Residual activity of bifenthrin treatments were evaluated in laboratory conditions from August 2004 to April 2005. Residual effects were determined by bioassays using WHO method WHO/VBC/81.5 on *An.dirus, Ae.aegypti* (laboratory colonies).

Following results were obtained:

Bistar™10WP sprayed at the dose of 50mg a.i/m^2 had a residual effect:

- On the walls made of wood and bamboo: for 28 weeks (mosquito mortalities: 70.00% - 86.67%).

- On the walls made of brick and earth: for 16 weeks (mosquito mortalities: 54.44% - 65.56%).

Bistar™10WP sprayed at the dose of 25mg a.i/m^2 had a residual effect:

- On the walls made of wood and bamboo: for 28 weeks (mosquito mortalities: 67.78% - 73.33%).

- On the walls made of brick and earth: For 12 weeks (mosquito mortalities: 53.33% - 76.67%).

RESIDUAL ANALYSIS, HALF-LIFE TIME AND RESIDUAL EFFECT ON *AN.DIRUS* OF PYRETHROID IMPREGNATED NETS.

Nguyen Anh Tuan, Nguyen Duc Manh, Ho Dinh Trung , et. al.

Affiliation: National Institute of Malariology, Parasitology & Entomology, Hanoi, Viet Nam.

The study has been carried out from 4/20001 to 5/2002 in the laboratories of Chemistry Department, Vietnam National University, HaNoi and the laboratories of Entomology Department, National Institute of Malariology, Parasitology and Entomology. Bioassays for determining residual effect to *An.dirus* followed procedure of WHO/VBC/89. 981. Analytical method was used by liquid-liquid extraction with solvent mixture of n-hexane: acetone (1:2, v/v), using solvent mixture of n-hexane: dichloromethane (3:1, v/v) for furification of extract on the silicagel column and n-hexane: dichloromethane (1:1, v/v) for elution of the pyrethroid compounds from the column, then their quantitative determination carried out by GC/ECD.

A satisfactory residual effect on *An.dirus* of 5 to 6 months was obtained for nets treated with Fendona 10SC, ICON 2.5CS, K-Othrin 1SC and Imperator 50EC.

Chemical analysis showed a half-life time of these chemicals of 125 - 188 days on polyester nets and 129 -167 days on cotton nets.

FIELD EVALUATION OF LAMBDA-CYHALOTHRIN MICRO-ENCAPSULATED FORMULATION (ICON 2.5CS) IMPREGNATED BEDNETS FOR MALARIA CONTROL IN NONG DISTRICT, SAVANNAKHET PROVINCE, LAO PDR.

Bounpone Sidavong

Affiliation: Centre for Malariology, Parasitology and Entomology, Vientiane, Lao
E-mail: bsidavong@gmail.com

A field trial was carried out to evaluate the efficacy of lambda-cyhalothrin CS (ICON 2.5CS) treated bed nets at 20 mg of active ingredient /m^2 and its impact on malaria control. ICON 2.5CS impregnated nets were distributed in three villages, Ban Sloykoa, Saloy Mai and Xangphou. In one control village (Ban Tamloung), non-insecticidal treated bednets were provided. The study covered a period of one year, from September 2005 to November 2006.

Pre-treatment baseline survey, using mass blood slide examinations, showed high malaria prevalence (around 34%) in the study sites. The main malaria vectors found were *Anopheles dirus, An. maculates* and *An. minimus,* representing 91% of total mosquitoes caught. The WHO test with 0.05% lambda-cyhalothrin impregnated papers was used for testing the insecticide susceptibility. These three mosquito species were found fully susceptible (100% mortality) against lambda-cyhalothrin.
In the ICON 2.5CS treatment sites, indoor and outdoor man-landing rates was significantly lower than in the control site (respectively $p < 0.001$; $p=0.0375$).

When analysis was conducted to investigate the pre and post treatment effect (i.e. man biting rate after introduction of ICON 2.5CS treated nets versus before treatment), ICON CS has significant impact in reducing the vector densities both indoor and outdoor.

The parasite index between February and November 2006 was also significantly lower in the treated villages compared to the control one. No complaints of transitory symptoms were reported among the users of treated nets and communities were willing to further using the treated nets.
The residual efficacy of ICON 2.5CS treated bed nets was investigated. *An. dirus* and *An. maculatus* were exposed to the treated nets after repeated washings with water, and with soap and water. When bioassays were carried out using WHO cone method, unwashed treated nets gave >95% mortality on both vectors for more than 12 months. When treated nets were washed with water, mortality was >95% after the 2nd wash and >80% after 3rd wash at 12 months after treatment. The addition of soap for washing still gave 12 months of residual effect with >70% mortality after the 3rd wash.

Therefore, lambda-cyhalothrin CS (ICON 2.5CS) is recommended for the treatment of mosquito nets at a dose of 20 mg of a.i./m^2. The expected duration of efficacy is up to 12 months when treated nets are not washed more than three times with soap and water.

SESSION 8:

Coverage and acceptance of ITNs

NATIONAL MOSQUITO NET COVERAGE IN MALARIOUS AREAS OF CAMBODIA IS SURPRISINGLY AND UNIFORMLY HIGH, BUT MOST NETS ARE NOT TREATED.

Jo Lines [1,2], Jane Bruce [2], Khol Vohith [3], Jonathan Cox [1,2], Mao Bunsoth [3], Sylvia Meek [2], Duong Socheat [4].

Affiliation: 1. London School of Hygiene and Tropical Medicine, UK. 2. Malaria Consortium, UK. 3. National Institute of Public Health, Cambodia. 4 National Center for Malaria Control, Phnom Penh, Cambodia.
E-mail: Jo.Lines@lshtm.ac.uk

The Cambodia Baseline Malaria Survey was conducted in the malaria transmission season of 2004, using a two-stage cluster sampling process. Villages were randomly selected by province from a national list of communities within forest or less than 2 km from forest. Epidemiological results are reported elsewhere. Data on net coverage were obtained for 3363 households, 15831 people and 6782 nets. 86% of people reported sleeping under a net (treated or untreated) the night before the survey; 23% reported sleeping under an insecticide-treated net (ITN). Overall coverage varied very little with distance from forest, but the proportion of nets that were treated was higher in villages within or close to the forest, presumably reflecting the policy of the national programme targeting ITN distribution to villages located inside or within 200m of the forest. 37% of nets came from Government/project sources, and 57% from commercial sources, the latter being more common in villages more distant from the forest. There was surprisingly little variation in usage by age and sex, but some evidence that some pregnant women tended to use an untreated net rather than an ITN. There was also surprisingly little variation by socio-economic status: poorer families tended to have fewer nets in the household, but were equally likely to be sleeping under a net. The data was used to re-evaluate the relationship between usage and the person:net ratio within households. More than a quarter of all households in the survey have more than four people per net, and in these households, only 61% of people reported sleeping under a net. By contrast, in households with 2.5 to 3 people per net, 94% of household members were sleeping under a net. There also needs to be enough nets in the house to allow one to be taken away on visits to the forest. Using this information, the Cambodia National Malaria Control Programme has adopted a combined strategy: free distribution of more LLINs, and supplementary net-treatment programmes to treat the existing untreated nets.

IMPROVING MALARIA CONTROL THROUGH THE USE OF ITNS AMONG THE JARAY MINORITY GROUP IN RATTANAKIRI PROVINCE, CAMBODIA.

Siv Sovannaroth & Srey Sophannaroth

Affiliation: National Center for Malaria Control, Phnom Penh, Cambodia.
E_mail: sovannaroaths@cnm.gov.kh

Malaria is a great problem in Cambodia because of the heavy burden in terms of illness and deaths among the country's poorest people. Malaria prevention relies mainly on insecticide treated net (ITNs). Present study aims to find key factors influencing ITNs use among the Jaray minority group. This group lives in remote malaria high risk area in Oyadav district, Rattanakiri Province along the Vietnam border.

The study was focus on socio-economic characteristics of the leaders and farmers, their level of knowledge about malaria etiology, signs and symptoms, malaria treatment and prevention, their provision of access to malaria health information and service, their beliefs or knowledge about malaria and the provision and use bed nets and ITNs. A exploratory descriptive research design was used in our study and conducted through the Key Informant Interview Guides and Household Questionnaires.

Socio economic characteristics of the leaders and farmers were not different, and both groups had limited knowledge of Khmer language. The two groups have erroneous ideas on cause, symptoms, risk factors and prevention of malaria. Knowledge of community activities to prevent malaria was very low for the farmers and only half of the leader knew such activities. We also found that the majority of the farmers and leaders possess a bed net or even an ITN, but most nets were dirty and torn, and not regularly used. The study reveals that farmers hardly had access to malaria information or services despite leaders unanimous claimed having provided such information to the villagers.

The study suggests to continue in disseminating information about malaria prevention and to adapt the messages to the Jaray community to correct misconceptions concerning all facets of malaria. Collaboartion of local health service providers as well as local leaders is than required.

ACCEPTANCE STUDIES OF LONG LASTING INSECTICIDAL NETS (LLINS) AMONG SELECTED COMMUNITIES IN LAO COMMUNITIES LIVING IN REMOTE AREAS.

Rattanaxay Phetsouvanh, Samlane Phompida, Bouasy Hongvanthon.

Affiliation: National Centre of Malariology Parasitology and Entomology, Lao PDR
E-mail: rattanaxay.phetsouvanh@theglobalfundlao.org

An acceptance study on LLIN was carried out in 4 districts of 4 LLIN target provinces of Laos. A total of 599 people were interviewed and 176 persons were involved in focus group discussions. The aim was to assess the acceptance of LLIN, the reasons for choosing or not a LLIN and other related issues as two types of LLIN were introduced in the target areas.

The percentage of LLIN and conventional ITN is 51.2% to 42.9%, respectively. About 80% of the LLIN were provided by the Global Fund project and 20.5% were bought on the market. Green LLIN was preferred by 47% of respondents and 31.7% like the white one. After 2 years of distribution, it was found that 10% of nets have holes or were torn. It was also found that 87.6% of the LLIN were used for visiting guests. Regarding the washing habits, 24% have washed their nets during the year, and of those 57.6% have washed their net 1 time, 30.3% twice and 11.4% more than 3 times. A majority of interviewed persons (55.87%) like the LLIN but 41.13% complain about is it because of the wide mesh, the smell and the difficulty to breath. One of the refusing reasons of having LLIN is the higher price when compared to the conventional ITN.

BARRIERS FOR NET-USING AMONG BANA PEOPLE IN K'BANG DISTRICT, GIA LAI PROVINCE.

Phan Thi Thu Hien

Affiliation: Medical Committee Netherlands- Vietnam
1A-B5 Nam Thanh Cong, Hanoi, Vietnam
Email: phanthuhien69@yahoo.com , mcnvhien@netnam.vn

The NGO Medical Committee Netherlands-Vietnam (MCNV) supported K'Bang district (Gia Lai province, Vietnam) in Community-Based Malaria Control since 2000. The main strategy was to encourage and train Village Health Workers (VHW) to propagate the proper use of Insecticide-treated bed-nets among the ethnic Bana population. In 6 out of the 8 most malarious communes net-usage increased from 40% to over 80%, often within one year. But in two communes, Kroong and Loku this rate still hardly reached 50% after four years. Local staff and the provincial Malaria Control Centre were unable to convincingly explain this difference.

To address this question and identify the factors influencing net-usage, a study with an anthropological approach was undertaken in December 2005 by two researchers who were not identified with the malaria project by the inhabitants. The two communes were compared with Dakroong commune where the project had been successful. Data collection methods included 28 in-depth interviews, 6 focus group discussions and observation. Qualitative tools such as ranking and mapping were applied to the information received from 88 people.

In the problematic communes, people mentioned many reasons for not sleeping under bed-nets: 1. afraid the net will burn when sleeping around the fire in the house; 2. often sleeping in plot huts without nets; 3. young people often sleep in the communal house where there are no nets; 4. the instructions to fold-up the net and store it in the plastic bag every day are tedious to follow; 5. the houses are not suitable for hanging nets, especially when there are many people; 6. the chemicals in the net cause allergic reactions; 7. the belief that evil spirits cause fever and disease and that praying and sacrifices can cure. The Bana people in the comparison commune mostly quoted positive reasons for using bed-nets, conform the messages they had heard from the VHWs.

The study found a large difference in the capacity of the village health worker network: in the successful commune the village health workers had been selected by the villagers themselves, they praised the efficient support and encouragement from the Commune Health Station and were more trusted, happier, more dedicated and self-confident with their tasks.

Another obvious difference between the communes was the high rate of Kinh immigrants (majority people in Vietnam) in Dakroong. The immigrants' more successful lifestyle, which includes bed-net usage, seemed to be an attractive example to many indigenous people.

The study can not provide hard evidence as to which difference between the communes was most influential because both the capacity and trust of VHWs and the good example of immigrants can have contributed to the change in beliefs and behaviors in respect of using bed-nets and relying on treatment at the Health Station. However, while building up a good and trusted VHW network and capable CHSs falls clearly within the mandate of the health (malaria) sector, stimulating immigration does not.

SESSION 9:

Approaches for better case management

THE POTENTIAL OF VILLAGE HEALTH WORKERS FOR MALARIA CONTROL AND HOW TO REALIZE IT.

Nguyen Tuyen Quang, Nguyen Ngoc Duong, Nguyen Thi Bich Lien and Ron Marchand.

Affiliation: National Institue of Malariology, Parasitology and Etomology, Hanoi, Vietnam / Medical Committee Netherlands-Vietnam
E-mail: kpmalaria@hn.vnn.vn

The Commune Health Station is the most peripheral branch of the public health system in Vietnam. In much of the country this is complemented by a Village Health Worker (VHW) network of local people who serve as contact persons between the inhabitants and the CHS, as well as for the vertical Health programmes. VHWs are especially valuable in the mountainous regions where there are physical (distance, terrain) and ethnic language/cultural barriers between the population and the governmental health system. At the same time these communities are among the poorest, with lowest education levels.

Khanh Phu commune (Khanh Vinh district, Khanh Hoa province, Vietnam), one of the most malaria endemic areas in the country, saw a great reduction in malaria endemicity since the universal use of Insecticide-trated bednets (ITN). Thusfar the role of the VHWs in malaria control was to encourage proper bednet-use and assist during re-treatment campaigns. From 2005 the five VHWs received training, coaching, means and incentives from the Khanh Phu Malaria Research Station to perform tasks in early case detection and prompt and adequate treatment (with Chloroquine or Artesunate). The research team measured the impact by recording all malaria cases, by whom they were detected, treated and the results of the treatments.

In 2005 the VHWs detected 17% of the total parasite positive cases and 24% in 2006. This is especially important in some villages furthest from the CHS, with most malaria and where the people hesitate long before going to the CHS. Not all these cases can be expected to be cases which would otherwise have escaped detection, but they certainly were detected earlier. There is no hard proof, but the VHW activities may well have contributed to the significant reductions observed in malaria incidence in 2005 and 2006 in Khanh Phu, which occurred in spite of increased case detection efficiency.

As expected, the sensitivity and specificity of correct treatment of parasite cases by VHWs are less than that of CHS staff. This points to the danger that if people would mostly rely on the VHW, the quality of treatment and health care will decline. For malaria, correct treatment might be substantially improved by using Rapid Diagnostic Tests (even in the CHS). Most health authorities believe that the advantage for malaria control outweighs possible disadvantages, but to realize the full potential of VHWs there still are big challenges: 1) the population is aware of the limitations of treatment by VHWs; 2) training, materials and incentives for VHWs suit their capacities as well as the health situation in their locality; 3) clear policies about the role and task of the VHW; 4) VHWs are respected (and chosen) by their communities, as well as supported by the local administration, and 5) CHS staff know well how to manage, encourage and support VHWs, taking into account that they are valuable volunteers, not health system staff.

VILLAGE-BASED EARLY DIAGNOSIS AND APPROPRIATE TREATMENT FOR MALARIA – THE EMERGENCY STRATEGY OF CHOICE FOR REMOTE AND HYPERENDEMIC VILLAGES IN CAMBODIA.

Chea Nguon

Affiliation: National Center for Malaria Control, Phnom Penh, Cambodia.
E-Mail: nguonc@cnm.gov.kh

Malaria remains a major problem in Cambodia. The provision of one Health Center per 10,000 and one Referral Hospital per 100,000 inhabitants does not meet the full health care coverage. More than 60 percent area is covered with forest, hills and mountains where about 15% of total population lives in scattered communities. In those remote inaccessible villages, malaria remained the biggest health problem. On the other hand, more than 80% patients seek treatment in the private sector.

To minimize the above major health care concerns, Cambodia's malaria control program became very advanced both in terms of its large-scale use of state-of-the-art rapid diagnostic tests (RDT) and pre-packaged artemisinin-based combination therapy (ACT) and its innovative public-private mixed approach to the provision of early diagnosis and appropriate treatment (EDAT). The public sector provides microscopic or RDT diagnosis and ACT through a slowly expanding network of health outlets. The Malarine® social marketing project provides the same RDTs and ACT (this time with glossy tamper-proof packaging) through the private sector. Despite this two-pronged tactic, an important gap in service provision remains and paradoxically it is the very poorest communities in the least accessible areas who are still unprotected.

In order to address this issue and develop a truly comprehensive National strategy to reach out to those that are otherwise not reached, a pilot project was established in 2001 to investigate the viability of providing village based EDAT for malaria through a network of male-female pairs of volunteers selected from their own villages. They are trained and equipped with RDTs, heat stable artesunate suppositories and ACT. This pilot was a resounding success and the 'Village Malaria Worker' (VMW) strategy was adopted by the MOH and strongly supported by WHO/USAID as the EDAT policy of choice for remote malaria hotspots.

With the commencement of GFATM support in 2004, the project has begun to expand from the earlier 45 pilot villages to 300 in 7 targeted provinces and cover the country's most remote, inaccessible villages, predominantly inhabited by ethnic minorities and other downtrodden people who are at present most vulnerable to the disease. Within the completion of 6 months since the commencement of the scaling up of the VMW approach in July 2004, a total of 18,983 patients were tested by VMWs using RDT. Slightly less than two-thirds (63% or 11,994 cases) were found to be positive. A total of 217 deaths were reported from these villages during this period, of which slightly less than a fifth (38 deaths or 18%) were confirmed to be due to malaria through RDTs performed before death and another quarter (55 deaths or 25%) were suspected to be malaria based on clinical signs and symptoms. Malaria among the pregnant women appeared to be a major problem in the VMW villages, with nearly three-fourths (63 out of 86 or 73%) of the pregnant women who were tested proving to be positive for malaria. Some of the pregnant women may have been missed out for a variety of reasons. Through this active network in the remote and

hyperendemic areas, the project covered more than 140,000 populations at risk. During these 3 years of the VMW project's implementation (2004-2006), 154,573 villagers used the service and 54.26% of them were malaria positive and received the ACT treatment from VMWs based in the villages. In addition, nearly 60% (59.41%) of the pregnant women consulted and tested were positive.

The VMW project has commenced making a tremendous impact and a significant contribution to the reduction of malaria morbidity and mortality in Cambodia. Successes were booked in the remote and hard-to-access geographical areas, which have been neglected in the past in terms of access to health services of any kind, owing to problems such as limited budget, difficult terrain, poor transport and communications and very low motivation among the health staff.

The VMW approach has emerged as an effective complementary strategy that plays a key role in bridging the gap and linking the community to the public health service by stimulating community participation, and heralding the shift to sustainable alternatives to malaria control in Cambodia, with people's own efforts in tackling their malaria problems.

EVIDENCE OF QUALITY OF CARE IN PRIMARY HEALTH CARE SYSTEM IN RURAL VIETNAM: A SYSTEMATIC REVIEW FROM STUDIES MANAGED BY LOCAL NGO'S AND INDEPENDENT RESEARCH INSTITUTIONS.

Tran Tuan
Affiliation: Research and Training Center for Community Development (RTCCD)-Hanoi, Viet Nam
E-mail: trantuanrtccd@gmail.com

Abstract

Background: Health care services in Viet Nam are provided by both public and private sectors and it is imperative that the quality of care should be monitored for the sake of community health. Part of this work has been conducted outside the Ministry of Health's routine information system and health care research projects. This study aims to review research evidence on quality of care in rural Viet Nam from studies conducted by the independent research institutions and local NGOs.

Methods: Published and unpublished reports/papers using either quantitative and/or qualitative research methods conducted by the local NGOs and independent research institutions registered to the Vietnam Union of Science and Technology Association have been collected through formal and informal contacts. Definition of quality of care applied to the developing countries was used. Critical appraisal was conducted for all reports to select scientific evidence, which reflect quality of care.

Results & conclusions: Research from the local NGOs/independent research institution provide community-based evidence reflected current practice in both public and private system fall below the national standard, especially for the management of chronic health problems including mental health. Poor medical training, including both background training and on the job support training, combined with lacking an independent quality monitoring system, are the roots of the problem. The low quality of health care services at a communal level may help explain the previously observed phenomena of high levels of self-medicating, low utilization of commune health centers and over utilization of tertiary health care services.

Policy oriented recommendations: The non-profit, independent research institutions in Vietnam have been the source of providing strong evidence for policy development of health care. Strengthening the national health information system for monitoring and evaluating health system functioning should not forget them. A professional, independent training institution on primary health care is urgently needed.

ANTIMALARIAL DRUG QUALITY MONITORING IN VIET NAM.

Trinh Ngoc Hai, Le Khanh Thuan

Affiliation: National Instuite of malariology, Parasitology and Entomology, Hanoi, Vietnam.
E-mail: trinhngochai@fpt.vn

Malaria continues to be a major public health problem in many areas of Africa and South-East Asia, including Viet Nam. Antimalarial drugs play a significant role in the fight against malaria. To ensure quality, safe and rational use of antimalarial drugs is important to provide effective malaria treatment. From 2004 to 2005, with the support of USP DQI, four study sites were selected for monitoring and evaluation of the quality of antimalarial drugs in four provinces of Viet Nam. In 2006, with the support of Global Fund, additional fourteen study sites were selected.

Methodology

- *Sample collection methods*: The use of official protocol is required; samples collected formally have been supplemented with samples collected by "mystery" shoppers. Sampling locations included in this project cover both the public and private sector supply and distribution systems and both formal and informal channels.

Geographical coverage: sentinel sites were chosen in different parts of the country both in urban/suburban and rural areas. Different brands/sources of manufacture and lots/batches were sampled.

E. Test methods, procedures and reference substances:

Samples were tested by the GPHF-Minilab and USP DQI doing.

. Physical/visual inspection/examination
. Simple disintegration
. Thin Layer Chromatography (TLC)

Verification and confirmation testing was performed by the National Institute of Drug Quality Control.

Results

- 2004 – 2005: One hundred twenty nine batch-based samples were collected in all three rounds from the provinces. Three of fourty nine samples collected (6%) in round 1 did not fulfil the criteria. One of the 40 artesunate samples (2.5%) collected in round 2 was counterfeit. From the 51 samples analyzed by the National Institute of Drug Quality Control two quinine samples (quinine ulphate 250 mg) and one artesunate sample (artesunate 50 mg) were of poor quality.

The counterfeit artesunate in all four provinces and Quang Tri accounted for 1.4% (1/72 samples) and for 6% (1/18) respectively. The source of this counterfeit batch of artesunate has not been found.

E. 2006: One thousand four hundred and seventeen samples were collected in provinces. Thirty-one of the 1417 samples were substandard (2.3%) drugs. Three of the 1417 samples collected were counterfeit (0.21%): 2 were counterfeit for artesunate and 1 for quinine.

Conclusions

This study confirms the presence of counterfeit as well as substandard quality antimalarial drugs in Viet Nam. This highlights the need for manufacturers and suppliers of antimalarial drugs to find ways how to prevent this problem. However, most of antimalarial drugs are provided by the NMCP applying strict quality control procedures.

Poster session on rapid diagnostic tests

THE VALIDATION OF THE THMBC MALARIA PF./PV. RAPID DIAGNOSTIC DEVICE FOR THE DETECTION OF FALCIPARUM AND NON FALCIPARUM MALARIA IN THAILAND 2006.

Pongwit Bualombai[1], K. Balachandra[2], P. Dhepakson[2], K. Congpuong[1], and W. Satimai[1]

Affiliation: 1.The Bureau of Vector Borne Diseases, Department of Disease Control, Ministry of Public Health, Nonthaburi, Thailand. 2. Medical Biotechnology Center, National Institute of Health, Department of Medical Science, Ministry of Public Health, Nonthaburi, Thailand
E-mail : pongwitb@yahoo.com , pongwit@health.moph.go.yh

An effort of validating newly developed rapid and specific rapid diagnostic kit, THMBC Malaria Pf./Pv. Was done to identify individual infected with *Plasmodium falciparum* and *Plasmodium vivax* at peripheral areas in Thailand. The study aimed to validate an alternative tool being used to control the severe public health impact of this disease. The kit was developed by utilizing gold particles linked monoclonal antibodies against the intracellular metabolic enzyme parasite lactate dehydrogenase (pLDH). Malaria parasites were differentiated on antigenic differences between the pLDH isoforms. The test could differentiate live from dead organisms as pLDH is produced only by live *Plasmodium* parasites. To validate this test, a golden standard, 100 fields of traditional Giemsa-stained thick-smear blood films examination was used to compare with the THMBC test result.
Patients suspected of having malaria were enrolled (n=369) for this validation.
A total of 101 samples (27.4 %) were positive by blood films, among which 35.6 % (36 of 101) positive for *P.falciparum* and 64.4 %(65 of 101) positive for *P.vivax*. With the THMBC test, 103 (27.9 %) were positive The THMBC test showed that 36.9 % (38 of 103) were positive for *P. falciparum* and 63.1 % (65 of 103) were positive for *P. vivax*. This study showed that the THMBC test had sensitivities of 77.8 and 87.9% and specificities of 97.0 and 97.4 %, respectively, comparing with the Gold standard test for detecting *P. falciparum* and *P. vivax* malaria. In addition, patients with parasitemia below 100 parasaites/µl could not be found positive for malaria with the THMBC test.
We can conclude that the THMBC test is an effective tool for rapid diagnosis of malaria, even if it could not replace the tradition blood film examination.

PRODUCING MONOCLONAL ANTIBODY AGAINST PLASMODIUM GLYCERALDEHYDE-3-PHOSPHATE DESHYDROGENASE (PGAPDH) TO DIAGNOSE MALARIA PARASITES.

Pongwit.Bualombai[1], K. Balachandra[2], P. Dhepakson[2], K. Aiem-Umporn[3], T. Sakuldamrongpanich[3]. K. Congpuong[1], and W. Satimai[1],

Affiliation: 1 Bureau of Vector Borne Disease, Department of Disease Control, Ministry of Public Health, Nonthaburi, Thailand. 2 Medical Biotechnology Center, National Institute of Health, Department of Medical Science, Ministry of Public Health, Nonthaburi, Thailand. 3 National Blood Centre, the Thai Red Cross Society, Bangkok, Thailand.
E_mail : pongwitb@yahoo.com , pongwit@health.moph.go.yh

Malaria is still a major problematic disease in Thailand and Tropical Countries. Various tools have been concentrated on controlling the disease but there are various factors obstructing the eradication of this disease. As it emerged in peripheral areas, various tools have been brought to deal with it. However, its specific characteristic depreciates some of those tools. Therefore, an early diagnosis and prompt treatment has been chosen to be a good alternative method to combat the disease. Regarding these, Malaria Rapid Diagnostic Test (MRDT) or dipstick has been used to detect the malaria patients and shows trends of superiority compared to some alternative malaria diagnostic methods. In Thailand, most of MRDT is imported and their quality is uncontrollable.
Therefore, local production of MRDT can be promoted. In this regards, a glycolytic enzymatic antigen of *Plasmodium falciparum*, Plasmodium Glyceraldehyde-3-phosphate dehydrogenase (pGAPDH) was chosen and monoclonal antibodies against the recombinant protein pGAPDH were produced. Hybridoma cells were created from the fusion of hyperimmunised mice's lymphocyte with SP2/0 myeloma cell. The positive hybridoma clones was screened by ELISA and Dot-ELISA and raised 263 clones. Strong stable positive clones were selected for their specificity against *P.falciparum*, *P.vivax* and PAN malaria (*P. falciparum* and *P. vivax*) by IFA or Western blot analysis. pGAPDH hybridoma cells gave 9 clones specific for *P. falciparum*, and 11 clones specific for PAN. Most of them were IgG2b class.

The epitope recognised by Mab, was further explored by the phage display technique. A amino acid sequence was recognised in position 286, QDF, belonging to the external part of the crystallized structure of pGAPDH. Determining of their detection limit in detecting field malaria sample, their capability range was from 356 to 152.8. Most of them revealed great genetic diversity. Eighteen Mabs were chosen to embed the strip for making MRDT.

SESSION 10:

Social approach of malaria control

HEALTH SEEKING BEHAVIOUR MODELS IN MALARIA RESEARCH.

Joan Muela Ribera

Affiliation: Partners for Applied Social Sciences. PASS International, Barcelona, Spain.
E-mail: koen.peeters@pass-international.org

Why do some people comply with treatment and others don't? Why do some people delay attending a health facility for severe malaria while others arrive on time? Why do some people sleep under mosquito nets and others don't? In order to answer these and similar questions, health-seeking behaviour models (HSBMs), developed by social psychologists, medical sociologists, geographers, anthropologists, and public health specialists, were introduced in the malaria field in the early 1990s . HSBMs can be classified into: (1) socio-behavioural models, (2) pathways models, (3) and the 'four As' model (Affordability, Accessibility, Affordability, Acceptability). HSBMs have been used for understanding patterns of treatment seeking, and the factors that facilitate or hinder access to care. HSBMs have enriched social science research in malaria, which was previously based on a too simplistic 'beliefs and attitudes' approach. However, HSBMs have their limitations. They are useful for analysing different factors, their weight and role. But if we want to understand behaviour and access to health, we have to place these factors into the wider context of social and political life, focusing on social resources and economic capabilities for people to cope with illness at the household and community levels. Furthermore, we have to consider key processes of health-seeking, such as illness interpretation and decision-making.

MALARIA BASELINE STUDY WITH KRENG MINORITY GROUP IN RATTANAKIRI PROVINCE.

Boukheng Thavrin[1], B Uk[1], S Kem[1], Y Ung[1], Siv Sovannaroth[1], V Huy[1], T Meas[1], Abdur Rashid[2], Pricha Petlueng[2], Doung Socheat[1]

Affiliation: 1. National Centre for Malaria Control/ Ministry of Health, Phnom Penh, Cambodia. 2. World Health organization (WHO)
E-mail : thavrinb@cnm.gov.kh

Malaria poses a great problem in Cambodia because it exacts a heavy toll in terms of illness and deaths among the country's poor. The appropriate and effectiveness on malaria control relies mainly on insecticide treated net (ITNs). The aim of our baseline study are finding, the key factors that influence bed nets/ ITNs use , and the information on seeking an advice and treatment for malaria among the Kreung minority group, who live in remote malaria high risk area in Ouchum district, Rattanakiri Province along the Vietnam border.

The study was focus on their socio-economic status in relation with malaria transmission and prevention, the level of knowledge about malaria etiology, signs and symptoms, cause of malaria and malaria prevention, the use of bed nets and ITNs, and the access to other health facilities. The exploratory descriptive research design will use in our experiment. The key factors for our experiment are conducted through the Focus Group Discussion (FGD) and Household Questionnaires.

The baseline finding that, knowledge in preventing malaria of household respondents appeared almost in correct tolls around 80%, and knowledge in malaria transmission indicated correct cause of transmission more than 90%. Notably, only around one third of the people who got fever within 48 hours had seek their advice/ treatment for fever, but interestingly this activity was high for pregnant women (6 out off 7) and children under five 50%. More than this, we also noted that the majority of them have sought their advice/treatment at health center.

Data on bed nets reveal that most of households owned at least one net (86%) but only around 30% owned ITN. And notably, only 62% and 24% of them had slept under nets and ITNs last night, respectively. We also found that the key issue for the low net re-treatment was the delay, cancelled and too early time by the re-treatment net teams.

Importantly, the baseline study also found the association between a socio-economic status with the malaria transmission and prevention, while the malaria knowledge was decreasing mostly among people with a lower socio-economic status.

THE RELEVANCE OF SOCIAL SCIENCE RESEARCH IN INTERNATIONAL HEALTH AND MALARIA CONTROL IN VIETNAM AND OTHER SETTINGS.

Koen Peeters Grietens

Affiliation: Partners for Applied Social Sciences. PASS International.
E-mail : koen.peeters@pass-international.org

Social sciences are vital to international and public health as understanding people's behaviour and social organization are key in gaining insight into disease and disease distribution, adherence to preventive health measures and disease control programmes. Research among the Raglai in South Central Vietnam is presented, highlighting various factors explaining why, despite the free of charge distribution of bed nets in the region, half of the population (48,5%) sleep unprotected at their forest fields, where they are most at risk for malaria infection. Other concrete examples of relevant social science research in international health from focused ethnographies in Asia and other settings are presented.

ADDRESSING THE CHALLENGE OF MALARIA CONTROL IN ETHNIC MINORITY COMMUNITIES: A MEKONG PERSPECTIVE.

By the Mekong Team on Ethnic Minorities[1]

Presented by Pricha Petlueng, WHO Laos.
E-mail : Petluengp@lao.wpro.who.int

Introduction

Malaria mortality and morbidity rates in the Greater Mekong Subregion (GMS) in 2005 were reduced at least by 50% compared to 1998. While the reported incidence declined, there are still challenges for national programs in addressing operational gaps. Of primary concern are people who live in remote areas, particularly poor ethnic minorities, migrants and forest workers that still remain at risk of malaria. In order to deliver effective malaria prevention and control to these populations, a shift from facility-based to community-based approaches may be needed. In 2006, the Asian Development Bank (ADB) and World Health Organization Western Pacific Region Office (WPRO) embarked on a project "Strengthening Malaria Control for Ethnic Minorities in the GMS" with the aim of strengthening national capacity in identifying strategies to expand malaria prevention and control programs to include ethnic minority groups (EMGs) and make recommendations for a regional approach to reach these groups.

Project interventions and findings

To date, the project has adopted eight different EMGs from six countries in the GMS. Village volunteers, selected by EMG communities in these countries, were trained to deliver intervention packages that included free distribution of insecticide treated bednets (ITN), impregnation of bednets with insecticide; early diagnosis and treatment with rapid diagnostic test (RDT) or blood smear and artemisinin-based combination therapy (ACT) or other anti malaria drugs based on national policy. Preliminary results from country-level monthly monitoring data show that the malaria situation in the targeted villages has improved. Malaria positivity rates compared with baseline data show a decrease from 62% to 38% in Cambodia; from 15% to 12% in Lao PDR; from 15% to below 1% in Thailand; and from 7% to 3% in Yunnan Province, China. The bednet utilization rate has increased in all countries, for example: from 62% to 100% in Cambodia; from 16% to 78% in China; from 89% to 96% in Lao PDR; and from 92% to 98% in Vietnam.

[1] Members are: National malaria control programme managers: Dr Duong Socheat, Cambodia; Dr Tang Linhua, China; Dr Samlane Phompida, Lao PDR; Dr Than Win, Myanmar; Dr Wichai Satimai, Thailand; Dr Le Khanh Thuan, Viet Nam; Project focal points: Dr Boukheng Thavrin, Mr Xu Jianwei, Dr Soudsady, Dr Myat Kyaw, Ms Kesanee Kladphuang, Dr Trieu Nguyen Trung and Dr Trung Van Co; WHO: Dr Eva Maria Christophel, Dr Tran Cong Dai, Dr Charles Delacollette, Dr John Ehrenberg, Dr Deyer Gopinath, Dr Kevin Palmer, Dr Leonard Ortega, Mr Pricha Petlueng, Dr Abdur Rashid; ADB: Barbara Lochmann; External expert: Ms Jane Bruce.

Discussion and recommendations

At this stage, the following suggestions could be considered to further strengthen national control programmes and to expand control interventions to poor ethnic communities:

1. promote advocacy among decision-makers at local and national level; this is the key to programme expansion and sustainability;
2. enhance collaboration among GMS member countries to highlight the need for better malaria control among remote and migrant populations;
3. integrate village volunteer support into the national health system to strengthen community malaria control activities;
4. explore alternative malaria control / personal protection interventions for better prevention among marginalized populations who stay overnight in the forest or field huts;
5. strengthen monitoring and supervision activities to increase effective malaria control measures;
6. improve overall malaria control and prevention interventions by strengthening capacity of national control programme staff;
7. reallocate budget from national to provincial and district levels, if necessary, to cover higher unit costs;
8. provide incentive packages for village volunteers , where necessary, to mobilize and sustain community-based control activities;
9. train VHVs to incorporate communication skills in educating and mobilizing communities for malaria prevention and control;
10. Utilize operational budgets from local administrative offices in Thailand and Viet Nam to play an important role in malaria prevention and control;
11. Gain support from various malaria partners at all levels to sustain the intervention.

SOCIAL FACTORS RELATIVE TO THE PERSISTENCE OF MALARIA TRANSMISSION IN DAK RONG AND HUONG HOA DISTRICTS IN QUANG TRI PROVINCE.

Doan Hanh Nhan, N.Q. Anh, N.T.ien, P.T. Xuyen, L. K.Thuan. M. Morrow, B.A. Bigis.

Affiliation: National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam.
E-mail: hanhnhan@netnam.vn

Despite many efforts in Malaria control activities, malaria transmission is still persistent in HuongHoa & DaKrong districts of QuangTri province. This study has found major reasons regarding malaria persistence.

According to results of studies in 6 communes (LaoBao, Thanh, A Tuc, Dakrong, TaLong, A Bung), 2 Viet-Laos border districts (Huong Hoa & DaKrong) in Quang Tri province, the persistence of malaria transmission in Huong Hoa & DaKrong districts occurred throughout the year and was at high levels in September, October, November. Annual parasite rates (1997-2006) varied from 30%-79%, most of them were *P.falciparum* (95%). Malaria patient rates were found from 60% - 82% of total of malaria cases in the province. Malaria index/1000 residents per year (1996-2006) was always 3,7- 4,5 folds higher than that of Quang Tri province. Especially in Viet-Lao border communes, malaria index was high (98%o Thanh, 30.8%o in Lao Bao, 57%o in DaKrong, 52%o in A Tuc)

Malaria remains and spreads over the 2 districts due to the co-relation between human-mosquito-parasite in the suitable environment and social conditions. Some social factors relative to the persistence transmission in the 2 districts show that:

1. Migration & Cross–Border mobility and exposure to malaria
Interviews in 6 communes show that 84% of the population work in the forest, 57% in villages close to the forest, 10% stays overnight in the forest without bed nets. In 9 months of 2006, the number of migrants raised to 5.036 persons in Huong Hoa district and all were much exposed to malaria.
In the 2 districts there are 16 communes, 59 villages along the Vietnam- Laos border. People usually cross the border. In 9 months of 2006, 2801 peoples crossed the border. The Pako and Vankieu ethnic groups live at both side of the border and visit their relatives every year. They stay for at least one week in the host family and in most of the cases, they do not bring along their bed-net. Laotian people cross to take malaria treatment in CHS, because they can get drugs free of charge. About 36% of total malaria patients (231/632) in the Huong Hoa district were probably infected in Laos.

2. Weakness in bed-net use.
The percentage of bed-net use varies from 60 to 80%. People still don't want to use bed-net. Observation of net use in the evening (9pm-11pm) showed 73 % of nets are used. We see that all households have bed-nets and half of them have enough nets, but cultural habits do not allow sleeping together. Consequently, they usually say they lack nets. In each household, the children are given priority to use bed-net, then the women, and man. The people who often cross the Vietnam-Lao border and go into the forest do not take the bed-net in their luggage.

3. Inappropriate treatment and anti malaria drugs use:
Most of people when get sick, go to health service people, including VHW (38%), CHS (60%)and hospital (10%) and 2.5% does not.

VHW: They go to VHW ask for medicines. VHWs diagnose based on symptoms and temperature and take blood slide if they think malaria is involved. VHWs use chloroquine (CHL) and artesunate (AS) tablets, without gametocytocidal drugs. They give anti-malaria drug based on fever; under dosage occurs. Drugs consumption is higher for VHW than in CHS.

CHS: In most of the cases, when going to CHS, they had diagnosis based on the symptoms and temperature and a thick film is made. They give the first dose and patients return every day to CHS to complete the treatment. They do not use primaquine for clinic cases, artesunate based treatment are under dosed.

4. Residents
Almost all people in 6 study communes belong to Van Kieu or Pako ethnic groups. Most of them have low level of education: 59% illiteracy, 19.4% primary school attendance, 21.2% secondary school attendance, 80% illiteracy among women in Van Kieu ethnic, 36 % illiteracy among men. Most of households are poor, and 60% of them get the “poorest household book” from local government.

5. Management, health service provision to malaria control in CHS:
There is no medical doctor in most of the communal health stations, the health staff are mainly assistant doctors or nurses. According to respondents, there lacked health staff in the communes, and community management for the control of malaria.

Poster Session on Social Approaches

LOW RISK PERCEPTION OF CONTRACTING MALARIA AMONG THE RAGLAI ETHNIC MINORITY GROUP LIVING IN THE FOREST AND MOUNTAINOUS AREAS OF NINH THUAN PROVINCE, VIETNAM.

Nguyen Xuan Xa[1], Koen Peeters[2], Annette Erhart.A[3], Joan Muela Ribera[2] Le Xuan Hung[1], Umberto D'Alessandro[3], Ngo Duc Thang[1].

Affiliation: 1. National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam. 2. Partners for Applied Social Sciences. PASS International. 3. Institute of Tropical Medicine, Antwerp, Belgium
E-mail: ngxxa@yahoo.com

The vulnerability to contract malaria was researched among the Raglai ethnic minority population living in the forest and mountainous areas of Ninh Thuan province, South-central Viet Nam, one of the areas with highest incidence rates in the country. Results show that despite the burden of malaria the disease identified as such hardly has a perceived impact on Raglai forest farmers' daily live. In spite of the general awareness that mosquitoes transmit fever (84.2%), very few people actually know when they get malaria as patients and their families (77,9% of respondents) are unaware of the specific kind of fever they have had and its cause. Only 38,30% of the population stated ever to have had a fever due to mosquito biting. This is further reinforced by the fact that only 15.7% of the total population acknowledged the higher risk of contracting malaria in the forest than in the village and that perceived mosquito biting times only partially coincide with the results of *An. dirus* and *An. minimus* mosquito collections. This lack of concrete knowledge assuredly creates a low level of risk perception and susceptibility to malaria and reduces the necessity to sleep protected. Findings have important implications for health education and general malaria control policies.

MEDICAL ANTHROPOLOGY STUDY ON MALARIA CONTROL AMONG WA ETHNIC MINORITY GROUP IN XIMENG COUNTY, YUNNAN PROVINCE.

Xu Jianwei
Affiliation: Yunnan Institute of Parasitic Diseases, China
E-mail: xjw426@163.com

Objectives: To explore factors of medical anthropology related to malaria control among Wa ethnic minority in Ximeng County, Yunnan Province.

Methods: The study was conducted by the combination of anthropology and epidemiology using qualitative and quantitative methods.

Results:
Wa people considered malaria as one of three major diseases in the community. In Wa ethnical language, the word of malaria, ¡s Saihui¡ (Sai for illness and pain, Hui for being attacked quickly). Fever is often not considered to be the main symptom of malaria. Most of Wa people only know vivax malaria, but not falciparum malaria. Only 32.7% of people could connect malaria with mosquitoes, and a few of them could confirm mosquitoes as the only malaria vector. The proportions of sound knowledge of malaria causes, prevention and treatment seeking were lower than 25%. As a result of multivariate logistic regression, 3 kinds of malaria knowledge were closely correlated to each other. The connection between causal knowledge and prevention (adjusted OR: 36.610, 95%CI: 10.242-130.866, P<0.001)] is stronger than that between treatment seeking and causes (adjusted OR: 4.013, 95%CI: 1.020-15.787, P<0.05). The bednet coverage was extremely low in Wa communities. Multivariate logistic regression confirmed the relationship between bednet use and knowledge of malaria prevention. Sick villagers look first for self-medication by using herbs or medicines from drug store, and seek standard treatment only after self-medication failure. Inappropriate treatment seeking and low bednet use were attributed to poor access to facilities (economically and geographically) and health education.

Conclusion:
Poor accessibility is one of reasons that malaria can not be controlled effectively. Improving accessibility of health service through both public and commercial means is one of the strategies of effective malaria control among Wa ethnics.


MEKONG MALARIA

SESSION 11:

Monitoring and evaluation

ACCURACY OF THE HEALTH INFORMATION SYSTEM ON MALARIA SURVEILLANCE IN VIETNAM.

Annette Erhart[1], Ngo Duc Thang[2], Nguyen Xuan[2], Nguyen Quang Thieu[2], Le Xuang Hung[2], Nguyen Quoc Hung[3], N.V. Nam[4], L.V. Toi[4], N.M. Tung[5], T.H. Bien[5], Tran Quoc Tuy[2], Le Dinh Cong[2], Le Khanh Thuan[2], Marc Coosemans[1], Umberto D'Alessandro[1].

Affiliation: 1. Institute of Tropical Medicine, Antwerp, Belgium. 2. National Institute for Malariology, Parasitology and Entomology, Hanoi, Vietnam. 3. Institute for Malariology, Parasitology and Entomology, Ho Chi Minh city, Vietnam. 4. Malaria and goitre control center of Binh Thuan province. 5. Provincial Malaria Station of Bac Lieu province, Vietnam.
E-mail: aerhart@itg.be

The health information system (HIS) is a key component of control programs and its accuracy is necessary for the assessment of disease risks, the formulation of priorities and the evaluation of the cost-effectiveness of different interventions. In order to assess the quality of the HIS in estimating malaria morbidity in Vietnam, we compared data obtained by a 2-year active (ACD) and passive case detection (PCD) study with those routinely collected at the local commune health centres (CHC) in 3 sites having a different malaria epidemiology. The majority of malaria cases (80% to 95%) detected by ACD were missed by the HIS. Similarly, most malaria cases (50% to 90%) detected by PCD were also missed by the HIS, and this was proportional to the number of active private practitioners. Reasons for this low sensibility are low CHC attendance, high attendance to private health facilities, widespread self-medication and attendance to central health facilities. In conclusion, although malaria has sharply decreased in Vietnam over the past 10 years, the current HIS greatly underestimates the malaria burden. Involvement of the private sector and the establishment of sentinel sites might improve the quality of data and the relevance of HIS in malaria control.

PILOTING OF A STRATEGY FOR COLLECTION OF MALARIA INFORMATION FROM THE PRIVATE SECTOR IN CAMBODIA.

Kheng Sim

Affiliation: National Centre for Parasitology, Entomology and Malaria Control/ Ministry of Health, Cambodia
E-mail: khengsim@cnm.gov.kh

Background
Malaria continues to be a leading cause of mortality and morbidity in the Kingdom of Cambodia. There are no nationally representative data on the incidence of malaria or burden of disease estimates. Currently the monitoring and evaluation (M&E) of malaria program is essentially based on the health information (HIS) recorded through the fixed pubic health facilities. Most of the malaria therapy in Cambodia takes place in the commercial sector, with malaria medicines procured by patients and care providers through local grocery shops and pharmacies However, since around four-fifths of those affected by malaria seek care from facilities and providers outside the public health system in the country, CNM is acutely aware that exclusive reliance on HIS for making programmatic M&E may lead to erroneous conclusions. CNM therefore conducted a pilot strategy supported by The GTZ BACKUP Initiative for collection, compilation and analysis of malaria related information from the private sector in 4 provinces with duration of one year (February 2005- January,2006).

Methods
Private practitioners in selected 4 provinces enrolled in pilot survey. A user-friendly format designed, tested and finalised in order to enable the private practitioners in the project area to record malaria cases and deaths. Formats for compiling the information from the private practitioners have also developed and tested before adoption. Suitable training curriculum with a focus on national treatment gudielines, recording of information and dissemination of health education to patients and their families designed and field tested. After the collection of data for a period of 6 months, a review and evaluation process had taken place involving key stakeholders of the malaria control program in Cambodia. Project report, strategy document finalised in January 2006.

Results
A highly satisfactory finding was that either microscopic diagnosis (52.6%) or RDT diagnosis (45.3%) was being carried out by the project PPs as against the 2002 drug use practice survey finding that more than 60% of market and village providers offered no blood tests for malaria. Similarly at least 60% of the malaria cases received ACTs from the project PPs, significantly higher than the 11% of adults who received ACTs in the 2002 drug use practice survey.

Conclusions
The GTZ BACKUP Initiative supported pilot project has demonstrated that the approach adopted by CNM in working with the private providers has indeed worked well in the 4 pilot provinces. All the trained PPs filled and maintained the registers provided to them. A total of 10,722 cases were recorded in the 4 project provinces during the one year period by the 199 trained PPs and based on a comparison with the data for the corresponding period from all the public health facilities in these provinces, it may be overall inferred that the crude ratio of malaria cases in the public and private sector is approximately 1:2 *(*i.e. *at least twice* the number of cases reported in the public health sector, appear to be seeking treatment from the private sector).

PRIVATE HEALTH SECTOR IN MALARIA CONTROL IN VIETNAM.

Doan Hanh Nhan

Affiliation: National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam.
E-mail: hanhnhan@netnam.vn

In Vietnam, private health activities emerged in the 1980s and developed rapidly over the past 10 years covering almost the whole country. Services include private clinics and private pharmacies, and the staff, medical doctors, assistant doctors, pharmacists of high degree and assistant pharmacists. Many of them are government staff doing their private practice at non-office hours. The emergence of this health care sector was born from the social demand and became legal by the State decrees and regulations. Though the Government provides free of charge medical care to the poor people, the private health services is still favourable due to its availability, conveniences, and readiness.

The private health sector was reported to largely participate in malaria control since its emergence: diagnosis, treatment, sale of anti-malarial drugs, but mainly with substandard services and medicine. Inspection surveys were made by the National Malaria Control Program and National Institute of Malariology, Parasitology & Entomology to investigate and evaluate the real situation of the private health sector's involvement in malaria management. The services of the private health sector were found to have many problems: incorrect diagnosis and treatment of malaria due to the low malaria knowledge of the practitioners; sale of substandard, counterfeit or fake anti-malarial drugs. Findings of these surveys helped make the new policies on management of private health participation in malaria control. The private practitioners have been trained on malaria management. As a result, the quality of the health sector participation in malaria control was found to be improved.

As the network of the public malaria control services has been much improved over the country, the role of private health sector in malaria treatment is reducing. However, its further participation in malaria control is still necessary, and therefore it needs to be better organized in management, training and retraining on malaria control.

IDENTIFYING KEY INDICATORS FOR MONITORING AND EVALUATION OF THE ACTIVITIES AND IMPACT OF THE MALARIA CONTROL PROJECT IN VIETNAM.

Le Xuan Hung, Le Khanh Thuan, Nguyen Manh Hung, Nguyen Quang Thieu et al

Affiliation: National Institute of Malariology, Parasitology and Entomology, Hanoi, Vietnam.

E-mail: lxhung1952@yahoo.com

The Vietnam National Malaria Control Program (NMCP) has gained great achievements during the recent years. However, the NMCP still has to face big challenges such as populations movements from non endemic to malaria endemic areas and to the forest, high percentage of drug resistance in some areas, low economic and education status of the population, and difficult access to the health services in remote areas. Thus, the risk of malaria resurgence is very high particularly in the remote and mountainous areas. To continue to roll back malaria in Vietnam, the NMCP has been supported by the Global Fund with the objective to consolidate and sustain the achievements of the last decade and to decisively roll back malaria in the remaining high risk areas. A set of key indicators has been developed as a basis for monitoring and evaluation of the project activities. In order to have baseline data before project implementation, the data should be collected from different sources: malaria information system (MIS), individual, household and health facility surveys. Therefore, a baseline survey have been conducted in the project provinces and from province to commune levels.

In 2004-2005, a baseline survey was carried out in 30 districts representative for 23/64 provinces, 180 commune health facilities, 29 districts & 23 provincial hospitals and 5,400 households. This survey aimed at identifying the key indicators for monitoring and evaluation of the project activities/impacts. A set of key indicators were set up based on the different objectives of the programme:

- To improve access to early diagnosis and treatment of malaria for people in remote areas,
- Improve access to good vector control measures and improve malaria prevention among people,
- Develop and implement specific interventions targeting migrants to malaria endemic areas and malaria prevalence in hotspots

The results of the survey showed that:

- The malaria parasite infection rate was very low (the SPR was 0.61%). One of the reasons was that the cross-sectional survey was conducted in late dry season, when the number of malaria cases in all localities was lowest in the year, so it was difficult to find positive cases;
- The rate of patients with fever consulting health facilities was 89% and proportion of them receiving diagnosis by slide reading or rapid tests (RDTs), 22%;
- Over 95% of the households had bednets, however only 57% had a sufficient number of nets, and even less (35.7%) in the poor communes. 69% of the existing nets had been bought by their owner;
- 65% of the total existing bednets had been impregnated with insecticide in the previous year. In 2004, indoor residual spraying (IRS) had been applied to about 25% of the households;
- People were regularly using bednets in 91% of the total households surveyed, and 68.5% of the people interviewed were sleeping under ITNs

- 66.1% of the total interviewees knew at least 2 key messages about malaria and its control measures (malaria caused by mosquitoes and sleeping under a bednet can prevent from malaria);
- The proportion of pregnant women receiving IPT was very low, almost none of those consulting antenatal care were given IPT;.
- About 71% of health facilities had adequate diagnosis equipment/supplies for malaria examination (microscope and other necessary supplies), and 97.8% of the CHCs had necessary supplies for taking blood slides. Only a small proportion of the CHCs had rapid tests.
- 58% of the health facilities used artemisinin based combination therapy (ACT) as first line treatment. In total, 48.5% of the *P.falciparum* cases were treated with ACT.

RESOURCE SHARING AND COMMUNICATION: SERVING THE NEEDS OF THE MALARIA CLIENTELE.

Joseph Yap

Affiliation: ACTMalaria, Pillipines.
Email: joseph.yap@actmalaria.net

The Asian Collaborative Training Network for Malaria (ACTMalaria) has been recognized in the region for its collaborative efforts through inter-country and cross-border relationships with its ten member countries. Previously based in Thailand and now in the Philippines, it has been running for ten years and is still growing and developing to provide networking, capacity building, resource sharing and training. The aspect of resource sharing has evolved and to make things better and organized, the AIRC or ACTMalaria Information Resource Centre has been launched in 2005. This project, previously known as Mekong Malaria Documentation Centre (MMDC) was started by Dr. Carlo Urbani but due to unforeseen events, it vanished. After an assessment by Healthlink, the project was restarted and is now transferred under the responsibility of ACTMalaria. Its primary purpose is to collect all possible materials related to the malaria situation in the Mekong Region and upload it on the database or seek authors or users that can also share their resources online. This presentation will tackle the history, importance and application of creating a networked database of malaria information for the malaria professionals in Asia and in the world.


MEKONG MALARIA