



Strategy for **Malaria Elimination** in the Greater Mekong Subregion (2015–2030)



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in the Greater Mekong Subregion
(2015–2030)**



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Cover illustration: A family in Pailin, western Cambodia, shows the long-lasting insecticidal bednet from the national malaria programme distributed as part of the emergency response to artemisinin resistance. © WHO

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ACRONYMS AND ABBREVIATIONS

ABER	annual blood examination rate
ACD	active case detection
ACT	artemisinin-based combination therapy
ADB	Asian Development Bank
API	annual parasite incidence
APLMA	Asia Pacific Leaders Malaria Alliance
APMEN	Asia Pacific Malaria Elimination Network
ARCE	Strategy for the containment of artemisinin tolerant malaria parasites in South-East Asia (project from 2009 to 2011)
BCC	Behaviour-change communication
CHW	community health worker
DOT	directly observed treatment
DRC-TEG	WHO drug resistance and containment technical expert group
ERAR	Emergency Response to Artemisinin Resistance in the Greater Mekong Subregion
FAO	Food and Agriculture Organization of the United Nations
G6PD	glucose-6-phosphate dehydrogenase
GDP	gross domestic product
GIS	geographic information systems
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
GMS	Greater Mekong Subregion
GTS	WHO <i>Global Technical Strategy for Malaria 2016–2030</i>
IEC	Information, education, communication
IRS	indoor residual spraying
ITN	insecticide-treated mosquito net
LLIHN	long-lasting insecticidal hammock net
LLIN	long-lasting insecticidal net
LSM	larval source management
M&E	monitoring and evaluation
MPAC	Malaria Policy Advisory Committee (WHO)
NGO	nongovernmental organization
PCD	passive case detection

PCR	polymerase chain reaction
PMI	United States President’s Malaria Initiative
QA	quality assurance
RAI	Regional Artemisinin Resistance Initiative
RDT	rapid diagnostic test
RSC	Regional Steering Committee (for RAI)
TES	therapeutic efficacy study (of antimalarial medicine)

STRATEGY AT A GLANCE

VISION

- A region free of malaria and the continual threat posed by antimalarial drug resistance.

GOALS

- The ultimate goal of the regional strategy is to eliminate malaria by 2030 in all Greater Mekong Subregion countries and, considering the urgent action required against multidrug resistance in the GMS, to eliminate *Plasmodium falciparum* malaria by 2025.
- In areas where malaria transmission has been interrupted, the goal is to maintain malaria-free status and prevent reintroduction.

PRINCIPLES

- All countries can accelerate efforts towards elimination through combinations of interventions tailored to local contexts.
- Country ownership and leadership, with participation of communities, are essential to accelerate progress through a multisectoral approach.
- Improved malaria case¹ and entomological surveillance, monitoring and evaluation, and stratification by malaria disease burden are required to optimize implementation of malaria interventions.
- Equity in access to services is essential, especially for the most vulnerable and hard-to-reach populations.
- Innovation in tools and implementation approaches will enable countries to maximize progress.

OBJECTIVES

1. Interrupt transmission of *P. falciparum* in areas of multidrug resistance, including artemisinin-based combination therapy (ACT) resistance, by no later than 2020², and in all areas of the GMS by 2025.
2. Reduce malaria in all high-transmission areas to less than 1 case per 1000 population at risk and initiate elimination activities by 2020.
3. Prevent the reintroduction of malaria in areas where it has been interrupted.

¹ Case means any infection where, regardless of the presence or absence of clinical symptoms, malaria parasites have been confirmed by quality-assured diagnosis.

² In areas of multidrug resistance, including ACT resistance, that have already been identified, elimination will be achieved as rapidly as possible, and by no later than 2020. Transmission of *P. falciparum* in any additional areas of multidrug resistance, including ACT resistance, detected in the future, will be interrupted as soon as possible depending on the epidemiological setting but by no later than 2025.

PRIORITIES

At regional level

- Eliminate malaria in areas with multidrug resistance, including ACT resistance, surrounding the Cambodia–Thailand border.
- Reduce transmission in high-transmission areas in Myanmar.
- Prevent and respond to the resurgence of malaria.

At country level

- Eliminate malaria in areas of multidrug resistance, including ACT resistance.
- Flatten the epidemiological landscape by reducing transmission in highly endemic areas.

MILESTONES AND TARGETS

By end of 2015

- GMS countries have updated their malaria policies and included malaria elimination in their broader national health policies and planning framework.
- All countries have updated their national malaria strategic plans and action plans based on the strategy for malaria elimination in the GMS.

By end of 2016

- Transmission of malaria in Thailand interrupted in 60% of districts.

By 2017

- Each country has an established system at national level to implement elimination-phase surveillance in areas with low burden and has substantially strengthened malaria case and entomological surveillance in areas of high burden (including case reporting by the smallest administrative unit).
- Universal coverage with long-lasting insecticidal nets (LLINs) achieved for all populations in areas of malaria transmission.

By 2020 or earlier

- Transmission of *P. falciparum* malaria interrupted in all areas of multidrug resistance, including ACT resistance.

By 2020

- *P. falciparum* malaria eliminated in Cambodia.
- Malaria eliminated in Yunnan Province, China.

- All first subnational level administrative units (provinces, states and regions) where malaria has not yet been eliminated are in the elimination phase (with malaria case surveillance meeting WHO standards and annual parasite incidence below 1/1000).

By 2025

- *P. falciparum* malaria eliminated in all GMS countries.
- Malaria eliminated in Cambodia and Thailand.

By 2030

- Malaria eliminated in all GMS countries.

KEY INTERVENTIONS

- **Key intervention 1:** Case detection and management
- **Key intervention 2:** Disease prevention in transmission areas
- **Key intervention 3:** Malaria case and entomological surveillance.

SUPPORTING ELEMENTS

- **Supporting element 1:** Expanding research for innovation and improved delivery of services
 - Development of novel tools and approaches to respond to existing and new challenges, such as insecticide resistance, outdoor biting and varying patterns of population mobility.
 - Operational research to optimize impact and cost-effectiveness of existing and new tools, interventions and strategies.
 - Action to facilitate rapid uptake of new tools, interventions and strategies.
- **Supporting element 2:** Strengthening the enabling environment
 - Strong political commitment and adequate financial support for elimination.
 - Capacity development appropriate to the implementing strategy.
 - Health systems strengthening to facilitate elimination.
 - Policies for delivery of services to meet the needs of mobile and migrant populations.
 - Intersectoral collaboration and community involvement.
 - Advocacy to support collective action.
 - GMS regional functions (including coordination, technical support, capacity-building, cross-border or regional collaboration, monitoring progress, priority research and information sharing).

EXECUTIVE SUMMARY

Over the past 15 years the greatly improved malaria situation in the Greater Mekong Subregion (GMS) is reflected in the steady decline in annual malaria incidence and deaths. However, GMS nations still face daunting challenges as malaria epidemiology in this region exhibits enormous complexity and the disease is concentrated mainly in remote areas.

Plasmodium falciparum is the species of malaria parasite that accounts for 55% of cases and most malaria deaths in the GMS. Resistance of *P. falciparum* to several antimalarial medicines, including resistance to ACTs, has reached alarming levels in several areas of the GMS. In the area straddling the Cambodia–Thailand border, *P. falciparum* malaria could become untreatable with currently available drugs within a few years. Multidrug resistance is both an impediment to elimination and a reason for pursuing it. Therefore, it is imperative that efforts are based on evidence, and are coordinated and monitored.

The *Strategy for malaria elimination in the Greater Mekong Subregion 2015–2030* was developed based on the new WHO *Global technical strategy for malaria 2016–2030* (GTS). It was further refined through a series of consultations that involved the GMS national malaria programmes and their partners, WHO consultants, and staff from WHO's Global Malaria Programme, the WHO Regional Offices for South-East Asia and the Western Pacific, and the WHO Emergency Response to Artemisinin Resistance in the GMS Regional Hub. The strategy also benefited from inputs from the WHO Malaria Policy Advisory Committee. In further articulating the strategy, targets adopted in the national malaria strategic plans in the GMS countries, and the East Asia Summit leaders' agreement to the goal of an Asia Pacific free of malaria by 2030, were taken into consideration.

The ultimate goal of this strategy is to eliminate malaria by 2030 in all GMS countries and, considering the urgent action required against multidrug resistance in the GMS, to eliminate *P. falciparum* by 2025. In areas and countries where transmission has been interrupted, the goal will be to maintain malaria-free status and prevent reintroduction, with particular emphasis on tackling the growing problem associated with imported malaria.

The proposed strategy emphasizes the progression from burden reduction, which needs to

be pursued in high transmission areas, and the elimination phase with rigorous norms for surveillance and management of active foci. In addition, the rapid interruption of transmission in areas affected by multidrug resistance, including resistance to ACTs, is prioritized. In every country and setting, design of operations will be based on a careful assessment of technical and operational factors.

The strategy highlights the necessity of a conducive policy environment both in countries and the subregion. All GMS countries need to seek support from the highest level of state to ensure effective multisectoral engagement; address human resources requirements for malaria centrally and at all levels; ensure effective national leadership and governance, including stakeholder coordination; expand health services to provide full access for people in remote areas; and determine appropriate approaches to sustain community-level services beyond malaria specific services. Malaria programmes must possess a broad range of capabilities and be supported by an enabling environment.

To succeed, the GMS malaria elimination strategy has to be backed by effective national policies in which a high-level intersectoral national malaria committee is established and functional and political commitments are translated into adequate and sustained financing of malaria elimination.

Under the Strategy, in all areas of the GMS:

- the health system is strengthened and able to deliver basic health services, including interventions for malaria elimination;
- universal coverage of disease management is rapidly achieved and maintained;
- universal coverage of appropriate vector control in transmission areas is rapidly achieved and maintained;
- mobile and migrant populations have full access to services; and
- systems for adequate case-based malaria surveillance and collection of entomological data are established and fully functional.

In GMS areas already in the elimination phase and those with no transmission:

- notification of each case of malaria is mandatory;
- operations are based on epidemiological investigation and classification of each malaria case and focus;
- there is total and effective coverage of all active foci with proven vector control measures based on entomological data; and
- a national malaria elimination database is established and operational.

At the GMS level, there is ample scope for a number of functions including training and technical collaboration, collaboration in border areas, ensuring quality of antimalarial medicines, management of high-priority research, monitoring and evaluation, and governance and coordination.

A study to assess the feasibility of eliminating *P. falciparum* malaria in the GMS estimated a total malaria programme cost of US\$ 3.2–3.9 billion over 15 years. The costs including elimination of *P. vivax* have not yet been estimated, but are expected to be only marginally higher. Specific and detailed costing for each country is planned in 2015.

1. BACKGROUND

The Greater Mekong Subregion (GMS) countries are Cambodia, the People's Republic of China (specifically Yunnan Province and Guangxi Zhuang Autonomous Region), the Lao People's Democratic Republic, Myanmar, Thailand and Viet Nam.

The GMS is bound together by the Mekong River, and is characterized by important commonalities in social and economic development, and extensive population mobility within and across national borders. The area considered covers 2.4 million km² and has a population of about 278 million (1).

Over the past 15 years the malaria situation in the Greater Mekong Subregion (GMS) has greatly improved and is reflected in the steady decline in annual malaria incidence and deaths (see Annex 2). However, GMS nations still face daunting challenges as malaria epidemiology in this region exhibits enormous geographical heterogeneity (2). Within each country, malaria distribution is uneven, exemplified by high transmission occurring along international borders, and in forests and forest fringes.

Furthermore, resistance of *P. falciparum* to artemisinin and other antimalarial medicines has reached alarming levels in certain areas of the GMS. In the area straddling the Cambodia–Thailand border, *P. falciparum* is becoming resistant to one medicine after another, and it could become untreatable within a few years. The only solution is to eliminate *P. falciparum* from the GMS. The quandary is that multidrug resistance is both an impediment to elimination and a reason for pursuing it. Therefore, it is imperative that efforts are based on evidence, and are effectively coordinated and monitored.

In September 2014, the Malaria Policy Advisory Committee of WHO (MPAC) reviewed the situation and a malaria elimination feasibility study. It recommended that the affected countries in the GMS adopt the goal of elimination of *P. falciparum* in the GMS by 2030,

to counter the threat of multidrug resistance. MPAC further recommended the establishment of an effective joint subregional governance structure, noting that success will also require greater involvement of the private sector, ongoing operational research, and trialling and validation of novel interventions.

Following this recommendation, a draft strategy paper on the elimination of *P. falciparum* in the GMS was prepared by WHO. The paper was presented and discussed among representatives of the ministries of health of GMS countries, as well as partners, at a workshop in Phnom Penh, Cambodia, in November 2014. There was consensus at the workshop that time-bound elimination of not only *P. falciparum*, but of all species of human malaria, is feasible and should be pursued by all GMS countries, with coordinated support from interested partners. Staff from national malaria programmes worked together to propose specific time-bound targets for each country as well as for shared regions straddling borders. As a result, a second draft of the strategy was prepared and discussed at national consultations during December 2014. This led to a third draft, which was reviewed at an informal consultation with partners on the emergency response to artemisinin resistance, held in Bangkok, Thailand, in February 2015. The version revised on the basis of this consultation was reviewed by MPAC in March 2015.

This final version of the strategy incorporates feedback from all of the consultations described above. It is designed to serve as a framework for revising or developing national level malaria elimination strategies and action plans adapted to local realities, which will then be consolidated and supplemented with regional activities to form a comprehensive GMS malaria elimination action plan. This process should proceed urgently at both country and regional levels.

As well as serving to guide national planning, this strategy will provide countries with an opportunity to apply for funding, both domestic and external, based on a WHO-recommended region-specific strategy. This GMS malaria elimination strategy has been developed in line with the principles of the *Global technical strategy for malaria 2016–2030* (GTS, see Annex 1). The objectives of the GTS are only achievable if the problem of multidrug resistance, including resistance to ACTs, is vigorously addressed in the GMS.

The need for a GMS malaria elimination strategy

Various factors have converged to create an urgent need for action to eliminate malaria in the GMS: the magnitude of the global threat of drug resistance, the substantial impact of the scaled-up interventions currently being applied, the commitment of governments, the keen interest of partners, and the momentum of recent scientific advances.

The rationale for undertaking malaria elimination in the subregion is based on the following observations:

- scaled-up interventions on malaria have had a marked impact, particularly on *P. falciparum*, bringing malaria incidence down to such low levels that interruption of transmission appears to be a realistic objective in the subregion;
- further delay in addressing the problem of multidrug resistance could lead to the emergence of untreatable *P. falciparum* malaria;
- affected countries and partners have reaffirmed their political and financial commitments to achieving a greater impact and eliminating malaria; and
- there is a need to establish an effective mechanism to ensure proper intercountry coordination of malaria elimination activities, particularly where movement across international boundaries occurs.

The international attention and political commitments given to malaria elimination in recent years are now being translated into real action, and should be leveraged for the planning and implementation of elimination interventions across the GMS.

2. THE STRATEGY FOR MALARIA ELIMINATION IN THE GREATER MEKONG SUBREGION (2015–2030)

2.1 Vision, goals, principles and objectives

VISION

- A region free of malaria and the continual threat posed by antimalarial drug resistance.

GOALS

- The ultimate goal of the regional strategy is to eliminate malaria by 2030 in all GMS countries and, considering the urgent action required against multidrug resistance in the GMS, to eliminate *P. falciparum* by 2025.
- In areas where malaria transmission has been interrupted, the goal is to maintain malaria-free status and prevent reintroduction.

PRINCIPLES

In line with the GTS, this GMS malaria elimination strategy adopts the following principles:

- all countries can accelerate efforts towards elimination through combinations of interventions tailored to local contexts;
- country ownership and leadership, with participation of communities, are essential to accelerate progress through a multisectoral approach;
- improved malaria case and entomological surveillance, monitoring and evaluation, and stratification by malaria disease burden are required to optimize implementation of malaria interventions;
- equity in access to services is essential, especially for the most vulnerable and hard-to-reach populations; and
- innovation in tools and implementation approaches will enable countries to maximize progress.

OBJECTIVES

The strategy has three objectives:

1. To interrupt transmission of *P. falciparum* in areas of multidrug resistance, including ACT resistance, by no later than 2020³, and in all areas of the GMS by 2025.
2. To reduce malaria in all high-transmission areas to less than 1 case per 1000 population at risk and initiate elimination activities by 2020.
3. To prevent reintroduction of malaria transmission in areas where it has been interrupted.

These three objectives will be achieved through the implementation of a number of key activities, presented below. Further details on implementation are presented in Section 2.4.

OBJECTIVE 1. To interrupt transmission of *P. falciparum* in areas of multidrug resistance, including ACT resistance, by no later than 2020, and in all areas of the GMS by 2025

Deterioration in the efficacy of ACTs in specific areas and the risk of malaria becoming untreatable in the GMS with the currently available drugs calls for urgent and aggressive measures.

Key activities should include:

- Reduce transmission rates through:
 - universal coverage of at-risk populations with LLINs or IRS and supplementary measures where appropriate;
 - reduction of the parasite reservoir through effective treatment and use of low-dose primaquine for *P. falciparum*;
 - deploying newly recommended transmission reduction tools.
- Apply universal parasitological confirmation of malaria through:
 - reinforcing quality microscopy and increasing access to quality assured RDTs;
 - using diagnostics correctly also in the private sector;
 - adhering to results of microscopy or RDTs.
- Supervise drug administration where possible to help to ensure adherence.

³In areas of multidrug resistance, including ACT resistance, that have already been identified, elimination will be achieved as rapidly as possible, and by no later than 2020. Transmission of *P. falciparum* in any additional areas of multidrug resistance, including ACT resistance, detected in the future, will be interrupted as soon as possible depending on the epidemiological setting but by no later than 2025.

- Ensure efficacious treatment is recommended in national treatment policy by:
 - performing routine monitoring of therapeutic efficacy of first- and second-line medicines;
 - timely change of antimalarial treatment policy.
- Eliminate foci of *P. falciparum* malaria by:
 - rapid detection and full treatment of cases through intensified surveillance and response;
 - detection and treatment of asymptomatic parasite carriers by screening appropriate populations using rapid and highly sensitive diagnostic tools with appropriate WHO recommended tests;
 - full vector control coverage (100%) of all populations in active foci of malaria;
 - adopting measures to prevent the export of parasites to other areas where possible.
- Strengthen malaria case and entomological surveillance.
- Focus on detecting, protecting and providing access to diagnosis and treatment for priority population groups (e.g. mobile and migrant populations).

OBJECTIVE 2. To reduce malaria in all high-transmission areas to less than 1 case per 1000 population at risk and initiate elimination activities by 2020

In high-burden areas, massive and rapid scale-up of existing disease prevention and management interventions, aimed at achieving a significant reduction in malaria burden, should form a transitional stage on the path to elimination, reducing the risk of spread of malaria to areas approaching elimination.

Key activities should include:

- strengthen malaria programme management, to ensure that it is operating optimally at all levels of the health system;
- strengthen the malaria case and entomological surveillance system, to efficiently gather, use and disseminate data;
- deliver preventive measures appropriate to local vector biology, transmission settings and populations characteristics to accelerate the impact on transmission, morbidity and mortality;
- provide diagnosis and treatment in health facilities and at community level;
- ensure delivery of a comprehensive package of interventions to hard-to-reach, at-risk populations;
- empower at-risk populations by ensuring they understand the disease through culturally

- appropriate and gender sensitive communication;
- rapidly roll out newly recommended tools and interventions, where locally appropriate, to accelerate progress towards elimination; and
- initiate programme reorientation towards malaria elimination.

OBJECTIVE 3. To prevent reintroduction of malaria transmission in areas where it has been interrupted

As areas and countries achieve interruption of transmission, programmatic focus needs to shift to prevention of reintroduction. The probability of malaria becoming re-established in a malaria-free area varies according to the area's receptivity and vulnerability. When importation of malaria (e.g. due to the arrival of refugees, soldiers or migrant workers from a malaria-endemic area) coincides with high receptivity (e.g. as a result of halting anti-malaria measures or of socioeconomic changes) re-establishment of malaria transmission can occur.

The following activities should be implemented:

- establish an early warning system to monitor malaria risk factors in terms of vulnerability and receptivity in order to predict and prevent re-establishment of malaria transmission;
- establish a reliable malaria case and entomological surveillance system with full coverage of malaria risk areas;
- maintain adequate epidemiological and entomological capabilities with an effective operational research component, to determine risk and underlying causes of transmission resumption;
- ensure easy access to reliable laboratory diagnosis, and effective and radical treatment for every individual;
- establish an epidemic preparedness and alert system; and
- ensure participation of at-risk communities and population groups in malaria prevention activities.

When malaria-free status is achieved, travel-associated and imported malaria will become a growing medical and health issue in all GMS countries. This situation will pose a hazard to the individuals who acquire malaria, because the disease may remain undiagnosed or be incorrectly diagnosed, resulting in high case–fatality rates.

Health systems should be strengthened to:

- improve early diagnosis of all cases of imported malaria and strengthen case-notification systems;
- treat promptly and adequately all imported malaria cases within the public and private health sectors, and prevent onward transmission and risk of death from imported malaria; and
- improve preventive practices among travellers through effective and evidence-based pre-travel health advice.

Once an elimination programme has been successfully implemented, the national government may officially proclaim that nationwide elimination of malaria has been achieved. To obtain international recognition of such a declaration, WHO certification is required.

2.2 Approach

PRIORITIZATION

This strategy aims for an accelerated scale-up of appropriate interventions in all endemic areas, tailored to the local epidemiology. Nevertheless, there is a need to prioritize at both regional and country level, at least initially.

Factors to be considered include the past and current intensity of transmission in an area, the degree of resistance to different antimalarial drugs and the size and mobility of affected populations. If a high-burden area is located near a low-burden area, then early reduction of transmission in the high-burden area will likely make it easier to achieve elimination in both.

Based on these considerations, the priorities at **regional level** must be:

- eliminating malaria in areas with multidrug resistance, including ACT resistance, around the Cambodia–Thailand border;
- reducing transmission in high-transmission areas in Myanmar; and
- preventing and responding to the resurgence of malaria.

The priorities at **country level** must be:

- eliminating malaria in areas of multidrug resistance, including ACT resistance; and
- flattening the epidemiological landscape by reducing transmission in highly endemic areas.

Local analysis may identify additional priorities.

This prioritization does not mean that efforts to eliminate malaria in low-transmission areas should be put on hold, only that such efforts must not take precedence over addressing severe drug resistance and burden reduction. In most countries, certain areas should be eligible for the elimination phase as soon as the necessary systems have been developed. Once the epidemiological landscape has been flattened, and all major areas achieve malaria incidence below 1 case per 1000 people at risk per year, then the entire country should be eligible for the elimination phase, which will simplify operations.

PROGRAMME PHASING

Successful malaria elimination requires a distinction between a transmission-reduction phase, where a combination of interventions is applied in all endemic areas, and an elimination phase, where these measures can be targeted to remaining foci and surveillance intensified with measures to rapidly detect and cure every case. Phasing is necessary, because premature application of the elimination-phase approach would be prohibitively demanding. Thus, the malaria burden must be lowered before it is possible (and rational) to investigate and treat every case. Programme phasing on the path to malaria elimination has two components:

- *The transmission-reduction phase* aims to bring malaria incidence down to a level at which elimination can be considered (below 1 case per 1000 people at risk per year⁴). Interventions aim to reduce transmission and have an impact on morbidity and mortality. This involves aggressive scaling up of effective preventive and curative interventions to achieve universal coverage in transmission areas.
- *The elimination phase* aims to reduce incidence to zero. Malaria case and entomological surveillance become the core interventions – every case is investigated and managed to avoid onward transmission. Based on the investigated foci of transmission identified, appropriate vector control and antimalarial drug-based interventions are deployed to rapidly interrupt transmission.

⁴Confirmed by population-based reporting from facilities with known catchment areas, very high and reliable case notification and, ideally, full participation of the private sector.

Although different parts of a country may belong to different programme phases, phasing should normally be applied to large areas (provinces, counties in the case of China and states or regions in Myanmar). Countries that are not yet in the elimination phase should focus on assessing when each target area will reach the threshold for entering the elimination phase. In all GMS countries, incidence has already fallen below this threshold in at least some provinces, and elimination-phase surveillance and other activities should be implemented in those areas. Establishing an elimination-phase surveillance system must start immediately as it can take several years, because it includes setting up databases and quality assurance (QA) systems, preparing and testing standard operating procedures at central level and training various staff at all levels (3).

The objectives of the national elimination programme have been achieved when:

- locally acquired malaria cases have been reduced to zero; and
- health services and malaria case and entomological surveillance operations are fully capable of preventing re-establishment of malaria transmission.

Once elimination has been achieved, the maintenance of malaria-free status should be the responsibility of general health services, as part of their normal function in communicable disease control, in collaboration with other relevant sectors.

There is consensus that for the elimination of malaria in the GMS, *P. falciparum* is a priority. However, the prioritization of *P. falciparum* is not of great operational importance, because in most endemic districts, both *P. falciparum* and *P. vivax* are found, and the same vector control strategies are applied. The key difference is in the treatment, where ensuring radical cure for all *P. vivax* cases poses a challenge.

2.3 Milestones and targets

The following timetable, with milestones and targets, is proposed for implementation of the GMS malaria elimination strategy. All of the country-specific elimination targets have been identified by the respective ministries of health.

By end of 2015

- GMS countries have updated their malaria policies, and included malaria elimination in the broader national health policies and planning framework.
- All countries have updated their national malaria strategic plans and action plans based on the strategy for malaria elimination in the GMS.

By end of 2016

- Transmission of malaria in Thailand interrupted in 60% of districts.

By 2017

- Each country has an established system at national level to implement elimination-phase surveillance in areas with low burden, and has substantially strengthened malaria case and entomological surveillance in areas of high burden (including case reporting by the smallest administrative unit).
- Universal coverage with LLINs achieved for all populations in areas of malaria transmission.

By 2020 or earlier

- Transmission of *P. falciparum* malaria interrupted in all areas of multidrug resistance, including ACT resistance.

By 2020

- *P. falciparum* malaria eliminated in Cambodia.
- Malaria eliminated in Yunnan Province, China.
- All first subnational level administrative units (provinces, states and regions) where malaria has not yet been eliminated are in the elimination phase (with malaria case and entomological surveillance meeting WHO standards and annual parasite incidence is below about 1/1000).

By 2025

- *P. falciparum* malaria eliminated in all GMS countries.
- Malaria eliminated in Cambodia and Thailand.

By 2030

- Malaria eliminated in all GMS countries.

2.4 Key interventions and supporting elements

Key interventions are aimed at guiding regional- and country-level actions to eliminate malaria in the GMS context, with the proposed elimination strategy based on the following three key interventions and two support elements. The three key interventions are:

The three key interventions are:

1. Case detection and management
2. Disease prevention in transmission areas
3. Malaria case and entomological surveillance.

The two supporting elements are:

1. Expanding research for innovation and improved delivery of services
2. Strengthening the enabling environment.

2.4.1 Key interventions

KEY INTERVENTION 1. Case detection and management

Components of case management

Universal coverage with early diagnosis and effective treatment reduces morbidity, mortality and transmission. Case detection can be done through passive case detection (PCD), active case detection (ACD), as well as screening for malaria cases in high-risk groups. In the elimination

phase, case detection and management activities aim to find and treat all cases according to national treatment policies and ensure that every case and treatment outcomes are reported to the national surveillance system.

Case management and surveillance are intimately linked. In the transmission-reduction phase, case management is primarily oriented towards decreasing morbidity and mortality. In the elimination phase, case management becomes part of surveillance, which has the goal of preventing secondary transmission from any case. Table 1 lists the main differences between case management policies and practices in the transmission-reduction and elimination phases.

Table 1. Case management in transmission-reduction and elimination phases

	TRANSMISSION-REDUCTION PHASE	ELIMINATION PHASE
Purpose	Early diagnosis of symptomatic cases and effective treatment of all detected cases to reduce transmission, morbidity and mortality.	Early detection and treatment of all cases to prevent onward transmission.
Diagnosis policy	All suspected cases should be examined by RDT or microscopy.	All suspected cases must be examined by RDT or microscopy.
Treatment policy	<i>P. falciparum</i> : ACT as defined by national policy; single dose of PQ is recommended. <i>P. vivax</i> : CQ, provided that efficacy is confirmed by TES, otherwise ACT.	<i>P. falciparum</i> : ACT as in transmission-reduction phase; single dose PQ is mandatory. <i>P. vivax</i> : CQ or ACT as in the transmission reduction phase; PQ is mandatory; G6PD status should be used to guide administration of primaquine for preventing relapse. When G6PD status is unknown and testing not available, decision must be based on assessment of risks and benefits of adding primaquine (41).
Service delivery	All public health services. Private medical practitioners. Not-for-profit sectors (NGOs). Informal private sector. Community-based services.	Same as transmission-reduction phase, but over-the-counter sale of antimalarial agents prohibited and informal private sector not allowed to treat malaria cases; service provision by other sectors (e.g. military, corporate sector) follows national norms and is monitored. Largely, universal coverage has been achieved.
Standby treatment	May be considered for certain migrant groups if it is impossible to provide diagnosis.	The same as in transmission-reduction phase, but this should be exceptional and be monitored.

ACT, artemisinin-based combination therapy; CQ, chloroquine; G6PD, glucose-6-phosphate dehydrogenase; NGO, nongovernmental organization; PQ, primaquine; TES, therapeutic efficacy study.

Case detection

The detection of malaria infection is primarily based on blood examination by RDTs or microscopy. With QA in place, both are now suitable for surveillance and case management, but microscopy has advantages for follow-up of patients, detection of gametocytes and determination of parasite density. Rapid diagnostic tests (RDTs) for detection of *P. falciparum* and/or non-*P. falciparum* infections should be available at health facilities and community-level services, while quality-assured microscopy should be made available at hospitals and malaria laboratories at district and higher intermediate and central levels. Determining what kind of diagnostic methods or their combinations to use at various levels requires analysis by each national programme.

Diagnostic methods with a higher sensitivity than RDTs and microscopy, such as polymerase chain reaction (PCR) or other molecular-based techniques, can detect parasite carriers with very low parasite densities. However, the definitive roles of these more sensitive methods in the transmission-reduction and elimination phase will depend on the epidemiological significance of low-density infections and the future availability of user-friendly, rapid, affordable tools. Currently, most molecular-based methods require a laboratory with sophisticated equipment and skilled personnel, and therefore samples must be transported for analysis. This approach may be appropriate in large scale surveys settings but not for case management.

Treatment

Treatment for *P. falciparum* and non-*P. falciparum* malaria should be based on national treatment policies and WHO guidelines. Currently, all medicines recommended for the treatment of uncomplicated *P. falciparum* malaria are ACTs. Treatment should include primaquine to eliminate gametocytes, responsible for mosquito-borne transmission of malaria. Primaquine may cause haemolysis in G6PD deficient patients but for treatment of *P. falciparum* malaria, a safe low dose of primaquine has been identified and recommended by WHO.

In patients infected with *P. vivax*, the standard treatment is CQ or ACT plus a 14 day course of primaquine. The G6PD status of patients should be used to guide administration of primaquine for preventing relapse. For *P. vivax* malaria, the safest solution is screening for G6PD deficiency prior to primaquine administration. Recently, more user-friendly, point-of-care G6PD tests have become available. These tests, however, cannot identify all patients at risk of haemolysis (e.g. female heterozygotes), and experience with their use in the field in the hands of routine health workers is limited. Therefore, operational research and/or piloting with monitoring are needed.

Universal coverage of case management

Achieving universal coverage with case management requires three channels of service delivery to be considered: public, private and community based. The optimal mix of these will vary among and within countries. While malaria incidence remains high, maximizing coverage through all three channels is likely to be the best approach, provided efforts are made to improve quality. In the elimination phase, the roles for each channel should be defined, depending on countries' situations and local conditions, to ensure optimal case management, surveillance and reporting in all areas.

The public health sector

In areas well served by health facilities, all health institutions in the sector serve as free diagnosis and treatment centres for malaria. Restricting certain services to public health facilities can help to ensure that they are delivered according to standard guidelines. However, the public health sector in some countries remains under-resourced and challenged by human resources and supply chain issues, while the health service network coverage is inadequate, especially in thinly populated areas.

The private health sector

Several national programmes have engaged with the private sector for delivery of malaria curative services. The private health sector includes medical practitioners, licensed pharmacies, non-licensed drug vendors, authorized services belonging to private companies catering to their employees, and not-for-profit services such as nongovernmental organizations (NGOs) and faith-based organizations. All of these can be involved in case management, provided that the public sector invests in communication, training, monitoring and, in many cases, provision of diagnostics and medicines. NGOs can have a key role in providing quality services. The informal private sector (in the form of drug vendors) is a major source of irrational treatment and substandard medicines. The strategies for addressing this issue can range from prohibiting them from treating malaria to fully enlisting them. Such schemes usually include an element of social marketing. Each country needs to develop a strategy for determining the most appropriate role for various types of private providers. In the elimination phase informal providers refer cases only and are not involved in treatment.

Community-level services

Most GMS countries already have well established free community-based case management services for malaria. Technically, community service providers are a part of public services, but the providers themselves are usually volunteers, who depend on the support of their community or an NGO, or are paid by performance. These services are usually the best solution for remote areas.

Services for mobile and migrant populations

Providing services for mobile and migrant populations is essential. Elimination will not be achieved unless these population groups have access to malaria protection measures, early diagnosis and treatment.

Mobile populations are difficult to reach for a number of reasons, including undocumented status for some. Improving their access to health services can be a complex multisector task (4). Although some migrants employed in informal or even illegal labour may prefer to avoid any contact with public services, others in regular legal employment may be easy to work with if they and their employers are approached in a sensitive manner.

Different modalities for service provision can be considered. Thailand's 'one-stop centres' for migrants provide information on malaria and may distribute LLINs. In Cambodia and elsewhere, mobile malaria workers recruited from migrant groups by the malaria programme appear to have been successful in delivering curative services. For solitary migrants and smaller migrant groups, it may be more effective to set up fixed-schedule mobile clinics to give treatment at specific times or places. Screening of migrants, including at border crossings, has worked well in some places. For the management of such differentiated services, intersectoral cooperation and proactive and systematic collection of information on migrants are key. Province-level malaria units should include mobile teams for managing malaria in mobile and migrant populations. These teams may overlap with elimination-phase surveillance teams and should travel to wherever migrants spend time, including key transit points, and ideally be authorized to work across borders when necessary. Mobile teams should also work with migrant recruitment agencies and with health authorities in places where migrants start their journeys (5).

Quality assurance

Quality assurance of diagnostics, treatment, patient care and surveillance is important in both transmission-reduction and elimination phases. The only difference is that QA of microscopy is even more essential in the elimination phase.

Diagnostics

It has become easier for countries to procure quality RDTs (6), however, there is still a need for better methods to ensure product quality control at point of care prior to use. In the elimination phase microscopy QA requires considerable investment and attention (7).

Antimalarial medicines

For case management, it is critical that medicines are of good quality. Efforts to eliminate counterfeit and substandard medicines carried out over many years in GMS countries must be continued and enhanced. Areas of work fall into the following broad categories:

- strengthening drug regulatory agency functions to:
 - eliminate artemisinin monotherapy products and register only quality-assured medicines, and diagnostics;
 - strengthen quality assurance during and after registration to prevent the manufacture and sale of substandard products;
 - intensify surveillance to detect and eliminate the sale of spurious, falsified, falsely labelled and counterfeit products;
 - improve national capacity for quality-control testing and cross-border enforcement activities to reduce the flow of counterfeit and substandard products;
- improving supply management to reduce any shortages and prevent stock out in the public supply chain;
- engaging the private sector to improve the availability of quality-assured products and eliminate substandard, falsified and counterfeit drug sales; and
- improving rational and responsible use of all malaria medicines to reduce unnecessary overuse that may contribute to resistance.

Key areas of focus include ensuring a sustained global supply of diagnostics and medicines; promoting the development of innovative technologies to address market shortcomings; and ensuring the quality of available malaria commodities through adequate registration,

good procurement practices and regular quality monitoring. Achieving this will require strong regional and national coordination of interventions related to pharmaceutical and commodity supply (including streamlining of stakeholders' efforts in this area), as well as cross-border and regional coordination.

QA of case management services

Supervision is the key to QA of patient care, and should be applied with clear protocols and monitoring systems. The directly observed treatment (DOT) principle should support patient adherence and monitoring. The problem is that many patients cannot remain in one place for the duration of the treatment. Until more evidence is available, programmes must conduct their own evaluation on where and when to apply DOT.

Standby treatment

Standby treatment – decided without a diagnostic test by the patient or somebody close to the patient – is a common practice, which has often been incriminated in relation to resistance to antimalarials in the GMS. With greatly improved service coverage and especially the availability of RDTs, this should now be much less needed. However, some mobile groups may be so small and isolated that standby treatment may be an option.

KEY INTERVENTION 2. Disease prevention in transmission areas

Vector control measures for transmission prevention

The selection of appropriate vector control interventions is to be guided by eco-epidemiological stratification informed by malaria case and entomological surveillance data. Implementation should be within the framework of integrated vector management. Use of insecticidal interventions will be guided by technical recommendations provided in the *Global plan for insecticide resistance management in malaria vectors* (42).

Table 2 lists the main differences between vector control in the transmission-reduction and elimination phases.

Table 2. Vector control in transmission-reduction and elimination phases

	TRANSMISSION-REDUCTION PHASE	ELIMINATION PHASE
Purpose	To reduce transmission intensity.	To reduce onward transmission from existing cases.
Stratification of malaria situation	Definition of major eco-epidemiological strata, with allocation of appropriate vector control by strata.	Foci-based stratification, with categorization of active and potential foci.
Vector control policy	Universal coverage of all at-risk populations with LLINs or IRS and supplementary measures where appropriate (e.g. long-lasting insecticidal hammock nets, larval source management, repellents) with special emphasis on mobile and migrant populations.	Geographical reconnaissance. Full coverage (100%) of all populations in active foci of malaria, with a view to interrupting transmission in a focus as soon as possible. Maintain universal coverage of at-risk populations with vector control in all areas in which malaria transmission has been interrupted.
Entomological surveillance	Yes	Yes
Monitoring and management of insecticide resistance	Yes	Yes
Epidemic preparedness and response	Yes	Yes
Research, technology, monitoring and evaluation	To introduce a GIS-based database on malaria vector bionomics and insecticide resistance. To consider operational research on technical and operational feasibility, effectiveness and sustainability of current or new vector control approaches.	A central repository of information related to entomological monitoring, and application of chosen vector control interventions established and fully functional.

GIS, geographic information systems; IRS, indoor residual spraying; LLIH, long-lasting insecticidal hammock net; LLIN, long-lasting insecticidal mosquito net.

Long-lasting insecticidal nets (LLINs)

LLINs have been shown to reduce malaria incidence by around 30% in forested areas in the GMS, despite the local malaria vectors being somewhat exophilic (outdoor resting) and exophagic (outdoor biting) (8, 9). LLINs are a core malaria prevention measure, widely used to reduce transmission and provide personal protection.

To achieve and maintain universal coverage of populations in areas of transmission requires distribution of LLINs based on actual needs. Analysis of the age and gender of malaria cases at village level, backed by an analysis of treatment-seeking behaviour in the different population groups, should indicate whether transmission is occurring locally, and thereby allow more strategic and cost-effective targeting of LLINs and related interventions.

Distribution of LLINs will be done through mass campaigns, coupled with locally appropriate and gender sensitive IEC/BCC to ensure high and correct usage. Factors to be considered when nets are distributed include which members of a household share a sleeping space. A population-wide coverage level of one net per two persons at risk does not necessarily mean that each household will have enough nets to protect all household members. Maintenance of coverage can also be an issue, with the effective lifetime of nets known to vary between settings. To maintain high levels of coverage and usage between mass campaigns, there should be a distribution system to continuously make additional or replacement nets available. Appropriate continuous distribution systems should be identified for each specific setting. Points of contact such as shops, plantation owners, the military and community malaria workers may be involved. While use of antenatal clinics may be feasible in forest villages, in forest-fringe environments this may not be suitable as risk is usually concentrated in adult males. Managers at all levels need real-time information on operations, to address gaps and problems before they have a negative impact. Currently, data on coverage of LLINs is often collected by surveys carried out at intervals of one year or more and may have limited geographical scope. There is a need for more dynamic monitoring of LLIN coverage to allow programmes to react in a timely manner to low coverage levels caused by losses or the arrival of mobile population groups in a particular risk area.

Indoor residual spraying

The effectiveness of indoor residual spraying (IRS) is constrained by factors similar to insecticide-treated mosquito nets (ITNs) and by the open nature of the construction of typical shelters in forested areas of South-East Asia. Spraying is carried out in Viet Nam in areas with low net coverage, and in other countries as an outbreak response intervention. In Cambodia, IRS has been a part of the strategy for eliminating artemisinin resistance. The consensus among experts is that regular preventive IRS is not an appropriate option in the GMS except in special circumstances, such as in areas where ITNs are not accepted for cultural reasons or for use as a resistance management strategy. Focal IRS should, however, be part of the set of tools that can be applied in outbreaks or as a short-term measure, to help interrupt transmission in persistent transmission hot spots where surveillance data indicate local transmission.

IRS operations across the GMS are conducted in different ways and are in need of better QA. Possibly because of the limited scale of operations, procurement cycles sometimes encounter serious delays, and there is a need to address stockpiling and related issues. These operational issues should be rectified by informed needs estimates and good planning.

Larval source management

Larval source management (LSM) refers to all measures to reduce mosquito breeding, including targeting aquatic habitats with larvicides and environmental modification or manipulation. LSM is applicable where breeding sites are few, fixed and findable. Currently, there are 12 WHO recommended mosquito larvicides representing five different mode of actions although most current formulations have limited residual efficacy, and the role of LSM in insecticide resistance management is as yet undetermined. Identification of all breeding sites is notoriously difficult in malaria-endemic forest and foothill areas of the GMS, and although larvivorous fish are used in some programmes, the confidence in their effectiveness is low. However, new methods of application of insect growth regulators make it possible to consider their use in situations where the contact between humans and vector populations is limited to defined areas.

Long-lasting insecticidal hammock nets

Long-lasting insecticidal hammock nets (LLIHNS) can provide some protection for forest workers and other high-risk mobile and migrant groups, but have only been adopted on a large scale in Cambodia. While LLIHNS have not yet been assessed by WHO, their use has potential in some settings (12, 13). These may be most appropriate in areas where there is already a culture of hammock net use (e.g. Viet Nam), though experience from Cambodia suggests that this situation could be changed through communication and delivery. Where LLIHNS are not already part of national strategies, evidence on acceptability and effectiveness may be generated through local pilot studies. Work will be required to identify the best delivery mechanisms for each of the various target groups. In Cambodia, the malaria programme is making LLIHNS available as part of 'forest packs', containing a hammock, an LLIHNS, personal repellent and information on malaria prevention and treatment, which are delivered through strategically positioned private outlets.

Spatial repellents

Spatial repellents may have potential as a supplementary measure to LLINs and IRS for reducing human–vector contact and controlling malaria transmission and disease. However, despite increased research efforts during the past several decades, the mechanism of repellency is not yet fully understood. The utility of spatial repellents for both malaria and dengue control is currently under evaluation in multi-country trials (39), and outcomes will inform the integration of this tool into vector control strategies in the GMS.

Personal protective measures

Vector control products that protect specific populations in certain circumstances but do not necessarily contribute to community protection also have public health value and importance (40). These include hammocks, clothing, curtains, wall hangings, material-based emanators, blankets and tents. However, the safety, acceptability and effectiveness of specific products within these paradigms have yet to be comprehensively evaluated by WHO and hence their contribution to malaria control and the conditions governing their appropriate deployment have not yet been defined. The burden is therefore on national programmes to generate sufficient local evidence to inform their use.

Personal repellents and insecticide-treated clothing may be of interest for application in forest-related malaria settings, where transmission takes place outdoors while certain risk groups are active. Personal repellents must be applied repeatedly; thus, there needs to be high compliance and a regular supply from the programme or an employer and availability for individuals to purchase. So far, these delivery channels have not been established.

Insecticide-impregnated clothing has the advantage of requiring limited behaviour change. Recent intervention trials using permethrin-impregnated clothing have shown a marked reduction in the risk of malaria infection among users, but there is still a lack of data on skin absorption and potential adverse effects. The use of pyrethroid-treated clothing would not be appropriate in areas where there is pyrethroid resistance.

Drug based interventions

Chemoprophylaxis

Chemoprophylaxis should be provided to international travellers going to high-risk areas in and outside the GMS, and is particularly important in the elimination phase. The drugs for chemoprophylaxis are currently limited to mefloquine, doxycycline and atovaquone-proguanil (14).

Mass drug administration

The emerging threat of antimalarial drug resistance and the renewed focus on malaria elimination has been accompanied by reconsideration of mass drug administration (MDA) as a means for rapidly eliminating malaria in a specific region or area. In MDA, the objective

is to provide therapeutic concentrations of antimalarial drugs to as large a proportion of the population as possible in an area in order to cure any asymptomatic infections and also to prevent reinfection during the period of post-treatment prophylaxis.

During mass campaigns, every individual in a defined population or geographical area is requested to take antimalarial treatment at approximately the same time and at repeated intervals in a coordinated manner. This requires extensive community engagement to achieve a high level of community acceptance and participation. The optimum timing depends of the elimination kinetics of the antimalarial. Depending on the contraindications for the medicines used, pregnant women, young infants and other population groups may be excluded from the campaign. Thus, the drugs used, the number of treatment rounds, the optimum intervals and the support structures necessary are all context-specific and are still subject to active research. MDA rapidly reduces the prevalence and incidence of malaria in the short term, but more studies are required to assess its longer-term impact, the barriers to community uptake, and its potential contribution to the development of drug resistance. The role of MDA in acceleration towards elimination is currently being evaluated by WHO (41).

KEY INTERVENTION 3. Malaria case and entomological surveillance

Malaria case surveillance

The elimination phase is defined by the application of malaria case surveillance according to specific and rigorous standards. Table 3 presents the main differences between malaria case surveillance in the transmission-reduction and elimination phases in the GMS. The transition from transmission-reduction to elimination phase will require revision of guidelines, recruitment of staff, training and supervision (3).

Malaria case surveillance in the elimination phase aims at:

- detecting and notifying all malaria infections, and ensuring that they are given early treatment, to prevent secondary cases; and
- investigating each malaria case to determine whether it was locally acquired or imported; case investigation and classification should be completed within one to three days.

Once a local case of malaria has been detected and notified, a focus investigation is carried out by malaria staff to assess the risk of transmission in the locality where malaria occurred.

Design of malaria case surveillance

The design of a malaria surveillance system depends on the level of malaria transmission and the resources available to conduct surveillance. In the transmission-reduction phase, there are still many cases of malaria; hence, it is not possible to examine and react to each confirmed case individually. Instead, any response is based on aggregate numbers, and action is taken at a population level. As transmission is progressively reduced, it becomes increasingly possible (and necessary) to track, investigate and respond to individual cases.

The government can regulate reporting by formal health providers which makes it easier to incorporate details into national malaria surveillance systems. In contrast, the informal health sector is more difficult to include, because of a lack of regulation and enforcement. In the elimination phase, the roles for each provider should be clearly defined, depending on each country's situation and local conditions. This will help to ensure that quality malaria data are provided on a timely basis from public, private and community-based health sectors, and from autonomous health services, such as military, border forces, police, private companies and development projects.

Table 3. Surveillance policies and practices in transmission-reduction and elimination phases

	TRANSMISSION-REDUCTION PHASE	ELIMINATION PHASE
Purpose	To allow targeting of interventions, detection of potential outbreaks and tracking of progress.	To discover any evidence of the continuation or resumption of transmission; detect local and imported cases as early as possible; investigate and classify each case and focus of malaria; provide a rapid and adequate response; and monitor progress towards malaria elimination.
Data reporting, recording and indicators used	Private sector is requested to report cases. Aggregate numbers of outpatients, including those with uncomplicated <i>P. falciparum</i> malaria. Number of inpatients with severe or complicated malaria, and deaths due to malaria. Conventional malariometric indicators (API, SPR, ABER).	Malaria is a notifiable disease. Private sector must report every case by law. Number of local and imported cases, and residual or new active and potential foci of malaria.
Detection method	PCD at all levels of health system. ACD in high-risk groups, especially migrants.	PCD at all levels of health system. ACD to fill gaps in PCD system, in order to detect infections as early as possible, with particular focus on high-risk groups. Reactive ACD in case investigation and clearing of foci.
Case and foci identification, investigation and classification	No	Yes
Technology, monitoring and evaluation	Consolidate the use of new tools such as web-based data transmission, volunteer reporting via SMS. Introduce case-based malaria surveillance.	Adequate case- and foci-based malaria surveillance fully functional across the entire territory of a country. National computerized malaria elimination database or register established. National malaria elimination monitoring committee set up.
Data elements	Aggregate counts, health facilities or districts/villages.	Case based, foci.
Case definition	Confirmed clinical cases.	Any malaria infection (symptomatic and asymptomatic).
Case investigation	Admissions, deaths.	All cases.
Timescale	Monthly.	Immediate notification.

ABER, annual blood examination rate; ACD, active case detection; API, annual parasite incidence; PCD, passive case detection; SPR, slide positivity rate.

Monitoring of resistance to antimalarial agents

Monitoring of resistance should be done in each country, based on most recent WHO guidelines. First-line treatment efficacy should be monitored through therapeutic efficacy studies (TES), where blood samples are also collected and analysed for molecular markers of resistance.

Once the number of patients falls to low levels, it is no longer possible to perform TES; instead, the focus should be on attempting to follow up all patients (especially *P. falciparum* patients) on the days specified in the WHO TES protocol.

Human resources and infrastructure for surveillance in the elimination phase

Health staff and malaria volunteers can usually be trained to investigate malaria cases. In hospitals, this is often done by laboratory technicians. The investigation form, when filled in, is normally forwarded to a province or district malaria officer, who reviews it, classifies the case and communicates it to higher levels, where it is again reviewed. The investigation and management of foci requires a team that includes staff trained in epidemiology, entomology and operations management. Such mobile teams normally need to be present at province level.

Timeliness of response is key, and China provides a good example with its '1–3–7 initiative'. This requires malaria cases to be reported within one day, full case investigation to be conducted within three days, and response actions to be taken within seven days. Such a scheme makes it clear to health workers what is required; it also allows the monitoring of performance against a benchmark (15).

Detection and prevention of malaria outbreaks and epidemics

It is essential to ensure that mechanisms are in place to predict outbreaks where possible, detect them at early onset and rapidly respond with a comprehensive package of services to halt transmission at the earliest opportunity.

ACD, focused screening and treatment (FSAT) and focal-responsive IRS, combined with early detection and prompt treatment of malaria through the existing health services, have proven to be effective in containing transmission and preventing the further spread of epidemics in affected areas.

In accordance with the most likely risk scenarios, national contingency plans should be worked out with an indication of the channels to be used to import any necessary supplies and an identification of resources to be rapidly mobilized. The effectiveness of preventive action is heavily dependent on the speed with which national health services mobilize the necessary resources.

Entomological surveillance

Knowledge of entomological aspects is key to selecting appropriate vector control interventions and monitoring their impact on mosquito populations. Entomological surveillance can include assessments of species distribution, densities, aquatic habitats, feeding and resting behaviours. Monitoring of the susceptibility of vector populations to insecticides used or planned for use is critical. Resistance to DDT has been reported for malaria vectors from all five countries in the GMS, and pyrethroid resistance has been reported for Cambodia, Thailand and Viet Nam. Increased use of pyrethroids in agriculture is likely to exert further selective pressure for resistance and may well prove to be an important risk factor (10).

Entomological surveillance systems should be established to actively monitor for changes in key parameters such as species composition and sensitivity to insecticides in relation to interventions and malaria epidemiology. Resultant entomological data can be used to inform programmatic decisions such as the choice of insecticide for IRS or priority areas for combining LLINs and IRS for resistance management purposes.

Spot checks may be conducted randomly in selected areas to supplement routine entomological observation or to obtain a clearer indication of the effects of control measures. Entomological foci investigations are undertaken in areas of new or persistent active foci to determine why there is transmission (e.g., to ascertain whether it is due to insecticide resistance or to a shift to outdoor biting vectors) and to identify the best approaches for maintaining effective control or sustaining elimination. Entomological intelligence is also useful to evaluate risk of reintroduction where malaria-free status has been achieved recently.

Establishing and maintaining such surveillance systems requires human and infrastructural capacity – vector technicians and facilities such as insectaries and laboratories appropriately placed to support vector sampling, identification and characterization at sites selected based on eco-epidemiological representativeness. Countries need to ensure that they maintain a core group of trained entomologists to carry out monitoring, make recommendations

about any necessary changes in interventions or delivery strategies (11), and to address any elimination-specific challenges. Decisions on the monitoring and management of insecticide resistance should be informed by national plans developed on the basis of a comprehensive situation analysis.

2.4.2 Supporting elements

The strategy has two supporting elements, each covering a number of key requirements for the successful implementation of the GMS elimination strategy.

1. Expanding research for innovation and improved delivery of services

- Development of novel tools and approaches to respond to existing and new challenges, such as outdoor biting and varying patterns of population mobility.
- Operational research to optimize impact and cost-effectiveness of existing and new tools, interventions and strategies.
- Action to facilitate rapid uptake of new tools, interventions and strategies.

2. Strengthening the enabling environment

- Strong political commitment and adequate financial support for malaria elimination.
- Capacity development appropriate to the implementing strategy.
- Health systems strengthening to facilitate malaria elimination.
- Policies for delivery of services to meet the needs of mobile and migrant populations.
- Intersectoral collaboration and community involvement.
- Advocacy to support collective action.
- GMS regional functions (including coordination, technical support, capacity-building, cross-border or regional collaboration, monitoring of progress, priority research and information sharing).

The rest of this section discusses each of these key requirements for the successful implementation of the GMS elimination strategy.

SUPPORTING ELEMENT 1. Expanding research for innovation and improved delivery of services

The potential novel interventions described here will require a concerted research effort to move quickly towards operational adoption. Equally important is operational research that addresses bottlenecks in operations and finding innovative ways to effectively deliver services to hard-to-reach populations.

Among the potential areas of research for innovation and improved delivery of services are:

- mass drug administration;
- triple combination therapies;
- improved molecular diagnostic techniques;
- test kits for G6PD for community level;
- endectocides reducing the survival or fecundity (or both) of mosquitoes that feed on those people, thus reducing vectorial capacity;
- vector control, including more cost-effective deployment of LLINs, alternative interventions for personal protection, and spatial repellents; and
- vaccines.

It is important to distinguish between novel interventions that would require limited operational research to become applicable (e.g. kits for detection of G6PD status, repellents and insecticide-treated clothing, and molecular diagnostic techniques) and those that still require a systematic, multidisciplinary and objective-oriented research effort, such as endectocides and vaccines.

The main lesson from the current status of implementation of standard methods is that any tool to be introduced should be accompanied by operational or implementation research to optimize coverage and quality, and limit wastage. Between policy adoption and wide application of a novel intervention, there is usually an interval of at least three years. To meet timelines, especially for *P. falciparum* elimination, it will be necessary to introduce and scale up novel interventions rapidly in eligible areas, once the interventions are approved. New interventions used should be effective for areas and population groups where standard interventions have already had a major impact, but are not achieving the annual parasite incidence 1/1000 benchmark or, having achieved the benchmark, are not reaching zero.

SUPPORTING ELEMENT 2. Strengthening the enabling environment

Strong political commitment and adequate financial support for elimination

To succeed, the GMS malaria elimination strategy has to be backed by effective national policies, in which:

- a high-level multisectoral national malaria elimination committee or task force is set up and functional;
- political commitment is translated into adequate and sustained financing of malaria elimination;
- the health system is strengthened and is able to deliver basic health services, including interventions for malaria elimination;
- malaria is made a notifiable disease;
- adequate case-based malaria surveillance is established and fully functional across the country;
- the planning of elimination measures is based on epidemiological investigation and classification of each malaria case and focus;
- universal coverage of disease management is supported;
- full coverage with proven vector-control measures of all populations in active foci of malaria; and
- a national malaria elimination database is set up and operational.

Successful malaria elimination requires adequate planning and budgeting (permitting programme staff to focus on implementation issues rather than fund-raising), and activities should be conducted with sufficient lead time and the necessary mobilization of resources.

A strong participatory approach (with clear roles and responsibilities of all partners concerned), and regular exchange of information and consultations between WHO, partners and national programmes, should be encouraged and promoted, to enable the regional partnership to function more effectively and to better coordinate malaria elimination efforts and facilitate resource mobilization.

It is crucial for every GMS country to ensure that adequate financial resources are available during all phases of the strategy.

Countries must be prepared to increase national investments. As an elimination programme proceeds, the costs shift towards human resources, and, when the country is malaria free, towards general health services. Greater flexibility is also needed as the epidemiology changes. With such changes, government funding is likely to be more efficient. Therefore, national commitment, which is so crucial for the achievement and maintenance of elimination, will be gauged by the extent to which domestic investments are increased, and this becomes important in leveraging donor support.

Nonetheless, external funders should remain mobilized to support the common long-term objective. Elimination of malaria in the GMS is both a regional and global public good, because addressing resistance of *P. falciparum* to antimalarial agents is both a driver and an outcome of the GMS elimination programme with global repercussions. Thus, it merits continued support from global as well as emerging regional development partners. Stability of funding is essential for an elimination programme as delays in disbursements can lead to malaria resurgence, where gains made over five years can be lost in less than five months.

Various options for innovative financing to support malaria elimination programmes have been reviewed (16), and a combination of some of these mechanisms might well support malaria elimination. The Asia Pacific Leaders Malaria Alliance (APLMA) is well placed to analyse which schemes would be best adapted to country-specific situations, or collectively to the GMS malaria context. However, this requires strong involvement of all the national governments concerned and relevant partners.

Capacity development appropriate to the implementing strategy

Technical capacity within national programmes has declined in several GMS countries in recent years due to a number of factors, including an ageing workforce, limited opportunities for high-level training, and increased staff attrition due to recruitment by partner agencies. Urgent steps will need to be taken in affected countries to strengthen capacity at all levels of the health system in line with the demanding requirements for elimination.

Health systems strengthening to facilitate malaria elimination

The health systems in most of the GMS countries need to be strengthened in terms of human resources, services, financing, information systems and governance. Conversely, all the GMS countries have strong economic growth and their health systems are improving. The following health system functions are of particular concern, and in decision-making and planning for elimination they should be analysed at the highest level of the ministry of health and possibly at cabinet level.

- **Human resources**

Due to the need for strong surveillance systems and high quality of all operations, human resources must increase at all levels. In the malaria elimination phase, some personnel should be devoted to malaria; alternatively, general public health staff may have sufficient time for malaria surveillance and response, in which case they should be trained accordingly. Staff must be motivated and maintained until transmission is interrupted, and possibly thereafter, at least for some time. Human resources required will appear to be disproportionate to the disease burden, and this can be justified by referring to overall programme goals.

- **Financial allocations**

During the elimination phase financial allocations need to be maintained, despite low burden and even after the attainment of malaria-free status, because surveillance systems to prevent reintroduction are costly in countries with high receptivity and vulnerability (17). Donors will expect to pay decreasing proportions of the elimination budget, because the major expenditures are for human resources. Thus, after interruption of transmission, it is unrealistic to expect significant donor support.

- **Governance and regulation**

The two main issues are pharmaceutical regulation and regulation of the private sector. In the elimination phase, malaria must be a notifiable disease. Enforcing the relevant legislation will be a major challenge in countries where most fever patients seek care in the informal private sector. There is no example of a country having eliminated malaria in this situation.

- **Administrative capacity**

The recruitment and maintenance of human resources (from the village volunteer to the programme manager) and access to services depends not only on commitment and financial allocations, but also on the capacity of the system to plan and implement budgets, execute payments on schedule, and rapidly reallocate or mobilize funds to deal with unexpected events. Administrative disruptions can lead to malaria epidemics and derail elimination programmes.

- **Leadership and management in the malaria programme**

Adoption of a malaria elimination strategy increases the need for leadership and management in malaria programmes. Operations will need to be managed with rigour and flexibility, supported by robust monitoring and quality control. Programmes will need to be responsive to the evolving needs of the elimination effort and risks will need to be taken in the interests of innovation and to accelerate programmatic impact.

The reality is that some malaria programmes in the GMS have lost staff in recent years, because of competing priorities. Elimination activities are not necessarily cost-effective in the short run and do not always respond to the population's perceived needs or necessarily support the development of health systems. It is not surprising that in many of the elimination success stories around the world the presence of a respected and inspiring leader was a crucial element.

NGOs are often well placed to provide support which extends to distribution of LLINs, surveys, insecticide resistance studies and health education.

In summary, for a programme having elimination as its objective the following capabilities must be present at the central level, and to some extent, at other levels:

- technical competence;
- ability to advocate, communicate and convince;
- ability to manage human and financial resources and time;
- ability to work with partners and other sectors, and within the health sector;
- ability to train other professionals;
- ability to interpret and use epidemiological and operational information; and
- information management skills.

In addition, when adopting a malaria elimination objective, higher levels of ministries of health must ensure:

- malaria elimination is recognized at cabinet level as a national concern, led by the ministry of health and involving all relevant sectors;
- there is oversight by a higher level than the ministry of health (or at least by the top level of the ministry of health);
- reports are scrutinized by the cabinet or a parliamentary committee; and
- the malaria programme is given administrative power to re-programme and react rapidly to emergencies, recruit additional short-term staff as needed and mobilize funds.

Policies for delivery of services to meet the needs of mobile and migrant populations

At-risk populations will need prompt access to free quality services, despite low population density, mobility, different languages and undocumented status. This requires sustained investments on the part of the ministry of health, including for general health service staff in remote areas.

Intersectoral collaboration and community involvement

Social and environmental determinants of malaria are not the sole responsibility of a single sector (18). For example, although the association between rubber plantations and malaria is well known in South-East Asia, the potential for re-emergence of malaria should receive substantially more attention from economic, agricultural and environmental planning bodies. Understanding the influence of land use change on malaria occurrence is critical for shaping future surveillance strategies (19). As highlighted by the recent work on developing a multisectoral approach to malaria (18), several recommended strategies could be seen as applicable to GMS countries for greater coordination between health and non-health sectors, as well as within the health sector.

- Trade and industry sectors should be involved in developing corporate social responsibility programmes for improved health which includes malaria prevention and treatment. Large-scale infrastructure, agriculture, mining, oil and gas exploration projects are attracting significant local and foreign investment and labour forces in GMS countries. There is a need for clearer guidance on the type of services companies could provide (e.g. awareness, vector control, case management and surveillance), which could be achieved through a menu of options relating to the nature of business (20).
- Evidence to demonstrate the clear economic advantage of malaria investment (building a business case) needs to be presented (18). Opportunities for integrating malaria in financing mechanisms for other non-health sectors that impact malaria, such as food security and adaptation to climate change, should be sought. In doing this, it is important to realize that there is no one-size-fits-all solution for private sector engagement in country elimination plans, and that the right actions must be identified per sector and per company, based on comparative advantage and strengths. As shown by recent initiatives in Myanmar, one method that can be initiated by national malaria programmes is conducting a thorough mapping exercise of companies (for a start among those that have corporate social responsibility programmes or those that have already malaria prevention and control activities) and their geographic/population catchment areas.
- A few countries in the GMS have documented Public Private Partnership/Public Private Mix (PPP/PPM) initiatives for diagnosis and treatment as well as prevention. In this regard, two recommendations can be proposed: (a) country malaria elimination programmes develop a PPP/PPM legislative framework to clarify how the private sector should work

with government/public sector entities and work in consultation with stakeholders and in-country partners, as initiated in Myanmar through its accreditation scheme with companies and other non-state actors; and (b) national programmes should include in their elimination plans participatory research or other methods to determine the incentives for other sectors to contribute to malaria control. These may vary for different sectors: agriculture, climate change and food security, the impact of urbanization and population mobility on malaria; and the potential of the military in implementing malaria control (18).

- To scale up multisectoral malaria programmes at country and subnational levels as well as an action-oriented implementation, a research, monitoring and evaluation component should be included. The articulation of an endorsed and validated results framework with key expected results and indicators for monitoring a country programme's multisectoral engagement activities should be considered. This results framework should also include strong political will and commitment to malaria at the highest level and inclusion of malaria elimination as an issue in national development plans (18).

Countries should also explore how financing opportunities in non-health sectors can be leveraged for malaria, for example the potential of using revenues from extractive industries investments.

Service provision

To be effective, intersectoral action needs to be supported by high-level political leaders; ministries of health alone are not usually powerful enough to motivate other ministries or the corporate sector for effective collaboration. Adoption of malaria elimination as a national goal offers an opportunity for enactment of policies mandating intersectoral collaboration by the cabinet or prime minister's offices. Such commitment at the highest level should then be reflected at lower administrative levels, to ensure that health staff are: informed in advance about population movements and other potential risk factors; involved in planning of development projects; and has sufficient collaboration with the other sectors, whether public or private, to implement the necessary mitigation measures.

Recruiting agencies and employers of migrant labour (e.g. for large-scale development, plantations and infrastructure projects) may be known or can be identified. There may be opportunities for providing migrants with information and commodities through those involved in their transport or accommodation, or through NGOs providing social services.

There are good examples of collaboration with plantations owners and petroleum or gas companies in GMS. Ministries of health may lack administrative procedures for binding agreements with private enterprises; sometimes such agreements can be facilitated by involving entities with specific expertise.

Efforts are required to ensure that military, police and security forces have access to malaria services. This cannot be taken for granted, because their health services may be underfunded. WHO has developed guidelines for the United Nations regarding security forces from the GMS who serve as peacekeepers or participate in exercises or training in other countries.

Prophylaxis for travellers to endemic areas also needs to be supported by intersectoral collaboration with travel agencies.

Producers and importers of malaria control commodities

Producers of various tools for control of malaria could be engaged in malaria elimination beyond the sale of products. For example, producers can be contracted to deliver products closer to the point of use, taking advantage of commercial supply chains. This could be useful for obtaining different types of LLINs to suit different consumer demands. Producers could also be engaged in provider and consumer education, and cooperate in bundling commodities in kits with instructions for use (e.g. nets with insecticide packs for treatment).

Such collaboration will also help a country to prepare for malaria-free status, for example, where some populations in receptive areas are still at risk of reintroduction, but the risk is not high enough to justify continued vector-control coverage by the public health system. The availability of consumer-friendly quality products through commercial channels could be an efficient way to reduce transmission risk.

Community involvement

Another crucial element is the involvement of communities, and their partnership with the health sector to empower them in their own health development. Malaria prevention must go hand in hand with community participation. Unless individuals in communities see the merits of preventing the illness, even the best-designed prevention strategies might not be used. It is necessary to understand existing behaviours that may either complement or hinder preventive measures. Knowledge, attitudes and practices should be assessed to ensure that strategies and approaches are compatible with the practices, customs

and beliefs of various social groups and minorities, and to develop effective information, education and communication (IEC) strategies and targeted materials. Community and family care, and preventive practices, should be strengthened through the provision of IEC materials as well as capacity-building through mass media and community support. Health education and community participation can greatly facilitate the work, reduce the cost and help to ensure success. The supportive involvement of local people can be fostered through community awareness sessions to explain malaria interventions and their benefits.

Advocacy to support collective action

Advocacy can leverage political commitment, create new funding opportunities and support partnerships. Economic modelling is required to develop robust cost–benefit modelling that focuses on elimination targets. This is a core need for ongoing elimination advocacy.

There are a number of global and regional malaria partnerships that could provide a platform for elimination advocacy. Advocates for malaria elimination can work within developmental frameworks, building synergies with other health and social programmes, to maximize outcomes from investment and prevent competition for increasingly scarce resources.

Key elements of advocacy for malaria elimination in the GMS are likely to include (21):

- this regional strategy document, supported by international health bodies, including the World Health Assembly and WHO;
- a regional elimination plan with national and regional components, together with thorough costings and tools to support the business case;
- core elimination advocacy messages;
- provision of advocacy tools for partners;
- extensive and effective community engagement; and
- strong partnerships.

Malaria elimination is a dynamic process. Elimination advocacy will need to adapt to new technologies and research findings, emerging successes and challenges, changes in the sociopolitical landscape of eliminating countries and changes in global health financing. The global malaria community needs to work together to ensure that the early steps are taken to reach the end goal of malaria elimination.

GMS regional functions

Although national leadership is the centrepiece of this strategy, there is a clear need for a supportive and coordinating platform at the regional level. The key areas of focus at regional level are outlined below.

Coordination

Governance and coordination of malaria activities across the GMS is essential and must be improved at both the regional and country level (*see Section 4*).

Technical support and capacity-building

To address future needs and achieve elimination of malaria, a creative and innovative approach to capacity development should be promoted at regional, national and subnational levels. National programmes should be supported and coordinated to:

- develop and regularly update human resource development plans;
- maintain a core technical group of adequately trained professionals with the necessary epidemiological expertise to address the new elimination challenges;
- update knowledge and enhance the skills of specialized and general health staff;
- ensure that training programmes are updated as necessary to support national elimination strategies (training should be oriented to tasks and problem solving and supported by regular supervision and needs-based refresher courses); and
- ensure that training increases the motivation of health staff to maintain their skills and competence and remain in service.

Generally, the malaria programmes in the GMS have benefited from more technical collaboration than others because of the complexity of malaria problems and the fact that drug resistance is seen as a global threat. In consequence, most of the capabilities required for control and elimination are present within each country. Nevertheless, with the adoption of a GMS malaria elimination strategy there will be additional need for training and technical collaboration in direct relevance to:

- malaria elimination approaches, using WHO's manuals and training materials, adapted to the epidemiology of GMS;
- information technology, including management of geographical information;
- QA for microscopy and RDTs;
- new methods, such as diagnostic techniques, if and when these have been sufficiently validated for operational use;
- entomological surveillance and vector-control QA.

Some capabilities are probably better developed by workshops, where participants learn from each other. These should include:

- advocacy and intersectoral collaboration;
- management of malaria in mobile and migrant populations; and
- intersectoral collaboration and management of human resources for elimination.

Cross-border and regional collaboration

The GMS countries belonging to the WHO South-East Asia and Western Pacific Regions share many commonalities in relation to eco-epidemiological and socioeconomic settings. Therefore, closer coordination and cooperation should be promoted through the regular exchange of malaria-related information of mutual interest. This should include provision of regular updates on the malaria situation in border areas, organization of border meetings and participation in interregional trainings.

Many meetings have been conducted with representatives from GMS countries' disease control programmes to discuss intercountry collaboration, including cross-border operations. Presently, the Regional Artemisinin Resistance Initiative (RAI), which is supported by the Global Fund, supports cross-border operations. This is a difficult area because of issues of national sovereignty, and because those working at border areas may be far from the national capitals where decisions are made.

As progress towards malaria elimination in the GMS gathers momentum, it may be necessary to create intercountry oversight bodies on cross-border collaboration that can meet regularly and quickly resolve any issues that might jeopardize the elimination effort. Such collaboration should be facilitated at high levels of governance, in line with the East Asia Summit decisions. In the context of malaria elimination, special attention should be given to situations where there is a risk of malaria spreading between countries. In particular, there should be a focus on endorsement of joint statements on cross-border collaboration and development, or implementation of joint border action plans, to facilitate malaria elimination measures in border areas.

Product quality is also a cross-border issue, and a need may now exist for a well-coordinated and funded regional programme that involves all relevant government agencies and other stakeholders, including relevant regional bodies.

Progress monitoring

A coordinated six country elimination effort requires careful monitoring of progress and periodic evaluation (*see section 2.5 below*).

Priority research

Regional oversight of research activities at national level is needed to minimize unnecessary duplication and to take full advantage of any opportunities for collaborative research and synergy.

Information sharing

Sharing information quickly and effectively, particularly between neighbouring countries, will help to ensure a coordinated regional approach to any of the numerous potential malaria-related issues that have cross-border implications.

2.5 Measuring progress and impact

Monitoring and evaluation

National malaria elimination programmes should be evaluated at regular intervals for compliance with the targets and objectives to be achieved. Parameters should be established to monitor and evaluate all programme areas, with a focus on four key issues:

- monitoring the operational aspects of the programme, and measuring impact or process indicators to ensure that the activities are yielding desired results and moving the programme towards achieving its operational targets and objectives;
- monitoring changes in epidemiological indicators resulting from the activities implemented;
- appropriately interpreting results and informing revisions in policies or strategies, when needed, to help ensure progress; and
- documenting progress towards malaria elimination.

Information on coverage and quality of interventions, mapping out residual and new active foci of malaria, relevant eco-epidemiological data and first-line treatment efficacy are particularly important.

For the elimination phase, each country will need to establish a malaria elimination database. This will serve as the national repository of all information related to malaria elimination, and should include the following.

- National malaria case register: a single database of all individual case information from identified sources in the entire country, allowing detailed analysis and synthesis of epidemiological information and trends, which can help to guide the elimination programme over time.
- Malaria patient register: a central repository of all malaria patient records.
- Laboratory register: a single database, linked to the patient register, which contains all pertinent information regarding malaria diagnosis of the patient. Comparison of the laboratory and malaria patient registers allows cross-checking for completeness of case data.
- Entomological monitoring and vector-control records: a central repository of information related to entomological monitoring and application of chosen vector-control interventions.

Ideally, the oversight of the malaria elimination database should be the responsibility of a national committee that is independent of the malaria programme (22).

Progress on the path to malaria elimination within the GMS will be based on countries' surveillance efforts. Progress will be measured using multiple data sources, including routine information systems, household and health facility surveys, and longitudinal studies. Progress should be monitored through a minimal set of outcome and impact indicators (see Annex 3 & 4) drawn from a larger set of indicators recommended by WHO and routinely tracked by malaria programmes.

Essential steps in strengthening monitoring and reporting

A number of essential activities will need to be implemented to develop and strengthen the surveillance, monitoring and reporting systems required for the effective implementation of the GMS malaria elimination strategy.

At national level, strengthening of surveillance, monitoring and evaluation (SME) will need to include:

- establishment of country SME technical working groups;
- updating of the national SME plan;
- SME capacity-building;
- establishment of a national malaria elimination database;

- regular external or joint malaria programme reviews; and
- annual national malaria reporting.

At subregional level, strengthening SME will need to include:

- establishment of intercountry SME technical working groups;
- development of a GMS surveillance and monitoring and evaluation (M&E) framework;
- harmonization and standardization of SME tools;
- monthly reporting against a GMS scorecard;
- establishment of a web-based data sharing platform; and
- joint external monitoring and evaluation.

M&E framework

A draft M&E framework has been developed by the WHO ERAR Regional Hub, in consultation with GMS countries and partners. The framework, which was reviewed by the ERAR SME Regional Technical Working Group, will be adjusted to suit the *Strategy for malaria elimination in the Greater Mekong Subregion (2015–2030)*. In further refining the framework, the following principles and assumptions will be taken into account.

- Malaria surveillance is the central component in M&E in the elimination phase. Programmes are assumed to be capable of rapidly transferring funds to ensure coverage and quality.
- Operationally, the main information requirement is to indicate which areas are in the elimination phase at a given point in time. Based on the criteria for the elimination phase, it is possible to distil a shortlist of criteria that can be verified for each first level administrative area. From the perspective of coordinated GMS elimination, it is then important to report exactly which administrative units have reached this operational status.
- Indicators on surveillance coverage are central to verification of elimination and to its sustainability. One indicator can be collected from surveys asking people what kind of provider they will go to or went to last time, in case of fever. The other should cover all kinds of health service provider, and the questions should address how the provider would manage a case of fever and how it would be reported, if the provider manages malaria. In countries that have eliminated malaria, health services are usually reasonably well developed. Setbacks on the pathway to malaria-free status or reintroduction of malaria are often related to lack of awareness on the part of physicians and other kinds of service providers.

3. COST OF IMPLEMENTING THE STRATEGY

In 2015, a costing exercise of malaria elimination will be carried out in collaboration with the national malaria programmes in each GMS country and then consolidated at regional level.

A cost estimate for *P. falciparum* elimination was prepared as part of an elimination feasibility study done in 2014. This cost estimate was based on the funding gap analysis developed by WHO to mobilize resources for resistance containment. This analysis was expanded to cover the period until 2030 and to include a new set of activities for elimination. The projection is made for the 15-year period from 2015 to 2030 (see Table 4).

Table 4. Total costs and distribution of costs by category for two scenarios for elimination of *P. falciparum* malaria in the GMS, 2015–2030

	SCENARIO 1	SCENARIO 2
Assumptions	Relatively difficult to reduce <i>P. falciparum</i> malaria; continued need for high coverage with LLINs in all high- and low-transmission areas.	Faster decline of <i>P. falciparum</i> ; high coverage of LLINs only in high-transmission areas and 40% of low-transmission areas; gradual cost-sharing for community health workers.
Costs		
Total cost 2015–2030, US\$	3.9 billion	3.2 billion
Vector control	27%	22%
Case management	26%	23%
Surveillance	17%	22%
Private sector	7%	9%
Supporting activities	23%	24%

Based on the specific assumptions included in these estimates, the total cost of eliminating *P. falciparum* malaria in the GMS would range from US\$ 3.2 to 3.9 billion over 15 years; that is, it would be an average of US\$ 1.8–2.2 per capita for the population at risk of malaria per year. Although the total cost is significant it should not be out of reach. These costs should be weighed against the epidemiological and economic costs of inaction.

4. GOVERNANCE AND COORDINATION

There is a general consensus that governance and coordination of malaria activities across the GMS is essential, and must be improved at both the regional and country level.

Countries need to establish strong and proactive national malaria elimination committees responsible for monitoring progress and coordination. Efforts to strengthen coordination will need to focus on strategic planning, research, data sharing, resource mobilization, review mechanisms, communications and advocacy, oversight of implementation, division of labour and private sector engagement.

At regional level, a governance and coordination structure would comprise three components: a political component with strong country representation; a technical component led by WHO; and a financial component responsible for fund-raising and fund management.

The final regional governance and coordination structure for malaria elimination in the GMS will be determined by countries in consultation with partners. In proposing options for a future governance structure for malaria elimination in the GMS, several principles need to be taken into account, as outlined below.

Strong country ownership and representation

National governments are key to the success of the elimination effort and need to take the lead role in governance.

Building on existing structures

If one of the reasons to strive for better coordination is to improve efficiency, this is unlikely to benefit from yet another separate mechanism. With this in mind, and to guard against duplication of mechanisms in the future, the structure adopted needs to be acceptable to a range of partners, including those that are currently funding, or may in future be funding, malaria elimination in the region.

Key stakeholders and constituencies adequately represented

This does not mean that every stakeholder can participate directly in the mechanism, because this would result in an unmanageably large group. Constituencies (e.g. civil society organizations, NGOs, private sector, academia and military) should be asked to agree on a regional representative to participate in meetings of the governance mechanism.

Strong engagement and accountability of members

It is critical that members of the governance mechanism are actively engaged. This is more likely if they are selected for their interest in malaria elimination, if the mechanism gives them authority to influence the use of resources and they are provided with appropriate and up-to-date information.

Ability to challenge

Effective governance mechanisms need to be able to question the information being provided to them and, where necessary, call for its verification. Whatever the governance mechanism decided for malaria elimination in the GMS, it is likely to benefit from being reported to by an independent monitoring group that can provide an objective assessment of how malaria elimination activities are progressing across the region.

Flexibility to respond to changing circumstances

The governance mechanism should not be bound by institutional limitations that make decision-making a lengthy process. The mechanism must be empowered to make decisions.

Accepting of risk

Elimination of malaria will require innovation, which almost always involves risk. The governance mechanism should not be set up under the auspices of an organization that is highly risk averse.

Stability

Funding and the institutional base for the governance mechanism and its secretariat need to be predictable for a reasonable duration.

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Annex 1. The WHO *Global technical strategy for malaria 2016–2030* at a glance

VISION – A WORLD FREE OF MALARIA			
Goals	Milestones		Targets
	2020	2025	2030
1. Reduce malaria mortality rates globally compared with 2015	>40%	>75%	>90%
2. Reduce malaria case incidence globally compared with 2015	>40%	>75%	>90%
3. Eliminate malaria from countries in which malaria was transmitted in 2015	At least 10 countries	At least 20 countries	At least 35 countries
4. Prevent re-establishment of malaria in all countries that are malaria-free	Re-establishment prevented	Re-establishment prevented	Re-establishment prevented
Principles <ul style="list-style-type: none"> All countries can accelerate efforts towards elimination through combinations of interventions tailored to local contexts. Country ownership and leadership, with involvement and participation of communities, are essential to accelerating progress through a multisectoral approach. Improved surveillance, monitoring and evaluation, as well as stratification by malaria disease burden, are required to optimize the implementation of malaria interventions. Equity in access to services especially for the most vulnerable and hard-to-reach populations is essential. Innovation in tools and implementation approaches will enable countries to maximize their progression along the path to elimination. 			
Strategic framework Comprising three major pillars, with two supporting elements: (1) innovation and research and (2) a strong enabling environment			
Maximize impact of today's life-saving tools <ul style="list-style-type: none"> Pillar 1. Ensure universal access to malaria prevention, diagnosis and treatment Pillar 2. Accelerate efforts towards elimination and attainment of malaria-free status Pillar 3. Transform malaria surveillance into a core intervention 			
Supporting element 1. Harnessing innovation and expanding research <ul style="list-style-type: none"> Basic research to foster innovation and the development of new and improved tools Implementation research to optimize impact and cost-effectiveness of existing tools and strategies Action to facilitate rapid uptake of new tools, interventions and strategies 			
Supporting element 2. Strengthening the enabling environment <ul style="list-style-type: none"> Strong political and financial commitments Multisectoral approaches, and cross-border and regional collaborations Stewardship of entire health system including the private sector, with strong regulatory support Capacity development for both effective programme management and research 			

Source: The WHO *Global technical strategy for malaria 2016–2030*

The Greater Mekong Subregion malaria elimination strategy is based on the principles, strategies and support elements described in the GTS. The WHO *Global technical strategy for malaria 2016–2030* elimination strategy roll-out will be guided by the three pillars and supporting elements, adapted in response to local epidemiological settings.

Annex 2. The malaria situation in the Greater Mekong Subregion

Historical aspects and lessons learnt

Malaria control in the GMS began in the 1930s. In the 1950s, WHO promoted mass drug administration with chloroquine as an additive to household salt, and by 1960, chloroquine-resistant *P. falciparum* had emerged on the Cambodia–Thailand border. Genetic studies indicate that chloroquine resistance then spread from South-East Asia to India and later to Africa. About 20 years later, resistance to sulfadoxine-pyrimethamine emerged in Thailand, and soon after some of the causative polymorphisms spread from Thailand to Africa (23).

As with other endemic regions, during the late 1950s and 1960s the GMS participated in the WHO-coordinated Global Malaria Eradication Programme. While the programme was successful in eliminating malaria from most temperate countries, it failed to achieve its goal and was abandoned in 1969 (24). It was recognized that the weapons used had been inadequate against two challenges: the high vectorial capacity in African savannah areas and the convergence of resilient vectors and population movement in the forests and forest fringes of South-East Asia and South America.

After termination of the Global Malaria Eradication Programme, China, Thailand and Viet Nam maintained strong control programmes and saw gradually reducing malaria burdens. Viet Nam experienced a resurgence in 1990–1991, but from 1992 the situation once more improved, thanks to increased investments and the adoption of insecticide-treated mosquito nets (ITNs) and artemisinin-based antimalarials. From the mid-1990s, Cambodia and then the Lao People's Democratic Republic began to attract international support and were able to introduce new tools and start to reduce their malaria burdens.

Progress accelerated around 2003 thanks to the adoption of ACTs, RDTs and high levels of coverage of interventions, which became possible with support from the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund). However, Myanmar was neglected and, because of the continued high burden there, the disease has persisted in western Thailand and in Yunnan Province, China. From around 2011, increased international support for Myanmar has allowed increased coverage with malaria control interventions with the result that the country is now catching up with others in the subregion.

Recent history and current trends

Estimates of malaria morbidity and mortality show a 35% reduction in cases between 2000 and 2012, and a 30% reduction in the annual number of malaria deaths. The estimates are derived from routine surveillance data adjusted for factors such as health-seeking behaviour. In 2012, Myanmar accounted for 77% of the estimated cases and 79% of estimated malaria deaths in the GMS, and the regional trends in incidence in the last few years have been dominated by the significant reductions there. Population at risk, reported cases and deaths and trends since 2000 are shown in table A2.1. In Cambodia, reported malaria cases have also been falling, but in the Lao People's Democratic Republic, malaria resurgence has led to an increase in the number of reported cases (*Fig. A2.1*). Increases in numbers of reported cases in recent years have occurred because of more inclusive reporting in Cambodia, Myanmar and Thailand.

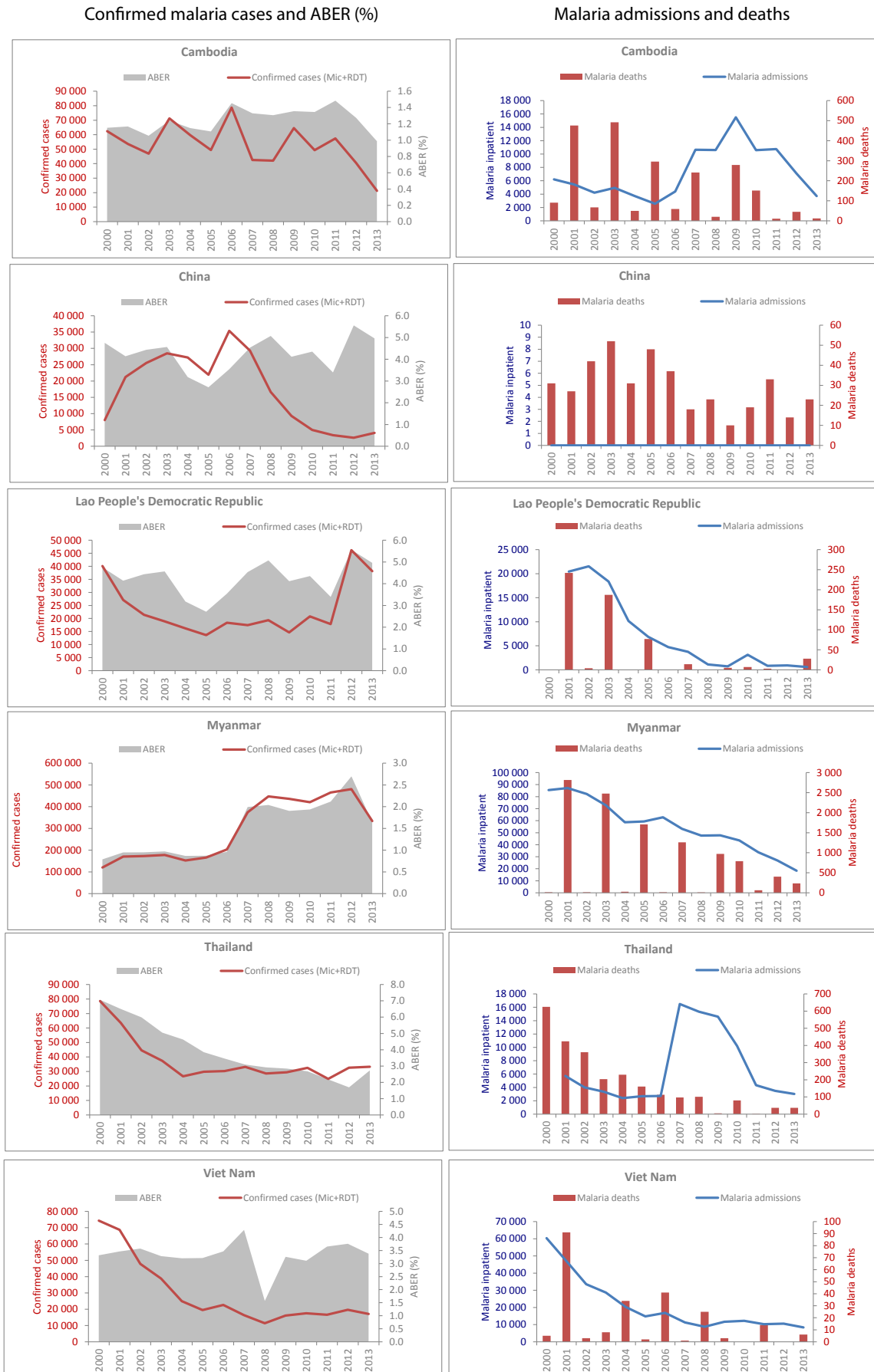
Annex 2 continued

Table A2.1 2013 Malaria situation in Greater Mekong Subregion countries

COUNTRY	TOTAL POPULATION (UN)	POPULATION AT RISK (LOW + HIGH)	CONFIRMED CASES (#)	REDUCTION IN CASES SINCE 2000 (%)	MALARIA DEATHS (#)	REDUCTION IN DEATHS SINCE 2000 (%)	% OF <i>P. FALCIPARUM</i> CASES	INPATIENT MALARIA CASES	ARTEMISININ RESISTANCE IDENTIFIED
Cambodia	15 135 169	8 021 640	21 309	-65.9	12	-97.5	55	18 362	Yes
China	1 385 566 537	579 466 850	4 086	-80.8	23	-14.8	71	3 014	No
Lao Peoples Democratic Republic	6 769 727	3 994 139	38 131	-4.9	28	-88.4	64	3 708	Yes
Myanmar	53 259 018	31 955 411	333 871	178.0	236	-91.6	70	–	Yes
Thailand	67 010 502	33 505 251	33 302	-57.6	37	-91.3	43	584	Yes
Viet Nam	91 679 733	34 373 702	17 128	-55.8	6	-93.4	56	8 384	Yes
TOTAL	1 619 420 686	691 316 993	447 827	-14.5	342	-79.5	59.8	34 052	5

Source: World malaria report 2014 (25)

Figure A2.1 Changes in key malaria indicators in the GMS, 2000–2013, WHO *World malaria report 2014* (25)



Annex 2 continued

The malaria drug resistance situation and efforts to contain it

In 2006–2007, WHO alerted the international malaria community to the emergence of artemisinin tolerant *P. falciparum* parasites at the Cambodia–Thailand border. Because artemisinin compounds are a key component of ACTs, the mainstay for the treatment of *P. falciparum* malaria, this was highlighted as a potential threat to malaria control worldwide. Continuous weakening of artemisinins could mean that any partner drug is being used as a virtual monotherapy. Ultimately, this could select for *P. falciparum* strains resistant to the partner drug as well, undermining the efficacy of ACTs.

A containment project was then initiated in Cambodia and Thailand with support from the Bill & Melinda Gates Foundation, based on *the Strategy for the containment of artemisinin tolerant malaria parasites in South-East Asia, 2009–2011* (ARCE), which established defined zonation associated with artemisinin tolerance in *P. falciparum*. In 2009–2010 emergence of artemisinin resistance was recognized in Myanmar and Viet Nam. In 2010, WHO launched the *Global action plan on artemisinin resistance* (GPARC), which delineated the roles and responsibilities of different actors. The definition of artemisinin resistance was further defined, and a tier-wise geographical prioritization based on status of artemisinin resistance was devised. Areas in countries were then classified as follows:

- **Tier I:** Areas for which there is credible evidence of artemisinin resistance, where an immediate, multifaceted response is recommended;
- **Tier II:** Areas with significant inflows of mobile and migrant populations from Tier I areas, with intensified malaria control to reduce transmission; and
- **Tier III:** *P. falciparum*-endemic areas that have no evidence of artemisinin resistance, where prevention and preparedness should focus on increasing coverage with standard malaria control.

The intensified activities in Tier I under ARCE led to a decline in the number of cases, but unsurprisingly, the level of artemisinin resistance increased (26). Following the assessment of the response to artemisinin resistance in the GMS in late 2011 and early 2012, the Emergency response to artemisinin resistance (ERAR) in the Greater Mekong Subregion was initiated, and a regional framework for action was launched in April 2013 (27). The framework highlighted areas where urgent action is needed to preserve ACTs as an effective treatment for *P. falciparum*, and ultimately eliminate malaria from the GMS. Fifteen essential actions, which constitute the basis for the current response to artemisinin resistance, were then defined in the following four areas:

- full coverage with high-quality interventions in priority areas;
- tighter coordination and management of field operations;
- better information for artemisinin resistance containment; and
- regional oversight and support.

WHO has received funding from the Australian Government and Bill & Melinda Gates Foundation to strengthen coordination and technical support for related activities. A dedicated office, the 'ERAR Regional Hub', has been established in Phnom Penh. The Global Fund has allocated US\$ 100 million to activities over three years (2014–2016) to fund containment and elimination operations and ultimately eliminate artemisinin resistance in the GMS. This funding supports activities both at country and regional levels. All GMS countries, with the exception of China, are now implementing an artemisinin resistance containment plan.⁵

There has been dramatic progress over the last few years in research on artemisinin resistance. The discovery of molecular markers for artemisinin resistance (mutation in the propeller domain of the *Plasmodium falciparum* Kelch 13 protein) has greatly impacted on definitions of resistance and surveillance methods and has allowed greater efficiency, precision and differentiation in the surveillance of artemisinin resistance.

According to the latest report from the Drug Resistance Containment – Technical Expert Group: “Genetic analysis has identified multiple genetic lineages of artemisinin resistance, suggesting that it is not only spreading but also emerging de novo, thus raising concerns about the effectiveness of a ‘firewall approach’ (delaying or preventing spread from a focus) and giving further support to the advisability of eliminating *P. falciparum* malaria transmission in all areas of confirmed artemisinin resistance. Prevention of spread of resistance from GMS, however, remains crucial because *P. falciparum* malaria has become increasingly resistant to the main new partner drugs (lumefantrine, mefloquine, piperaquine).” In consequence of this strategic reorientation, DRC-TEG also recommended that the category of Tier III be abandoned: within GMS, any *P. falciparum*-endemic area that is not Tier I should be considered as Tier II (28).

The recent emergence of significant resistance to partner drugs, especially piperaquine, in western Cambodia, raises the spectre of untreatable malaria in the GMS.

⁵<http://www.who.int/malaria/en/>

Annex 2 continued

Epidemiological characteristics

Vectors, climate and ecology

Due to interactions between bio-geography and ecology malaria transmission in the GMS is largely restricted to forest-like environments below 800–1500 m, foothills and coastal areas. It depends on, among other factors, vector behaviour and ecology, and the degree of contact between humans and the *Anopheles* mosquitoes. The primary inland malaria vectors are: *Anopheles dirus*, which only survives in shaded and humid areas; *An. minimus*, which can survive in light forest and in foothills after deforestation; and various less efficient vectors, which are associated with rice fields. In coastal areas with stagnant brackish water, members of the *An. sudaicus* complex are important; higher population density with better developed health services has made it easier to control malaria in such areas. All of the vectors exhibit tendencies to exophily (outdoor resting), exophagy (outdoor biting) and early biting, but such habits are especially pronounced for *An. dirus*; this to some extent constrains the effectiveness of IRS, and LLINs in forest-like environments (29).

In most areas of the GMS, transmission is perennial with seasonal peaks. North of 20–25°N, transmission is interrupted in the cold season. GIS mapping of malaria incidence rates confirms that malaria is concentrated in forested areas, but the burden can vary dramatically over short distances. Outbreaks in the GMS are mostly related to population movements and rarely to climatic factors, except in some instances like in the central ‘dry zone’ in Myanmar where outbreaks have been associated with increased rains. Over 2011–2012, there were outbreaks in six southern provinces of the Lao People’s Democratic Republic accounting for 95% of the cases reported in the country for 2012. These were attributed to a number of factors including unregulated logging and development projects attracting migrant workers. In late 2013, there was a tenfold increase of malaria cases in Ubon Ratchathani Province, Thailand, as loggers returned from the Lao People’s Democratic Republic.

Risk groups and mobility

The main risk groups in forested and foothill areas are:

- ethnic minority groups living in or near forested areas, who are typically engaged in swidden (slash and burn) agriculture;
- villagers and farmers living in forest fringes, including new settlers and planters;
- plantation workers, especially in rubber plantations with night-time work; these workers are often seasonal and often migrants;
- people who have been displaced to forest or forest-fringe areas as refugees or because of development projects such as dams;

- other persons who temporarily enter forests, such as security forces, loggers, miners, tourists and many others;
- military and police forces deployed at border areas; and
- people living or working in coastal areas involved in farming, aquaculture, fishing or smuggling.

These different groups can be distinguished by different degrees and types of mobility, as well as by their legal status or lack thereof. They may overlap: persons belonging to ethnic minority groups may, for example, be forest-fringe farmers or plantation workers.

In the recent past, ethnic minority groups practising swidden agriculture were the largest and most important populations in the GMS in terms of malaria burden. Among them, whole families but especially adult males spend days or weeks away from their villages, tending forest plots, gathering forest products or hunting (30). As a result, the cycle of transmission may continue in these communities, even if it is interrupted within the village (31). Swidden farming communities are gradually disappearing (though in Myanmar they may still number more than 2 million [5,6] (32, 33)) and most of those that remain are now relatively well served by LLIN provision and community-based case management services.

Migrants are not necessarily in very remote areas, nor excluded (4, 34). 'Recognizing mobility as a system involving multiple demographic groups, localities and intersecting socio-economic processes' is proving increasingly important (35). When malaria elimination in the GMS approaches the final stage, the main concern will be the risk of importation from other countries, especially malaria-endemic areas in Bangladesh and north-east India bordering Myanmar. Compared to flows within the GMS, movements across Myanmar's borders with these two countries appear relatively small. Malaria control there is making progress; the determinants of risk are the same as in the GMS. Good progress in elimination in the GMS will likely inspire similar efforts in Bangladesh and north-east India, reducing the vulnerability of Myanmar.

Increased global air travel may increase the risk of malaria importation. For example, China is experiencing frequent importation of *P. falciparum* from Africa, and travel between Africa and the capital cities of South-East Asia is also increasing (36). In a containment perspective, two problems at present are: migrants from western Myanmar, who are moving to other countries including Bangladesh, possibly to malaria risk areas; and soldiers visiting Africa either as a result of deployment as members of peacekeeping forces or for military training visits and exchanges.

Annex 2 continued

Other determinants

The reduction in the malaria burden in the GMS during the last decade is a result of not only investments in malaria control but also contextual changes such as deforestation and poverty reduction (37). Although economic growth should be expected to reduce migration-related malaria risk, such factors as inequity, demand for forest products and infrastructure projects near to or in forested areas will maintain migration-related malaria risk, possibly facilitated by the development of transport networks and opening up of borders. In the short term, one of the most important interventions, which could be undertaken by governments, would be to improve regulation and enforcement, to completely prevent such activities as illegal logging and to mandate companies that are licensed to operate in or near forested areas to seek the advice and collaboration of the health sector.

Insecurity and political instability remain the most serious potential risks. The situation in the GMS is improving in this respect, but a reversal could jeopardize the chances of malaria elimination and reverse many of the recent gains of malaria control.

Annex 3. Proposed indicators to measure progress and impact in the elimination phase

INDICATOR	TARGET OR NORM	DATA SOURCE
Impact		
Number and incidence rate of confirmed malaria cases by classification, sex, age group, risk group (e.g. schoolchildren, migrant workers)		Malaria case investigation database
Number of foci by classification		Malaria focus database
Quantity and quality of surveillance		
Annual blood examination rate by district and focus detected passively and actively ¹	Indicative target in endemic, residual active, new active and residual non-active foci: 8% of population in focus	District monthly and annual reports database
	Indicative target in cleared up and new potential foci: 1–3% of population in focus	
Percentage of expected monthly reports received from health facilities and laboratories (with number of patients tested for malaria and number positive)	Target: 100%	District monthly reports database
Percentage of confirmed cases fully investigated (including case investigation form, focus investigation form and active case detection)	Target: 100%	Malaria case investigation database
Percentage of foci fully investigated (malaria focus investigation form completed, including data from an entomological investigation) and registered (on register, with maps of each focus)	Target: 100%	Malaria focus database
Time from first symptom (fever) to first contact with the health system	Norm: within 48 h	Malaria case investigation database
Time from first contact to testing	Norm: within 24 h	Malaria case investigation database
Time from positive test result to start of treatment	Norm: same day	Malaria case investigation database
Time from positive test result to notification of the national malaria programme (to district or intermediate level, with copy to central level)	Norm: same day	Malaria case investigation database
Percentage of malaria testing laboratories participating in quality management system (all positive slides and 10% of negatives sent for retesting and the blind proficiency test completed each year)	Target: 100%	External quality assurance database
Percentage of past 5 years with national annual malaria programme report	Target: 100%	

Source: WHO *Disease surveillance for malaria elimination: an operational manual*.

¹ The annual blood examination rate targets are for supervisors. The surveillance work of staff at the primary level should be seen as service provision and not be quota-driven. An operational emphasis on annual blood examination rate targets could obscure the main objective, which is to ensure that any ongoing local transmission of malaria is detected in a timely manner.

Annex 4. Proposed surveillance indicators in the transmission-reduction phase

INDICATOR	DEFINITION / CALCULATION	PURPOSE
Confirmed malaria cases (number and rate per month or per year)	Number of confirmed malaria cases x 1000/Population at risk of malaria	To measure trends in malaria morbidity and to identify locations of ongoing malaria transmission. This indicator is the most important measure of progress and management in low-incidence areas.
Inpatient malaria cases (number and rate per month or per year)	Number of inpatient malaria cases x 10 000/Population at risk of malaria	To monitor the impact of programs on severe disease. This indicator may reflect the impact of treatment, as treatment attenuates clinical progression from uncomplicated to severe disease.
Inpatient malaria deaths (number and rate per month or per year)	Number of inpatient malaria deaths x 100 000/Population at risk of malaria	To monitor the impact of programs on the number of malaria deaths
Malaria test positivity rate (RDT and/or blood slide)	Number of confirmed malaria cases x 1000/Number of patients receiving a parasitological test	To reflect trends in malaria morbidity and identify areas with the most intense malaria transmission. Partially 'corrects' for incompleteness of reporting and RDT stock-outs because the numerator is derived from the same source as the denominator.
Percentage of cases disaggregated by species	Number of confirmed malaria cases by species x 100/Number of confirmed malaria cases	To reflect the proportion of cases due to various species and provide information on the likelihood of observing severe cases
Percentage of inpatient cases with a discharge diagnosis of malaria	Number of inpatient cases with a discharge diagnosis of malaria x 100/Total number of inpatients	To monitor the impact of programs on severe disease. Partially 'corrects' for incompleteness of reporting because the numerator is derived from the same source as the denominator
Percentage of inpatient deaths due to malaria	Number of inpatient deaths due to malaria x 100/Total number of inpatient deaths	To monitor the impact of programs on the number of malaria deaths. Partially 'corrects' for incompleteness of reporting because the numerator is derived from the same source as the denominator.
Annual blood examination rate	Number of patients receiving a parasitological test x 100/Population at risk of malaria	To reflect the extent of diagnostic testing in a population; aids interpretation of other surveillance indicators.
Percentage of suspected malaria cases that have had a diagnostic test	Number of patients receiving a parasitological test x 100/Number of suspected cases of malaria	WHO recommends that all suspected malaria cases should receive a diagnostic test by microscopy or RDT, regardless of age. The indicator reflects the extent to which malaria programs are able to achieve this goal and where further effort may be required.
Completeness of health facility reporting	Number of health facilities reports received x 100/Number of health facilities expected	Regular monitoring and follow-up can improve the completeness of reporting until all health facilities are consistently reporting every month. Aids interpretation of other surveillance indicators.

Source: WHO *Disease surveillance for malaria control: an operational manual*.



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