Vector control and personal protection of migrant and mobile populations in the GMS: A matrix guidance on the best options and methodologies

World Health Organization
Regional Office for South-East Asia

SEA-MAL-280

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The publication of this document was supported by the Australian Government and the Bill & Melinda Gates Foundation.

Printed in India

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Acronyms

ATBS	Attractive toxic sugar baits
BCC	Behaviour change communication
DIY	Do-it-yourself
DWL	Durable wall lining
ERAR	Emergency response to artemisinin resistance GMS Greater Mekong Subregion
IEC	Information, education and communication
IRS	Indoor residual spraying
ITK	Insecticide treatment kit
ITMs	Insecticide-treated materials
ITNs	Insecticide-treated nets
KAP	Knowledge, attitudes and practices
LLINs	Long-lasting insecticidal nets
LLIHN	Long-lasting insecticidal hammock nets
LSM	Larval source management
MMPs	Mobile and migrant populations
MARL	Most-at-risk location
MARP	Most-at-risk people
MPAC	Malaria Policy Advisory Committee
MOH	Ministry of Health
NMCP	National Malaria Control Programme
PPE	Personal protective equipment
VBDCP	Vector-Borne Diseases Control Programme

Glossary

Anthropophagy	Feeding on humans
Arthropod	An invertebrate animal having an exoskeleton (external skeleton), a segmented body and jointed appendages
Endophagic; endophagy	Feeding indoors by endophilic mosquitos
Endophilic; endophily	Tendency of insects (especially female Anopheles mosquitos of some species) to come into houses for biting nocturnally and resting diurnally (opposite of exophily)
Exophagous; exophagy	Behavioural tendency of biting insects (e.g. female mosquitos) to bite hosts outdoors
Exophilic; exophily	Tendency of insects to stay outside buildings (in contrast to endophily of the female Anopheles malaria vector that enter houses to bite and take shelter)
BCC	Behaviour change communication. The strategic use of communication to promote positive health outcomes which are based on proven theories and models of behaviour change
Insecticide resistance	A heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species (IRAC definition)
IRS	Indoor residual spraying is the application of a long-lasting, residual insecticide to potential malaria vector resting surfaces such as internal walls, eaves and ceilings of all houses or structures (including domestic animal shelters) where such malaria vectors might come into contact with the insecticide
ITMs	Insecticide-treated materials. Examples include treated bednets, curtains, clothing, blankets, bed sheets, vests, plastic sheeting and screens
ITNs / LLINs	Insecticide-treated mosquito nets/Long-lasting insecticidal nets
LLINs	Mosquito nets made from strong fibres impregnated with a quick-acting pyrethroid insecticide, which irritates or kills mosquitos on contact, for a period of up to three years from treatment
Leishmaniasis	A tropical and subtropical disease caused by leishmania protozoa and transmitted by the bite of sandflies. It affects either the skin or the internal organs

LSM	Larval source management is the management of aquatic habitats (water bodies) that are potential larval habitats for mosquitos in order to prevent the completion of development of the immature stages. There are four types of LSM: Habitat modification, Habitat manipulation, Larviciding, Biological control
Personal protection	Prevention of contact between the human body and disease vector
Phlebotomine sandflies	The Phlebotominae include many genera of blood-feeding (hematophagous) flies, including the primary vectors of leishmaniasis, bartonellosis and pappataci fever. In the New World, leishmaniasis is spread by sand flies in the genus Lutzomyia. Lutzomyia commonly live in caves, where their main hosts are bats. In the Old World, sandflies in the genus Phlebotomus spread leishmaniasis
Pyrethroids	Numerous synthetic organic compounds, mostly based on the chrysanthemate moiety of pyrethrum, having analogous neurotoxic modes of action causing rapid knockdown and insecticidal effects
Repellent	For insects, something that causes insects to make oriented movements away from its source
Residual malaria transmission	All forms of transmission that can persist after achieving full universal coverage with effective LLINs and/or IRS containing active ingredients to which local vectors are fully acceptable
Sporozoite rate	The proportion of sporozoite-infective mosquitos (in percentage) of total dissected or assayed
Synthetic	Chemical compound made by human directed process, as opposed to those of natural origin; the same material may be produced naturally or synthetically
Vector	Carrier of infection. Vector-borne pathogen cause disease; e.g. Plasmodium causes malaria, transmitted by vector Anopheles mosquito
Vector control	Vector control is any method to limit or eradicate the mammals, birds, insects or other arthropods that transmit disease pathogens. The most frequent type of vector control is mosquito control using a variety of strategies
Vector control tool (VCT)	Intervention that reduces the ability of an insect vector to transmit diseases

WHOPES	World Health Organization Pesticides Evaluation Scheme, responsible for assessments, specifications and recommendations for pesticides (including repellents) used for public health and vector control, on behalf of Member States of the United Nations (UN) (http:www.who.int/whopes.en)
Zoophagy; zoophily	Tendency of hematophagous insects to bite or prefer hosts other than humans (c.f. anthropophagy, anthropophily)

1. Introduction

1.1 What is vector control?

Vector control is any method to limit or reduce the arthropods that transmit disease pathogens. The most common type of vector control is mosquito control through a number of core and supplementary strategies, of which indoor residual spraying and long-lasting insecticidal nets are the most broadly applicable.

Vector control tools suitable for the community should:

- be effective;
- be affordable;
- use equipment and materials that can be obtained locally;
- be simple to understand and apply;
- be acceptable and compatible with local customs, attitudes and beliefs;
- be safe to the user and the environment.

1.2 What is personal protection?

Personal protection against mosquito bites remains the first line of defence against malaria. Measures to recommend include:

- avoiding outdoor exposure between dusk and dawn;
- wearing long, loose clothing after dusk, preferably in light colours;
- avoiding perfumes and colognes;
- using effective insect repellents, for example, products containing up to 20% DEET or picaridin;
- using knock-down sprays, mosquito coils, or plug-in vaporising devices indoors;
- using mosquito nets, preferably pretreated with an appropriate insect repellent.

There is no drug that is completely safe and completely effective for prophylaxis against malaria.

1.3 Who are mobile and migrant populations (MMPs) and why provide them vector control and personal protection?

Numerous situations exist where, through a combination of human and mosquito behaviour, malaria vector species are able to maintain malaria parasite transmission despite high coverage of quality insecticide-treated nets (ITNs), long-lasting insecticidal nets (LLINs) and/or indoor residual spraying (IRS)[1] and susceptibility of mosquitos to insecticides. Such vector species include Anopheles arabiensis in Africa,[2] An. dirus, An. minimus, secondary vector species in

South East Asia,[3,4] and An. darlingi in the Americas,[5] which display early biting, exophily and endophagic behaviours. Individuals who spend time outdoors between dusk and dawn are at risk of acquiring malaria due to a lack of effective anti-vector tools designed specifically to prevent outdoor (or what is referred to here as "residual") transmission.[6]

The term residual transmission is defined as all forms of transmission that persist after universal coverage has been achieved with effective LLIN and IRS interventions. This residual transmission occurs because the human population may be outside, away from the house (for occupational or other reasons), in a situation where LLIN use or IRS is not practical, and during a time when malaria vectors are most active. Residual transmission may also occur when local mosquito vector species exhibit one or more behaviours that allow them to avoid the core interventions, including:

1. Feeding outdoors (exophagy), which attenuates personal protection and any potential for community-wide protection provided to humans sleeping under LLINs or in houses treated with IRS;
2. Resting outdoors (exophily), which precludes contact with insecticide-treated surfaces of LLINs or walls and roofs treated with IRS;
3. Insecticide contact avoidance and early-exit behaviours that minimize exposure of indoor feeding vectors;
4. Preference for feeding upon animals rather than humans (zoophagy), allowing mosquitos to minimize contact with LLINs and IRS targeted at humans and their dwellings.

Despite a significant reduction in malaria through the successful scaling-up of LLIN and IRS activities, national malaria control programmes (NMCP) still face the challenge of persistent, residual transmission.

1.4 Outdoor malaria transmission and MMP; why are control tools needed?

In the Greater Mekong Subregion (GMS), migration is characterized by mixed flows, comprising diverse groups moving for a variety of reasons.[7] While there is no single or clear definition of mobile and migrant populations (MMPs), they can be broadly grouped into three classes of mobile groups:

1. affiliated to employer, including semi-mobile employees and seasonal farm workers;
2. affiliated with the government, including military, security personnel, and border guards;
3. nonaffiliated, including ad hoc labourers, new settlers, highly mobile labourers and short-term migrants.[8]

Box 1: Why provide vector control and personal protection to MMPs?

A significant reason MMPs require vector control and personal protection is because their labour or other practices may increase their exposure to malaria mosquitos, such as nighttime work (e.g. in a rubber plantation) or overnight trips to forested areas (e.g. for hunting). Overall, MMPs are more likely to have incomplete knowledge of malaria and lower access to preventive measures, and thus require targeted interventions that take into account their specific needs and the nature of their situation. From the broader public health perspective, it is also important to target MMPs and their host communities with vector control measures given the well-documented link between migration and the spread of malaria in the GMS, particularly in border areas, and the potential spread of artemisinin resistance due to population movements in malaria-endemic areas and across borders.

2. What are the inputs required from health services and communities?

Figure 1: Inputs required from health services and communities for vector control and personal protection.[11]

Requires high community input		Requires low health service input
	Simple, inexpensive self-protection methods, requiring the active participation of the whole community. **Examples:** ITNs/LLINs and treated curtains,[9] house improvement by sealing openings and eaves with mosquito netting[10] Simple, moderately expensive personal protection methods, requiring the active participation of individuals with guidance **Examples:** Do-it-yourself (DIY) treatment of clothing or conventional bednets, topical repellents Tools requiring equipment, trained personnel, and financial and technical involvement of the community **Examples:** insecticide spraying of house walls, refugee tents, installation of durable wall lining in rooms Methods for the elimination of malaria requiring high investment for a limited period by the health service under the guidance of vector control specialists **Examples:** smallpox eradication; Onchocerciasis Control Programme in West Africa, malaria eradication programmes during the 1960s and 1970s Emergency control methods, requiring intense action by health services assisted by vector control specialists **Examples:** space spraying with insecticides to control outbreaks	
Low		**High**

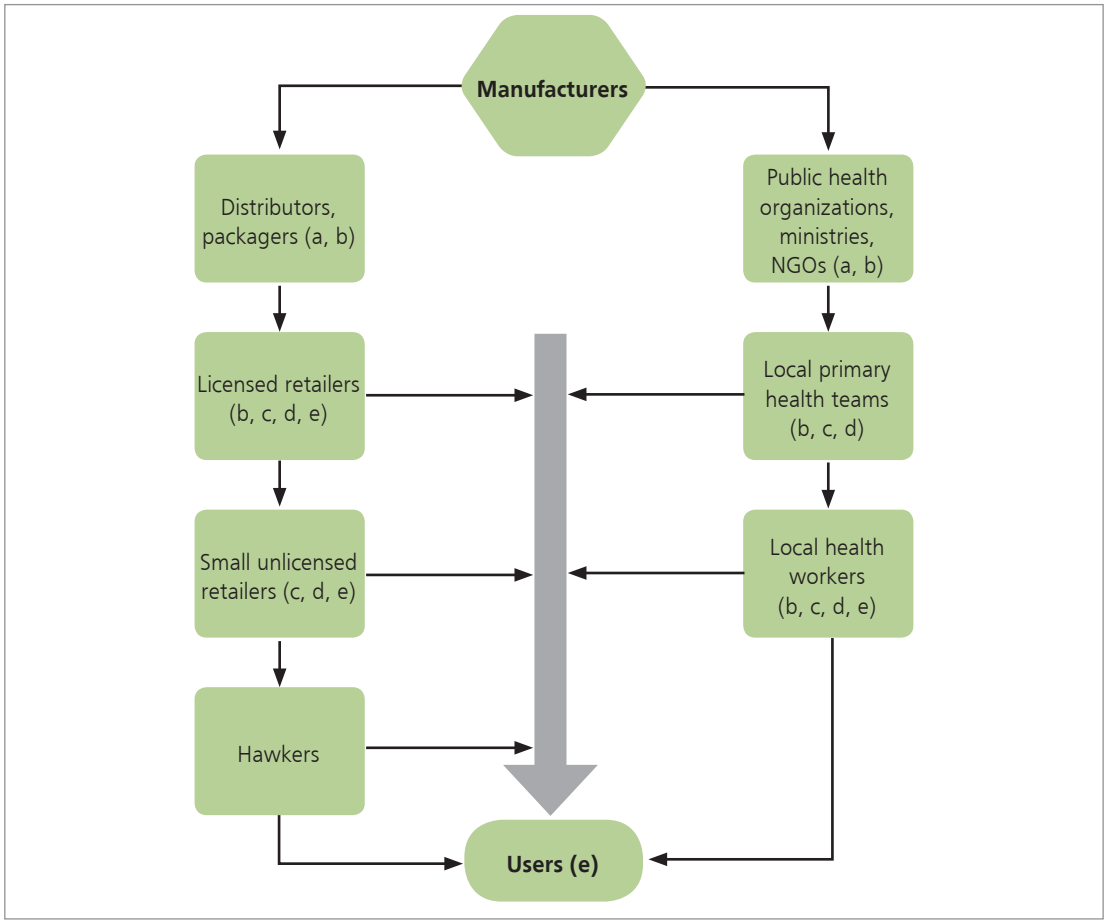
2.1 If the inputs required are simple, inexpensive self-protection methods, requiring the active participation of the whole community: What can they do and what might be useful?

Untreated bed nets – types, where they can be used and why they are needed

Where people are using or buying conventional nets, regular re-treatment on an annual basis is required, as the insecticide wears off. Two kinds of people are likely to take part in this

process: business people – including importers, wholesalers and retailers – and the staff of public health and community development organizations (Figure 2).

Figure 2: The two major routes by which insecticide to bednet treatment could be conveyed from manufacturer to user: (a) packaging, distributing, preparing information; (b) bulk impregnation of bednets; (c) selling and distributing treated bednets; (d) selling and distributing dip-it-yourself kits (sachets); (e) impregnating individual bednets.[12]



Several WHOPES-recommended insecticides are shown in Box 2.[13]

In the GMS, there is a functioning private sector market system that is working to get nets to people who are prepared to purchase them. To overcome the problem of nonavailability or lack of ITNs, insecticides used for conventional or long-lasting treatment of bednets or curtains (Box 2) are accessible in the market and can be distributed in the following ways:[12]

- Pre-treatment: an initial treatment is applied at the factory, warehouse or shop before the nets are transported, distributed or sold.
- Coordinated treatment: The nets or curtains of whole community are treated and re-treated all together in an operation organized and supervised by trained people.

- Individual treatment: Owners decide when their nets or curtains need re-treatment and bring them to a shop or health facility to be treated by trained staff.
- Home treatment: Owners treat their own nets and curtains at home with small quantities of insecticide packaged for domestic use.

Box 2: WHOPES-recommended insecticide products for the treatment of mosquito nets for malaria vector control (WHO, 2014)

Conventional treatment

Insecticide	Formulation[1]	Dosage[2]
Alpha-cypermethrin	SC 10%	20-40
Cyfluthrin	EW 5%	50
Deltamethrin	SC 1%; WT 25%; and WT 25% + binder[3]	15-25
Etofenprox	EW 10%	200
Lambda-cyhalothrin	CS 2.5%	10-15
Permethrin	EC 10%	200-500

Long-lasting treatment

Product name	Product type	Status of WHO recommendation
ICON® MAXX	Lambda-cyhalothrin 10% CS + binder Target dose of 50 mg/m2	Interim

1. EC = emulsifiable concentrate; EW = emulsion, oil in water; CS = capsule suspension concentrate; WT = water dispersible tablet.
2. Milligrams of active ingredient per square metre of netting.
3. K-O TAB 1-2-3®

Note: WHO recommendations on the use of pesticides in public health are valid ONLY if linked to WHO specifications for their quality control. WHO specifications for public health pesticides are available on the WHO homepage on the Internet at *http://www.who.int/whopes/quality/en/*.

Although an untreated net should provide a complete physical barrier to mosquitos, in practice, even intact, tucked-in nets offer only partial protection; mosquitos quickly find any body part touching the net or inadvertently left uncovered. ITNs affect mosquitos in several ways (Box 2).[14]

Insecticide-treated nets (ITNs)

When used correctly, ITNs can offer a protective effect at both the individual and community level, as explained in Box 3. For the successful implementation of an ITN programme, planners need to ensure that enough treatment kits are available for persons in need, and information required for planning promotional activities is considered (Annex 1). Home treatment kits with small quantities of emulsifiable or suspension concentrates are available in the market and in public health programmes for treatment of conventional nets for home use.

Box 3: Individual or community protection with ITNs

Insecticide treatment extends the useful life of a net. ITNs avert around 50% of malaria cases, making protective efficacy significantly higher than that of untreated nets, which, under ideal conditions, usually provide about half the protection of nets treated with an effective insecticide. Personal protection against mosquitos is an individual gain and is all that can be expected when an ITN is used in isolation. ITNs kill some of the mosquitos that come to bite, however, and this can produce a bonus for the whole community. When many people in a village use ITNs, marked reduction have sometimes been seen not only in the numbers of the local mosquito population but also, and especially in the sporozoite rate. This kind of "mass effect" does not always occur, but when it does, it benefits everyone in the village. Individual treatment, on the other hand, may be essential to the development of a viable domestic market in ITNs and will make public health operations more flexible, especially for MMPs.

Long-lasting insecticidal nets (LLINs)

National and international regulatory authorities are responsible for ensuring that minimum safety standards are met throughout manufacture, distribution and use of insecticide-treated materials (ITMs). This involvement includes approving the specifications of insecticide formulations and packaging and registering trademarked products. It may also include a retail licensing system and inspections to check storage and handling practices, to prevent adulteration and to ensure minimum standards of training.

Where LLINs are available or where there are only institutional sales of LLINs to government, the specific consumer needs to be defined. Assuming MMPs place a high enough value on ITNs to switch to a higher cost, lower specification LLINs (limited in colour, size and material), there are currently 11 WHOPES LLINs to choose from (Box 4). The stakeholders involved in the distribution system of LLINs would be quite similar to that shown in Figure 2.

Insecticide resistance management strategies

Pre-emptive action: use non-pyrethroid LLINs when they become available[15]

As soon as they become available, nets with non-pyrethroid active ingredients should be used in areas with confirmed insecticide resistance. Guidelines are needed to address incorporating LLINs treated with non-pyrethroids into existing LLIN programmes.[16] The current pipeline indicates that non-pyrethroid and bi-treated LLINs may become available in the shorter term (the next three to five years) and LLINs with new active ingredients in the longer term (the next seven to 10 years). As there is no strategic guidance and development of insecticide treatment kits (ITKs) for insecticide resistance, programmes should continue to use pyrethroid-based LLINs and assess susceptibility status when determining additional actions.

Box 4: WHO recommended LLINs[14]

Product name	Product type	Status of WHO recommendation	Status of publication of WHO specification
DuranetPlus® 2.0	Deltamethrin coated on polyester	Interim	Published
Duranet®	Alpha-cypermethrin incorporated into polyethylene	Full	Published
Interceptor®	Alpha-cypermethrin coated on polyester	Full	Published
LifeNet®	Deltamethrin incorporated into polypropylene	Interim	Published
MAGNet™	Alpha-cypermethrin incorporated into polyethylene	Full	Published
Olyset® Net	Permethrin incorporated into polyethylene	Full	Published
Olyset ® Plus	Permethrin and PBO incorporated into polyethylene	Interim	Published
PermaNet® 2.0	Deltamethrin coated on polyester	Full	Published
PermaNet® 3.0	Combination of deltamethrin coated on polyester with strengthened border (side panels) and deltamethrin and PBO incorporated into polyethylene (roof)	Interim	Published
Royal Sentry®	Alpha-cypermethrin incorporated into polyethylene	Full	Published
Yorkool®LN	Deltamethrin coated on polyester	Full	Published

Notes:

1. Reports of the WHOPES Working Group Meetings should be consulted for detailed guidance on use and recommendations. These reports are available on the WHO homepage on the Internet at *http://www.who.int/whopes/recommendations/wgm/en/*);
2. WHO recommendations on the use of pesticides in public health are valid **ONLY** if linked to WHO specifications for their quality control. WHO specifications for public health pesticides are available on the WHO homepage on the Internet at *http://www.who.int/whopes/quality/newspecif/en/*.

Sociocultural and behavioural considerations for promotional activities

Employing insecticide-treated materials (ITM) to reduce malaria involves three main types of behaviour:

1. acquiring ITM;
2. using ITM correctly and regularly;
3. proper maintenance of ITM, including retreatment, repairs and proper washing and drying.

When planning the promotion of insecticide-treated materials (ITMs), it is important to consider the possible sociocultural aspects that influence these three types of behaviour, including the objectives, product, audience, messages and communication channels. A useful reference tool for programme managers, which outlines practical considerations required for planning promotional activities targeted to each of the three behaviour sets, and reviews the products (nets, insecticides, hammock nets, repellents) and people's preferences is provided in Annex 1. This information is relevant whether the approach selected is public-sector health education, social

marketing with commercial distribution and promotion (e.g. ITN bundling strategy), LLIN-lending schemes, migrant taxi service programmes, or something else. In selecting objectives for the promotion efforts, the first questions to ask is: What do MMPs currently do about mosquito control in general, and mosquito nets or ITMs in particular? Information about current net users might indicate unprotected segments of the population for whom a special promotional effort should be made.

Information that is essential to message development includes the reasons why people should acquire ITMs (perceived positive and negative consequences) and social norms concerning the importance of malaria as a health problem.

What is needed for public health communication

Given the diversity of MMPs, effective public health communication among these groups requires customized messages and tools. Significant time and resources should be put towards conducting community consultations and formative assessments to develop the appropriate materials.

In areas where ITMs are to be introduced for the first time, a strong health education or health promotion component is essential. Strong messages are simple and straightforward[17] and take into account the specific needs and preferences of their target groups.[18,19] Interpersonal communication is one of the most effective channels, delivered by people who are respected by the community (such as trained village malaria workers, VMWs), and at locally- and culturally-appropriate times and occasions. Boxes 5 and 6 outline key messages relating to personal protection and provide further information about VMWs. By investing time and resources in public health communication, programmes are likely to be more effective in the long term, and individuals and communities more self-reliant in taking care of their health situation.[20] Public health actions for a range of vector control interventions among most-at-risk population (MARP) groups are presented in Table 1.

Box 5: Key messages for personal protection

(Adapted from WHO, 2007: LLIN nets for malaria prevention: A manual for malaria programme managers)

Suggested framework for emphasizing key messages regarding personal protection, which can be modified according to the specific measure of personal protection in question:

1. Transmission of malaria is by night-biting mosquitos.
2. Where and how the specified personal protection measure may be accessed.
3. The multiple benefits of using [personal protection measure].
4. The role of [personal protection measure] in terms of personal protection and mass effect.
5. The importance of proper and consistent use of [personal protection measure] (E.g. hanging of LLINs and sleeping under them every night).
6. Advantages of [personal protection measure] over nothing or other measure (E.g. LLINs over conventionally treated nets).

Box 6: Village Malaria Workers (VMWs)

VMWs can play a vital role in the delivery of health messages to communities. It is important to ensure that they remain motivated and proficient in their skills, which can be achieved through sustainable monetary and non-monetary incentive schemes, capacity building, regular training and refresher training, recognition of work through award schemes, adequate support and supervision, and involvement in decision-making.

Reference: Malaria Consortium (2011). Workshop to consolidate lessons learned on BCC and mobile/ migrant populations in the strategy to contain artemisinin-resistant malaria: Meeting report.

Table 1: Public health actions for specific interventions at the community or individual level for MARP groups

Population group										
Possible intervention	**Public health action for specific interventions at the community or individual level**	**Stable, affiliated with local village**	**Semi-stable, affiliated with company**	**Stable or unstable, attending evening social events/ entertainment**	**Security personnel, affiliated with government**	**New settlers, landless people**	**Highly mobile, unaffiliated, very hard-to-reach**	**International movements: displaced persons**	**International movements: economic migrants, short term**	**International movements: economic migrants, long term**
ITN	Retreatment of conventional nets; provision of ITKs; community mobilization	√	√					√	√	√
LLIN	Subsidized retail sale,[21] company distribution	√	Not practical for night-time workers	√	√	√		√	√	√
	Free distribution to households	Continuous distribution				√ When population reaches critical mass	√			

Possible intervention	Public health action for specific interventions at the community or individual level	Population group: Stable, affiliated with local village	Semi-stable, affiliated with company	Stable or unstable, attending evening social events/ entertainment	Security personnel, affiliated with government	New settlers, landless people	Highly mobile, unaffiliated, very hard-to-reach	International movements: displaced persons	International movements: economic migrants, short term	International movements: economic migrants, long term
LLIHN	Distribute to family	√		√		√				
	Distribute at workplace		√		√					
	Distribute at border posts to facilitate uptake	√	√	√	√	√	√	√	√	√
	Promote use for overnight trips to forest	√		√		√				

Population group										
Possible intervention	**Public health action for specific interventions at the community or individual level**	**Stable, affiliated with local village**	**Semi-stable, affiliated with company**	**Stable or unstable, attending evening social events/ entertainment**	**Security personnel, affiliated with government**	**New settlers, landless people**	**Highly mobile, unaffiliated, very hard-to-reach**	**International movements: displaced persons**	**International movements: economic migrants, short term**	**International movements: economic migrants, long term**
ITM – including clothing	Provide insecticide-treated uniforms				√					
	Advocate for use during night-time outdoor work		√		√		√			
	Advocate for combined use with topical repellent		√		√		√			
	Negotiate mandatory use of personal protection by plantation and other outdoor/nighttime workers[22]		√		√					

Population group										
Possible intervention	**Public health action for specific interventions at the community or individual level**	**Stable, affiliated with local village**	**Semi-stable, affiliated with company**	**Stable or unstable, attending evening social events/ entertainment**	**Security personnel, affiliated with government**	**New settlers, landless people**	**Highly mobile, unaffiliated, very hard-to-reach**	**International movements: displaced persons**	**International movements: economic migrants, short term**	**International movements: economic migrants, long term**
Topical repellents	Advocate use outdoors from dusk to dawn. Reapply every 4-5 hours. Provide demonstration. Combine with ITMs?	√	√	√	√	√	√			
	Provide community supplies at outdoor events (e.g. bush cinema, workplace)	√	√	√	√					
Stand-by treatment kit	Forest package approach[23]						√			
Preventive or responsive IRS	Advocate through campaign launches and closing ceremonies	√	√					√	√	√

Possible intervention	Public health action for specific interventions at the community or individual level	Population group: Stable, affiliated with local village	Semi-stable, affiliated with company	Stable or unstable, attending evening social events/ entertainment	Security personnel, affiliated with government	New settlers, landless people	Highly mobile, unaffiliated, very hard-to-reach	International movements: displaced persons	International movements: economic migrants, short term	International movements: economic migrants, long term
Village malaria workers (VMWs)	Use community gatherings for outreach and IEC activities	√		√		√	√			
	Conduct IEC campaigns at work sites, scheduled flexibly around working hours to increase attendance[24]		√		√	√	√			
	Engage and conduct malaria IEC with key stakeholders on malaria (e.g. women,[25,26] landlords, business owners, community gatekeepers)	√	√	√	√	√	√	√	√	√
Personal protection against other VBDs?	Personal protection against dengue in urban- and semi-urban areas							√	√	√

		Population group								
Possible intervention	**Public health action for specific interventions at the community or individual level**	**Stable, affiliated with local village**	**Semi-stable, affiliated with company**	**Stable or unstable, attending evening social events/ entertainment**	**Security personnel, affiliated with government**	**New settlers, landless people**	**Highly mobile, unaffiliated, very hard-to-reach**	**International movements: displaced persons**	**International movements: economic migrants, short term**	**International movements: economic migrants, long term**
IEC	Use promotional materials likely to be favoured by target population[27,28]	√	√	√	√	√	√	√	√	√
	Prioritize interpersonal communication methods. Use simple visual, verbal and interactive channels (e.g. images, games, performances, role-plays, workshops)[29]	√	√	√				√	√	√
	Advocate using billboards, radio broadcasts	√	√		√	√	√		If appropriate language/ dialect available	If appropriate language/ dialect available
	Increase frequency of campaigns just prior to and during malaria transmission season	√	√	√	√	√	√	√	√	√
	Conduct at culturally- and locally-appropriate times and locations	√	√	√	√	√	√	√	√	√

2.2 If the inputs required are complex, expensive community-protection methods, requiring the active participation of the whole community and local health authorities: What they can do and what might be useful?

Indoor residual praying

Delivery mechanisms: The second core malaria vector control intervention is indoor residual spraying (IRS), which is broadly divided into two types of strategic implementation in the GMS:

1. 'mass preventive'; or
2. 'focal responsive'.[30]

- **Mass preventive IRS** is a routine response in areas of consistently high annual malaria incidence. Spraying is generally carried out at regular intervals of six or twelve months depending on the length of the transmission season and the residual efficacy of the insecticide used.
- In contrast, **focal responsive IRS** is an emergency response to malaria outbreaks in endemic areas or to confirmed foci of malaria transmission in areas targeted for elimination (or for containment of artemisinin resistance). Focal responsive IRS normally relies on a single round of spraying. In the case of malaria outbreaks, all households in the outbreak community are usually targeted, whereas in the case of confirmed transmission foci, spraying is usually restricted to households within a given distance of each confirmed case.

The residual efficacy of IRS varies from around two to 12 months, depending on the insecticide used and the type of surface treated (see Box 7 for the expected duration of residual efficacy of insecticides, according to dosage and substrate). To ensure maximum effect, campaigns should be carried out before the peak malaria transmission season.

Box 7: Characteristics of the four classes of insecticide currently recommended for IRS and LLINs[17]

Insecticide cost : Estimated approximate cost range per household sprayed[a]	Current LLIN products	Current IRS products	Molecules recommended for use in IRS	Hazard classification	Duration of effect per spray (months)[b]
Pyrethroids	√	√	6	Class Ib/II/Uc	3–6
Organo-chlorines (DDT)	X	√	1	Class II	6–12
Organo-phosphates	X	√	3	Class II/IIId	2–3
Carbamates	X	√	2	Class II	2–6

From references (12-14)

LLINs, long-lasting insecticidal nets; IRS, indoor residual spraying

Hazard classification (active ingredient): Class Ib: Highly hazardous; Class II: Moderately hazardous; Class III: Slightly hazardous; Class U: Unlikely to present acute hazard in normal use

a. Analysis calculated for a household of five people (150 m^2 sprayed) and based on WHOPES spraying guidelines and PMI cost data (14).

b. Duration as based on typical formulation for use in malaria control.

c. Cyfluthrin is WHO class Ib, Alpha-cypermethrin, Bifenthrin, Deltamethrin, Lambda-cyhalothrin and Permethrin are WHO class II and Etofenprox is WHO class U.

d. Fenitrothion and Pirimphos-methyl are class II and Malation is class III.

Other prerequisites:

Achieving maximum impact is also heavily dependent on community acceptance. Stable and semi-stable MMPs who are affiliated with local villages or companies are required to remove furniture and belongings from their homes prior to spraying and must allow spray teams full access to their properties (Table 1). They must remain outside the properties for one to two hours during and after spraying to avoid adverse side effects associated with wet sprays on the walls and furniture. Displaced persons living in tents or camps, refugees, military and sometimes construction camps, will also need to comply with the above precautions (Table 1). Annex 2 outlines other key considerations for planning the essential elements of IRS operations and related promotional activities.

IRS programmes aim to achieve coverage in excess of 80% of targeted households in selected MARLs. Population number, density and ease of access need to be taken into account, while households themselves must have suitable surfaces for treatment using the correct insecticide formulations. Poor quality spraying and inadequate supervision will compromise the effectiveness of IRS, thus it is important to ensure supervision and refresher training activities are frequent and upheld. Further information on cost categories used for planning and cost-effectiveness analysis is presented in Annex 3.

Insecticide resistance management

Mass-preventive IRS can result in the development of insecticide resistance and, assuming pyrethroids are used, this could undermine the effectiveness of ITN campaigns. Established IRS programmes operating among settled populations and areas of economic importance, such as hydropower projects, irrigation schemes, mines and tourism need to seek technical guidance and support from NMCPs.[31] Rigorous monitoring of the insecticide susceptibility status of primary vectors is therefore particularly important where mass preventive IRS is in use (Annex 4).

2.3 If the inputs required are for outdoor settings/environments, moderately expensive, self-protection methods, requiring the active participation of the individual MMP: What can they do and what might be useful?

Importance of outdoor transmission in the GMS depends on people working outdoors after dark, prevalence of forest-related activities, unprotected workers in development and reforestation projects (rubber and fruit orchard plantations) and border security patrols. In villages where people have personal or household electricity systems that enable them to stay up later watching television, there is a greater chance of exposure to mosquitos before sleeping time (protection gaps are illustrated in Figure 3). People who frequent outdoor or bush "cinema" or story-telling venues may be bitten by mosquitos during their time at the venue or walking to or from it. Children attend with adults, and simply go to sleep in a parent's arms or on available space when they get too tired; if the child sleeps under a mosquito net at home, they may not be placed there until towards midnight. Families who sleep directly on the bamboo slat floor of their house (rather than on a mat made from woven rattan or a recycled bed net) are unable to tuck the apron of the mosquito net underneath their sleeping children, and often wake to find that children had rolled out of the net during the night. An additional period of risk, when people may sleep outside a LLIN, is during travel to the open "bush" markets; or to village market days to sell crafts (see photos) or fresh produce.

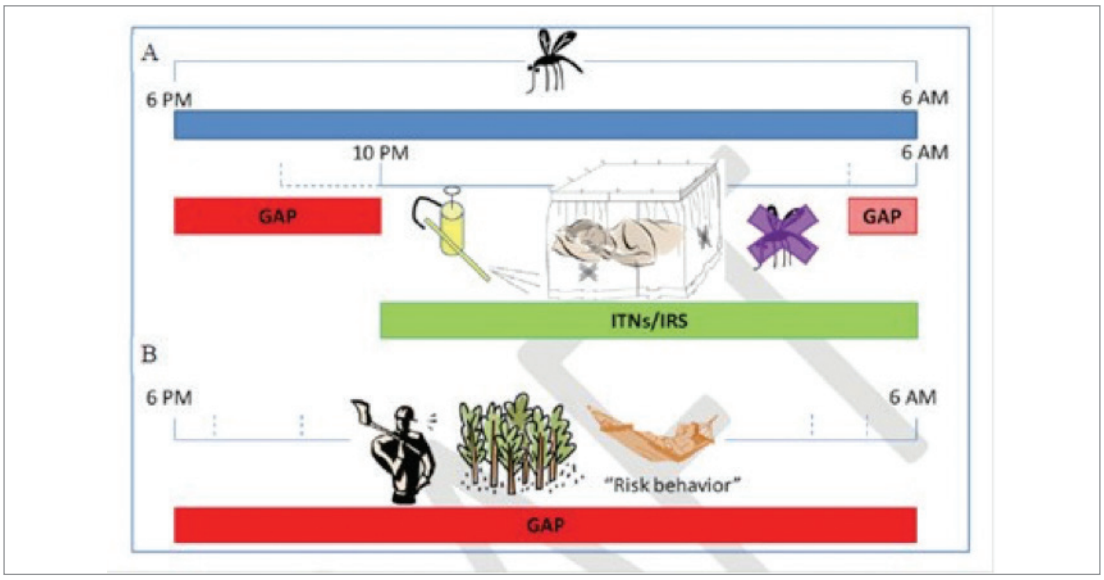
These violations in the protection gap have implications in the estimation of prevention coverage of ITNs/LLINs (Box 8).

Box 8: Estimating true coverage of ITNs/LLINs

The response to the simple question in a bednet utilization survey asking "Did your child sleep under a mosquito net last night?" may therefore be recorded as "Yes", but the child may have been outside the net and unprotected for part or most of the night. The methodology of the bednet utilization survey may need to be adjusted. For example, a supplementary question to measure approximate duration of coverage during the night could be included: "If yes, approximately what time did your child go to sleep under the net last night?"

Main malaria vectors in different localities show differences in early biting,[32] for instance, in most parts of Thailand, An. minimus are early biting (18.00-21.00 h),[33] whereas An. minimus in western Thailand showed late biting between 24:00-03:00 h;[34] late biting of An. dirus (21:00-02:00 h) occurs in Lao PDR.[35] In Viet Nam, up to 60% of nighttime biting occurs before 22:00 h.[6] An. epiroticus in western Myanmar has an early evening (17:00-19:00 h) and early morning (04:00-06:00 h) biting pattern.[36] Thus, human behaviours outside the protected structures become critical to further progress in controlling and eliminating malaria. While bednets are less effective when the vector bites outdoors and/or early in the evening when people are still active, IRS faces similar problems when the vector does not rest indoors or when house structures are open.[37]

Figure 3. Protection 'gap' when only indoor insecticide-based vector control measures are applied, see upper panel A. ITNs/LLINs will only protect from infective bites that are acquired indoors, and during sleeping time. IRS only target mosquitos that rest indoors. Therefore, there is a gap in protection both indoors and outdoors before and after people go to bed (A), but also for people conducting outdoor activities during the night (i.e. 'risk behaviour').[32]



Durnez, L. & Coosemans, M. (2014)[6].

Vector control tools

There are many ways of additionally reducing host-vector contact in outdoor settings, including:

- the use of topical repellents (e.g. picaridin, DEET);
- insecticide treated clothing; and
- long-lasting insecticidal hammocks.

Table 2 outlines the range of vector control tools and their targets in more detail, while Table 3 assigns appropriate vector control and personal protection measures to MARL in the GMS.

Temporary shelters are used by people who are on the move, among them gem miners, hunters, loggers, rubber-tappers and semi-nomadic forest people. In addition, new settlers may live for some time in unfinished (incomplete) buildings. Such shelters offer little protection from biting insects and, consequently, bednets, repellents and hammocks are often used to reduce biting. Tools that have been shown to be efficacious in the GMS and other settings are outlined in Table 2.

Table 2: Vector control tools and their targets[32]

Tool	Mosquito behavior that is targeted				Personal (P) or community (C)[b] protection
	Time of biting (E/N)[a]	Host preference (A/Z)[a]	Place of biting (I/O)[a]	Place of resting (I/O)[a]	
Tools relying on host-vector contact					
ITNs	N	A	I	I	P&C
Long-lasting insecticidal hammocks and other net designs adapted to outdoor conditions	(E&) N	A	O	O	P&C
Insecticide treated plastic sheeting for shelters in the forest	E&N	A&Z	I&O	O	P
Personal protection including topical and spatial repellents, Insecticide treating clothing	E&N	A	I&O	I&O	P& C*
Insecticide treatment of cattle	E&N	Z	I&O	I&O	C*
Tools not relying on vector–host contact					
IRS	E&N	A&Z	I&O	I	C
Larval source management	E&N	A&Z	I&O	I&O	C*
Toxic sugar baits	E&N	A&Z	I&O	I&O	C*
Treatment of outdoor resting places, e.g. with fungal biopesticides	E&N	A&Z	I&O	O	C*

[a] E: Early evening and morning biting; N: Night biting; A: Antropophilic; Z: Zoophilic; I: Indoor; O: Outdoor.

[b] Community protection can only be achieved if the coverage of the intervention is large enough.

*Community protection is assumed or shown in a limited number of studies, but more evidence is required for confirmation of community protection.

Durnez, L. & Coosemans, M. (2014).[6]

Suggestions for protection in the absence of a mosquito net

Topical repellents – People who visit or are active or involved in nighttime work in the forest or forest margins should be encouraged to use repellents to avoid being bitten. Any repellent containing DEET (Diethyl-m-toluamide) or Picaridin are suitable for use (common repellent trade names include Aerogard, Rid, Repel and Bushman). Note that Aerogard is formatted for flies while Aerogard Tropical Strength is formatted for mosquitos. It should be noted that repellents containing DEET should not be applied to children less than 12 months old. DEET-based repellents provided an additional protective efficacy against malaria disease in a small-scale community-based trial in India[38] and DEET-based repellent soap against P. falciparum malaria in a household randomized trial in a refugee camp in Pakistan.[39] A high degree of compliance to use 15% DEET lotion by individuals is necessary to have a significant reduction in malaria incidence as shown by an RCT study among agricultural populations in south Laos already using LLINs.[40] In a recently concluded study in Cambodia, Picaridin-based repellents provided a protection of more than 90% against the bites of the main malaria vectors, An. dirus and An. Minimus.[41]

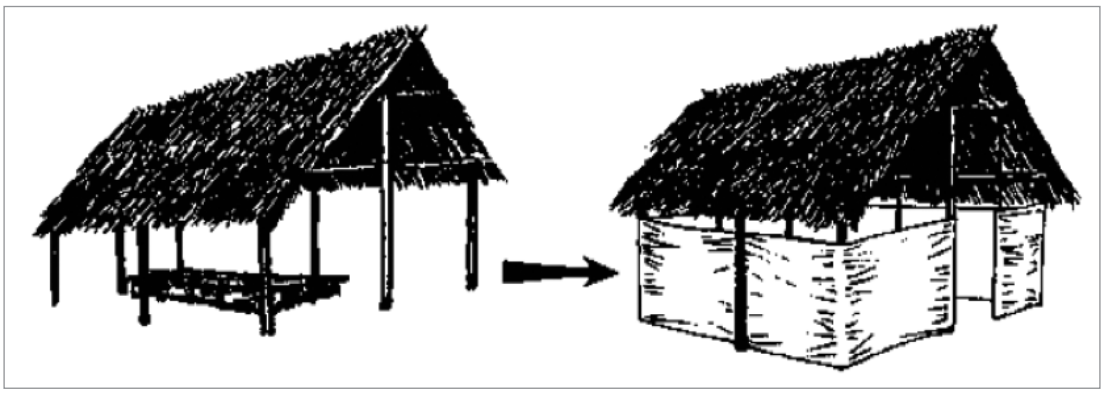
Mosquito coils – people working in forested areas where there is not much wind (wood cutters, rubber-tappers, plantation workers, gem miners) can obtain some protection from biting mosquitos and phlebotomine sandflies by attaching one or two smoldering mosquito coils in special holders to their belts (Figure 4). Each coil is kept in place between two pieces of metal or non-flammable fibre glass gauze. The advantages of coil holders over topical repellents are that they are cheaper, do not elicit any skin reactions when used frequently, and do not wash off owing to perspiration.

Figure 4. Commercially-available coil holder (A).[11] The holders are commonly used in Asia and improve the performance, convenience and safety of smoldering mosquito coils attached to a head cap (B)[42] or the belt of the rubber tapper (C43, D11).

Insecticidal treated plastic sheeting (ITPS) – the sheeting is attached to the poles and walls of the shelter which support the roof, and can also be used to cover door(s) and window openings (Figure 5); it can be rolled up during the day. Some mosquitos that rest outside or inside on the sheeting are killed, and others are repelled after brief contact. Additional advantages offered

by treated sheeting are those of privacy and protection from the wind, and the fact that when the shelter is abandoned, the sheeting can be removed and reused elsewhere. ITPS applied as an interior wall lining has demonstrated an impact on disease transmission, reducing malaria incidence by over 70% in India.[44] The ITPS treatment method is explained in Box 9.

Figure 5[11]: Insecticide-treated sheeting of woven polypropylene can be attached to the poles and walls of temporary houses.



Adapted from Rozendaal, JA. (1997).

Box 9: Treatment method for plastic sheeting

The material must be strong, cheap and suitable for treatment. Woven polypropylene meets these requirements and is widely available.

The sheeting can be soaked or sprayed with pyrethroid insecticides. For speed and convenience, spraying may be preferred where spray pumps are available. Recommended dosages per square metre are 0.75 g of permethrin, 0.05 g of cyfluthrin, or 0.025 g of deltamethrin or lambdacyhalothrin. CS (capsule suspension) formulations give better adhesion to the plastic material.

Insecticide-treated durable wall lining (DWL) – Successful control of outdoor vectors using deltamethrin-treated tarpaulins in refugee camps,[45,46] coupled with the widely recognized logistical constraints associated with household spraying campaigns, has initiated ITPS (see above) or durable wall lining indoors, fixed to walls and/or ceilings, as a long-lasting alternative to IRS. DWL is based on long-lasting net technology where deltamethrin is incorporated into the polymer before yarn extrusion, allowing it to migrate to the surface in a controlled fashion and ensuring uniform coverage, regardless of surface texture or wall shape. DWL requires few behavioural adjustments and adds aesthetic value to the rural home interior (Figure 6), thereby encouraging user cooperation.

Long-lasting insecticidal hammock nets (LLIHNs) – Hammocks protected by insecticide-treated nets (ITHNs) or by long-lasting insecticidal nets (LLIHs) have been recommended as additional malaria prevention tools in settings where standard control strategies have a limited

impact. Hammock nets are therefore expected to provide extra protection in the evening when people are not yet sleeping under bed nets and in conditions where bed nets are not likely to be used, i.e. during forest activities such as hunting, logging and sleeping at forest plot huts during harvests.

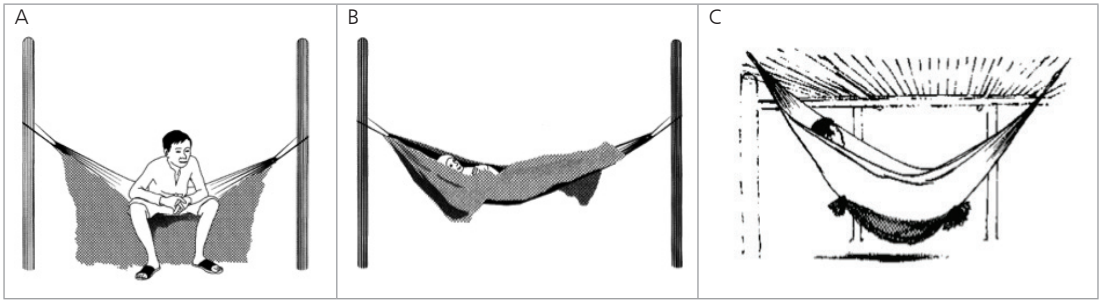
Figure 6: Durable linings (B) installed in traditional houses in rural Equatorial Guinea (A) and in Ghana (C, D)[47].

Messenger, L.A. et al. (2012), Malaria Journal, 11: 358.

Do-it-yourself (DIY) treatment of hammock nets such as:

- Application of a volatile repellent such as DEET to the lower part of the hammock at a dose of about 20 g/m2. The repellent persists for only a few days and some mosquitos may try to feed from above.
- Placing a burning mosquito coil close to the hammock. If used in a coil holder (Figure 4), it is safe to place the smoldering coil under the hammock.
- A method that provides longer-lasting protection is the impregnation of the whole hammock or the lower part of it, using a sponge, with a quick-acting pyrethroid insecticide. Mosquitos making contact with the treated part of the hammock are killed or incapacitated. Because of the thickness of the hammock material, this method requires a relatively high dose of insecticide (1.5 g/m2 of permethrin or more).
- A more economical method, requiring far less insecticide and probably equally effective, is that of protecting the lower surface of the hammock with an impregnated piece of netting or cloth (Figure 7C). This material can be loosely attached to the hammock with a few pins, Velcro or with stitches. It should be attached close to the hammock so that mosquitos are more likely to settle on it and be killed. However, the netting should not touch the hammock except where it is pinned or stitched on, because this would enable some mosquitos to feed before being killed. The advantages of sewing removable material are that it is easily impregnated, can be removed when the hammock is washed and can be stored in an airtight box when not in use.

Figure. 7: (A, B) Design and use of LLIHN. Treated flap sewed along one side of the hammock is to reduce the landing of mosquitos on the legs.[48] (C) A piece of cloth or netting impregnated with an insecticide or repellent and loosely attached to the lower part of a hammock can provide partial protection from biting mosquitos.[11]



Sochantha, T. et al. (2010), Trop Med Int Health 15: 336-341. Rozendaal, JA. (1997)11.

Insecticide-treated clothing – clothing can be treated with repellents to prevent insects from landing or feeding, or with quick-acting pyrethroid insecticides, such as permethrin. Permethrin act as both a repellent and insecticide by allowing mosquitos to make contact with the fabric and irritate or kill them before they manage to feed. Permethrin has low toxicity in mammals and is used widely in nuisance and disease vector pest control treatments for humans and cattle.[49] Permethrin or other synthetic pyrethroids are generally preferred to volatile repellents for treating clothing because:

- they act quickly and repel or kill a number of biting insects;
- they are long-lasting and to some extent withstand weathering, sunlight and washing in cold water;
- they are more pleasant to use (little or no odour, colour or greasiness);
- they are safe and do not irritate human skin if applied at the correct doses;
- they do not affect plastic products;
- they are cheaper than repellents, only infrequent applications of small amounts being required;
- they can reduce incidence of malaria and leishmaniasis, depending on the vector targeted and the potential for pathogen transmission.[50]

However, if the clothing is treated with a non-repellent pyrethroid, flying insects may feed on uncovered skin, necessitating the application of a repellent to the bare skin. In contrast to bednets, clothing is utilized in a more uncontrollable manner: sunlight is unavoidable in practical terms; wear can be assumed to occur but may vary between persons, and clothing is likely to be washed significantly more frequently than bednets.

Impregnated socks, stockings and trousers can give effective protection against mosquitos, which often bite around the ankles, including sandflies, biting midges, fleas, body lice, ticks and mites. Clothing treated with permethrin can remain toxic to insects and ticks for several weeks or months, depending on wear and exposure to washing and rain (Box 10 outlines treatment

method). Treated clothing may remain effective after up to 10 rinses with cold water and soap. However, more permethrin is lost after washing in hot water and soap.

Box 10: How to treat clothing

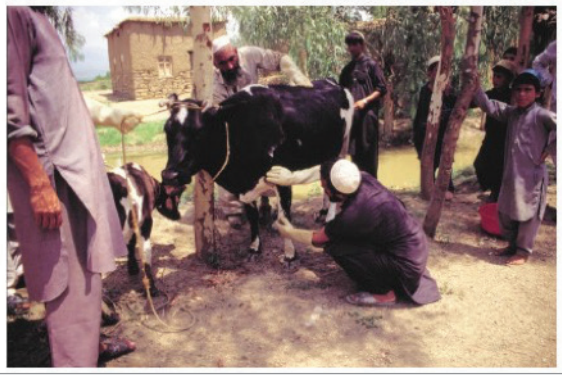
Clothing can be treated with permethrin by spraying the insecticide from a pressurized can or by soaking in an aqueous emulsion. The recommended dosage for coats, jackets, long-sleeved shirts, and trousers is 1.25 g/m2 (0.125 mg/cm2) and for short-sleeved shirts, it is 0.8 g/m2 (0.08 mg/cm2)

A pressurized spray can containing DEET may be more easily available. The recommended dosage for DEET is 20 g/m2 (2 mg/cm2), or about 70 g of active ingredient for one piece of clothing. Technical grade DEET suitable for the treatment of fabrics by dipping is available as 30% and 95% mixtures with alcohol.

Treated bed-sheets – People sleeping outdoors in places where the nights are cool, and for whom mosquito nets are unaffordable, impractical or unavailable, could consider covering themselves at night with sheets or other fabrics treated with insecticide or repellent. Treated top sheets, chaddars, patoos (blankets made of thin wool) and bedding materials gave 64% reduction in malaria in Afghan children aged 0-10 years in northwest Pakistan; the clothing and materials treated were the participants' personal items, rather than new clothing.[51] The utilization of existing clothing and habits promoted stronger compliance and greater acceptability.

Insecticidal treatment of cattle – where mosquitos prefer feeding on animal livestock, treating livestock can be an effective method for malaria control. Sponging livestock with deltamethrin insecticide (Figure 8; Box 11) produced a 56% and 31% fall in the incidence of falciparum and vivax malaria and 80% savings in cost compared to a standard IRS, that is, US$ 0.34 per person protected, versus US$ 0.07 for the animal sponging method.[52] Benefits are: the quick time for livestock sponging compared to indoor spraying for epidemic control, and significant weight gains among treated cattle. Local people must be committed to the programme, since all the domestic animals in the village must be treated and the insecticide must be applied every six weeks.

Figure 8: Sponging cattle with deltamethrin[52]



Rowland, M., Durrani N., Kenward M., Mohammed N., Urahman H., Hewitt S. (2001). Control of malaria in Pakistan by applying deltamethrin insecticide to cattle: a community-randomised trial. Lancet 357 (9271): 1837-1841.

Box 11: How to sponge cattle livestock

Provide information, encouragement, training and supervision for livestock owners. Apply insecticide solution (concentration 0.075 g/L deltamethrin, K-Othrine 2.5% suspension concentrate) at application rate of 30 mg/m2 AI. Using sponge and rubber protection massage and saturate the animal hair below the mid-line of cattle, undersurfaces and legs. Apply three or more rounds of sponging at 6 week intervals, depending on rainfall and local conditions.

Larval Source Management – WHO's Interim position statement on larviciding recommended that: "larviciding can be a useful supplement to core interventions but only in some specific locations, where vectors tend to breed in permanent or semi-permanent water bodies that can be readily identified and accessed, i.e. breeding sites which are 'few, fixed and findable', and where the density of the human population to be protected is sufficiently high to justify the necessary resources (WHO, 2012).[53] Although this would exclude forested areas frequented by MMPs in the GMS countries, a recent review showed "there are some vector species that do have these characteristics and are promising vector targets for larval source management" (Whittaker and Chang, 2012).[54] Although these species were not named, it is likely to be found in situations of rapid development change such as urban coastal areas and brackish swamps (An. epiroticus, An. sundaicus), agricultural development projects and extractive industry areas (secondary vectors such as An. maculatus, An. sinensis, An. barbirostris, An. philippinensis, An. nivipes, An. annularis, An. jeyporiensis).

WHO Statement also highlights the importance of assessing beforehand the feasibility of conducting and sustaining LSM in these settings (WHO 2013).[55] Based on the baseline information collected, a decision can be made about the feasibility of LSM; see Box 12 below.

Box 12: Feasibility of LSM in broad eco-epidemiological settings

In general, LSM will likely be most cost-effective and efficacious in locations **where larval habitats are relatively few, well defined, seasonal, readily accessible without aerial equipment and possibly artificial (i.e. – 'few, fixed and findable')**; and in more temperate regions where larval development is more protracted. Such conditions are common in areas of low to moderate, focal or epidemic transmission.

LSM is not a strategy for application in all habitats and **is not a stand-alone intervention**. However, LSM could be integrated into malaria control or general mosquito abatement programmes once transmission has been reduced to low or moderate levels by LLINs or IRS, or once these interventions have reached their maximum practical effect. LSM might therefore be **advocated for the pre-elimination and elimination phases** of malaria control, **alongside LLINs and IRS, where it may be targeted in space and time**. LSM may also have **potential in managing insecticide resistance and outdoor transmission**.

According to WHO (2012), "the feasibility of LSM as a tool in malaria vector control programmes should ultimately be determined locally." Expected resource requirement for LSM will need to be considered relative to the potential reduction in transmission intensity or disease incidence (if possible). It is important to consider that while complete control or elimination of all larval sources potentially affecting the control area is preferred, benefits may be realized from alternate, more focused interventions.

To determine the feasibility of LSM, the following questions should be addressed:

- *Where and when is LSM indicated?*
- *Can LSM be focused to protect populations at risk?*
- *Are there operational synergies with existing interventions?*
- *Can LSM be integrated into sectors outside healthcare?*
- *Is there an opportunity to increase knowledge at the district public health office level in order to initiate and improve LSM at the community level? Is there sufficient funding for LSM? From what level could funding be provided (national only or also at a more decentralized level, e.g. district health management teams)?*
- *Is there sufficient funding to target both anophelines and other mosquito species such as culicines (which is ideal if practicable and affordable)?*
- *Will LSM be cost effective? While not strictly a subcategory of " feasibility" the cost-effectiveness of LSM as a supplement to other vector control should be evaluated.*

The reader is guided to possible LSM strategies and selection of intervention in pages 17–24 of the WHO Manual (2013).

Figure 9. Typology of mobility as characterized by occupational activities at cross-border and internal areas in Myanmar, Tier[56]

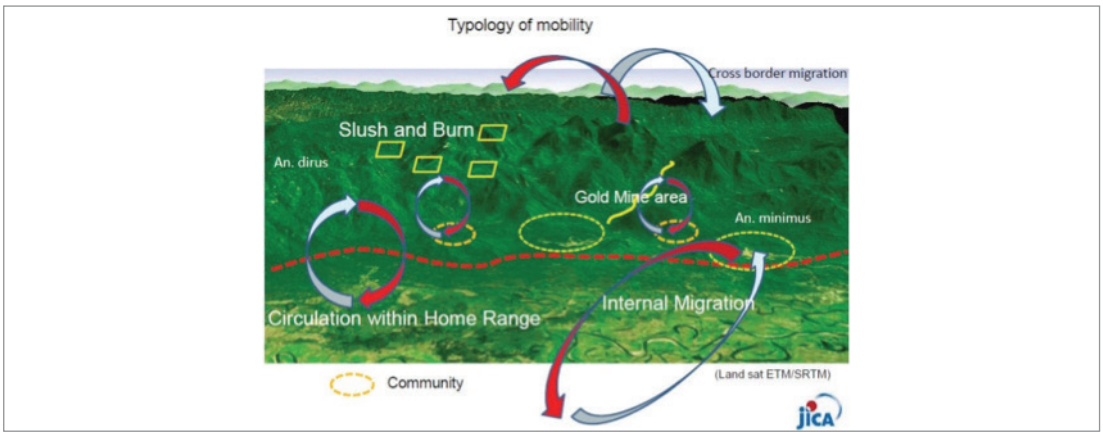


Table 3. Targeting vector control tools and personal protection measures at MARL in the GMS. Italicized headings denote the need for more operational research to substantiate proof of principle

Most-at-risk locations (MARL)	Vector control or personal protection measure							
	Mass preventive IRS[53]	Focal IRS	ITN/LLIN/ LLIHNs	House improve-ment	Insecti-cide-treated clothing	Insect repellent	Outdoor space spraying[54]	Larval source manage-ment[55]
Primary or secondary forest			LLIHN		√	√		
Temporary shelters in or near forests or cleared forests			LLIHN	√	√	√		
Plantations, e.g. rubber plantations, cash crops	√	√	ITN/ LLIN	√	√	√	√	√
Fixed settlements, e.g. hydropower projects	√	√	ITN/ LLIN	√		√	√	√
Highway road construction sites			LLIHN, ITN			√		
Open market places			LLIHN, ITN		√	√		
Refugee camps for displaced people	√	√	LLIN, ITN		√	√	√	
Border security check points			LLIN, ITN		√	√	√	

3. Policy issues

Ministry of Health (MOH) and partners are responsible for maintaining the continuous delivery of ITMs, and this requires the enhancement and strengthening of the structures and activities for distribution activities as described in this toolkit. These include:

- Coordination of malaria partners at central, regional and community level;
- Short- and long-term planning;
- Procurement;
- Storage;
- Transport and accountability of ITNs/LLINs, etc.;
- Communication for advocacy, social mobilization and behaviour change.

The toolkit also does not elaborate on methods and strategies for continuous delivery of ITMs, and the reader is advised to refer to MPAC reports and recommendations for achieving universal coverage with long-lasting insecticidal nets.[57] Whilst these processes are important, they are beyond the scope of this toolkit.

Additional activities also include training and re-training of personnel at different levels, accurate record-keeping, data management and transmission, and ongoing supervision, monitoring and evaluation of all aspects of the delivery programme.

The MOH must provide leadership, policy formulation and supervision, but may opt to subcontract the logistics, training, communication and/or monitoring and evaluation to a third party to ensure accountability, transparency and the comparative advantage of using a specialized agency or partners.

The material in *Annex 1* should be presented as a pocketbook, set of flashcards, or other useful reference tool. These are key considerations for programme managers in the planning stage, therefore should be published in a way that is practical and easy to use.

Table 4: Information about sociocultural aspects of main behaviours (ITM acquisition, use and re-treatment) that will be helpful in planning the essential elements of promotional activities in GMS countries.[58,59,60] Note: items are not presented in strict order[61]

	Getting nets, clothing, curtains or repellents	Using nets, curtains, clothing or repellents appropriately	Retreating or replacing conventional nets, curtains, clothing or repellents
Objectives	• Have the MMPs in this community used ITM previously? How new is the practice of using ITM in this community? • Has this community received education or information about malaria and personal protection? How recently did the community first receive information about malaria and personal protection? What mosquito prevention measures does this community currently use? • Are there sub-groups of the MMP that require special attention? • Do the MMP have guidelines on how to use, treat and maintain nets/ITM? • Are guidelines available in the local language(s)? • Are visual aids, such as flipcharts, or live demonstrations available for illiterate people?		

	Getting nets, clothing, curtains or repellents	Using nets, curtains, clothing or repellents appropriately	Retreating or replacing conventional nets, curtains, clothing or repellents
Product	• What are the MMPs' preferences – in terms of shape, colour, size, material, scent and design? What are the best distribution channels for this community, i.e. how can we distribute ITMs to MMPs? • What is the best distribution outlet for this community? Could a LLIN lending or bundling scheme be successful in this community? • Are there certain groups which are more difficult to access for net distribution? Are there certain target groups which are at higher risk? • How can these hard-to-reach and high-risk groups be reached? • What are the MMPs' perceptions towards nets or ITMs as a health or household commodity? Are the MMPs willing to use nets or ITM? • What are the MMPs' perceived barriers to using nets or ITM? • How affordable do the MMPs perceive the nets or ITMs to be? • What are people prepared to buy and use? • Is there the possibility to subsidize or provide free nets or ITMs? What will this entail? • What are the sources of public funding for procurement?	• What are the MMPs' net preferences – in terms of washing, hanging, drying and storing nets and other ITMs? • How do MMPs prefer to wash their nets or ITMs? • How frequently do MMPs wash their nets or ITMs? • How do MMPs prefer to dry their nets or ITMs? Where do they dry them? • How do MMPs store their nets or ITMs when they are not used? • What is the net or ITM use culture like in this community? • How often do MMPs in this community sleep under nets or use ITMs? What have household surveys said or suggested about net or ITM utilization? • What are household sleeping arrangements? Do nets fit within the household sleeping arrangement? • Are there certain areas or places where MMPs use nets or ITMs more or less often? (e.g. village, forest, etc.) • Are there certain times of year where net or ITM use is higher or lower? • What kinds of nets or ITMs do MMPs in this community use? Are certain types preferred over others (e.g. conventional vs. LLIN?)? • How are net or ITM use patterns in this community affected by perceptions of mosquitos as a biting nuisance versus as a vector of disease? • What are the alternative uses of nets or ITMs in this community? • What are the reasons nets or ITMs may not be used as intended in this community? • What behaviours, beliefs, attitudes and perceptions affect net utilization in this community and/or in specific sub-groups? • How does net or ITM lifespan vary between groups and individuals (in terms of perceptions and reality)?	• What are the MMPs' perceptions of retreatment methods? • How do MMPs make decision on retreatment or replacement? • Do MMPs in this community prefer a common dipping point or house-to-house delivery? • What are MMPs' perceptions towards insecticides on insects, animals, children, pregnant women? • Do the MMPs in this community understand the principles of retreating nets or ITMs, including the importance of drying in the shade? • What is the cost of retreating nets or ITMs for this community? • How affordable do MMPs perceive retreating nets or ITMs to be? Affordability of replacement? • When is the right time to replace nets or ITMs in this community? • What are the considerations for replacement of end-of-life (unserviceable) of nets or ITMs in this community? Could an ITN bundling programme (conventional ITN + ITK) strategy be applicable to this community? • Can net treatment become a norm? • Would a durability study of ITNs/LLINs or other ITMs be useful to inform replacement and distribution strategy?

	Getting nets, clothing, curtains or repellents	Using nets, curtains, clothing or repellents appropriately	Retreating or replacing conventional nets, curtains, clothing or repellents
Audience	• Who are the stakeholders involved in the purchase of nets or ITMs? What are the household dynamics like among MMPs in this community? • Who in the household decides to buy nets or ITMs? • Who in the household is responsible for buying nets or ITMs? • Who in the household pays for nets or ITMs? • What kind of community engagement is required to encourage uptake of nets/ITM?	• Who are the stakeholders involved in the use of nets or ITMs? • Who participates in household surveys and/or bednet utilization surveys? • Who in the household washes the nets or ITMs? • Who in the household dries the nets or ITMs? • Who in the household uses the nets or ITMs?	• Who provides retreatment services? Who pays? • Who are the stakeholders involved in the re-treating or replacement of nets or ITMs? • Who in the household retreats the nets or ITMs? • Who in the household pays for the retreating of nets or ITMs?
Message content	• What do MMPs in this community know about how malaria is transmitted? • What do MMPs in this community know about protecting themselves against mosquitos? What do MMPs in this community know about protecting themselves against malaria? • Has this community received education or information about malaria and personal protection?		

	Getting nets, clothing, curtains or repellents	Using nets, curtains, clothing or repellents appropriately	Retreating or replacing conventional nets, curtains, clothing or repellents
Positive consequences	What are the short- and long-term effects? • Higher bednet use associated with fewer malaria cases? • Higher bednet use associated with having to take fewer sick days? • Higher bednet use associated with increased school attendance? • Higher bednet use associated with increased crop yield or income? • Higher bednet use associated with higher overall economic productivity of community? • Using bednets offers additional protection against other insects/nuisances? • Communities are more self-reliant in taking care of their own health situation? • Communities have improved health awareness as a result of the ITN programme? • Establishing an outreach network to MMPs may facilitate an entrance point for other health programmes?		
Negative consequences	What are the short- and long-term effects? • Net distribution may not fit within household/sleeping arrangements? For example, too few nets, or too small, or not enough sleeping places • Cost issues: high cost may be a disincentive and lead to lower coverage, while subsidizing nets may reduce the sense of ownership and readiness of users to properly maintain and care for nets • Full cost recovery may not be possible • Bednets may be impractical to carry long distances; impractical to mount (small houses, forest, etc.) • Bednets may be impractical for certain groups (e.g. nighttime workers outside homes) • Bednets may be uncomfortable to sleep under (e.g. stuffy during hot season), and flammable or impractical around fire during cold season • Changing habits, perceptions and practices may take a long time (especially if nets were never used before) • There may be objections to insecticide or chemical use • Perceived risk of malaria may be low (e.g. in individuals with high immunity) • Perceived benefit of disease prevention may be low • Lack of biting nuisance may hinder uptake or utilization of nets		

	Getting nets, clothing, curtains or repellents	Using nets, curtains, clothing or repellents appropriately	Retreating or replacing conventional nets, curtains, clothing or repellents
Obstacles	• Affordability of nets or ITMs? • Net lifespan and need for maintenance is subjective. How do we encourage users to value nets, particularly if they are subsidized/free? How do we communicate the importance of proper net maintenance? • Nets often tear by catching on housing materials (e.g. bamboo) – how do we address this? • How do we motivate MMPs to adopt correct and consistent net utilization behaviour? • Increased knowledge does not always translate to good or improved practices – how do we address this? • How do we address community concerns or differing beliefs? e.g. May face difficulties in explaining that insecticide is incorporated into the netting material15 • How do we access hard-to-reach groups? • How do we establish trust with MMPs and hard-to-reach groups? • How do we encourage MMPs to participate in household surveys and net distribution/utilization schemes? • How do we monitor progress in a meaningful way? • How long should retreatment be continued? • Where should resources be concentrated? • What can be done if subsidization schemes or partnerships cannot be established? • How do we build capacity in this area, and how do we ensure the programme is maintained after initial implementation? • How do we overcome or respond to supply chain/procurement/delivery problems? • How will supply chain problems affect the effectiveness of this programme? • Are there political factors that need to be considered that may affect the success of promotional or outreach activities? • How does seasonality of income affect MMPs' willingness and ability to buy ITM? • How does seasonality of income affect MMPs' willingness and ability to retreat ITM? • How does seasonality affect mosquito density and MMPs' perception of risk of malaria infection or mosquito nuisance? • How does seasonality affect malaria transmission and MMPs' perception of risk of malaria infection? • How does seasonality affect MMPs' willingness to use ITM?		

	Getting nets, clothing, curtains or repellents	Using nets, curtains, clothing or repellents appropriately	Retreating or replacing conventional nets, curtains, clothing or repellents
Norms	• Is malaria seen as a problem in this community? • What are the differences between local (or traditional) and biomedical definitions of malaria? • How is malaria classified by MMPs and by the local health authorities?		
Channels	• Where do MMPs get their usual source of information and advice for commodities? – What communication channels/mediums are most popular among MMPs in this area? – What promotional materials are likely to be favoured by the target populations? • What channels are most effective for reaching MMPs in this area? – What channels are most effective for reaching the different sub-groups of MMPs? e.g. different ethnic groups, women, men, children, labourers, illiterate people, etc. – How should channels differ depending on the setting? What channels should be used in villages? What channels should be used in workplaces? What channels should be used in hard-to-reach locations? – Should promotional activities and campaigns be increased at certain times of the year? (e.g. just before and during peak period of malaria transmission) – Are IEC/BCC materials available in the local language(s) of MMPs? – Are IEC/BCC materials available in verbal and pictorial/visual formats? – Is it possible to engage with MMPs (particularly women) in their local language through verbal campaigns? – Are visual aids and live demonstrations available for illiterate people? – Is it possible to recruit and train peer educators and village health volunteers? – Can campaign launches and closing ceremonies be conducted to encourage community ownership and participation? – Can communities be mobilized and encouraged to participate in vector control schemes and personal protection activities?		

Table 5: Key considerations for planning essential elements of IRS promotional activities among niche populations

	Points to consider when assessing the relevance of and planning the promotion of IRS
Objectives	• Does this area have constantly high annual malaria incidence? Does this area have malaria outbreaks in endemic areas? • Does this area have malaria outbreaks in confirmed foci of malaria transmission in areas targeted for elimination? • Are the local vectors endophagic, endophilic and anthropophagic? • What is the transmission ecology? What is the duration of malaria transmission season in this area?[16]
Product	• Which class of insecticide is appropriate for this setting? Are the local vectors susceptible to the insecticide? What is the toxicity and safety profile of the insecticide?
Audience	• Is this audience appropriate for IRS? – Appropriate audiences may include: land development agencies, plantations, mining industry, hydropower projects • Has this audience been a target of IRS previously? • Is the community likely to be accepting of the intervention?[17] • Is the community likely to be willing to participate in the intervention?
Considerations	• Do we have the management capacity for planning? • Do we have the management capacity for organization? • Do we have the management capacity for implementation? How long should re-spraying continue? • Do we have the management capacity for supervision? • How do we establish technical support linkages with national regulatory authorities and insecticide suppliers? • How do we establish appropriate partnerships with the private sector? • How do we establish partnerships with relevant government ministries? • How do we reduce taxes and tariffs on IRS commodities? • How do we target key stakeholders through IRS advocacy? • Is there a safe storage facility for insecticides, spray pumps, PPE, etc?
Positive consequences	• Mass protective effect of community can be achieved at high coverage. • Potential additional impact on other vector-borne diseases, through integrated vector management.

Negative consequences	• Quality of spraying/IRS may be poor. • Poor spraying may result in incomplete protection of population. • Poor spraying may increase selection pressure for insecticidal resistance. There may be objections to insecticide use from community members. • As a niche activity, may be cost-prohibitive? • Need for regular respraying may be inconvenient and unpopular with householders.
Obstacles	• IRS is inconvenient for householders. • Negative perceptions of safety. • Residual efficacy is relatively short, meaning regular respraying is required. Effectiveness depends on timely spraying before peak malaria transmission period. • How do we establish trust with households and community members? • How can we mobilize the community, ensure their cooperation and create a sense of ownership? • How do we conduct malaria education alongside spraying activities in a cost-effective and time-efficient way? • Do we have the necessary capacity for effective IRS operations? How do we build capacity in this area? • How do we ensure training of spraymen is sufficient to ensure quality of spraying?18 • Do we have the necessary infrastructure for effective IRS operations? How do we build infrastructure for IRS? • How will supply chains affect the effectiveness of this programme? • Whom can we engage with to ensure timely delivery of resources? • Can we ensure that spraying operations are conducted and completed before peak malaria transmission period? • How do we establish effective IRS reporting and recording systems? • What cultural factors need to be considered that may affect perceptions towards IRS? • What cultural factors need to be considered that may affect community participation? • How does seasonality affect mosquito density and MMPs' perception of risk of malaria infection? • How does seasonality affect mosquito density and MMPs' perception of need for IRS? • How does seasonality affect malaria?

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Given their labour or other practices, mobile and migrant populations may have increased exposure to malaria mosquitoes. They are also more likely to have incomplete knowledge of malaria and lower access to preventive measures, and thus require targeted interventions that take into account their specific needs and the nature of their situation. From the broader public health perspective, it is also important to target mobile and migrant populations and their host communities that they pass through, live in or return to with vector control measures given the well-documented link between migration and the spread of malaria in the GMS, particularly in border areas, and the potential spread of multidrug resistant parasites due to population movements in malaria-endemic areas and across borders.

This is a toolkit to guide the management and implementation of malaria prevention programmes for mobile and migrant populations in the GMS. It is targeted to people and organizations that already have some experience in malaria prevention, particularly national programme managers and programme staff working with mobile groups.

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SEA-MAL-280