Malaria elimination – the interruption of local mosquito-borne malaria transmission – is the end goal in the fight against the disease. In addition to being vital for public health and part of overall development efforts, malaria elimination has a profound impact on other sectors, such as business and tourism. In this increasingly interconnected world, no country can afford to be complacent about the disease. Whether previously malarious or not, non-malarious countries must support the efforts of endemic countries to eliminate the disease. This manual has been developed to provide guidance to the increasing number of countries that have decided to eliminate malaria from their territory.

An elimination programme builds on the successful control of malaria mortality and morbidity. The evolution of the programme, from control to elimination to preventing re-establishment of malaria, is described in detail, along with the important programme reorientations.

Drawing on recent experience from various countries with malarious areas, the feasibility of malaria elimination is discussed, helping countries to set realistic targets and timescales. Descriptions are provided of tools and approaches that are specific or particularly relevant to elimination: case detection, prevention of onward transmission, and management of malaria foci and of importation of malaria parasites.

As monitoring and evaluation are essential components of the programme, recommended indicators, data sources and methodologies are outlined. Monitoring and evaluation not only allow the progress of the programme to be assessed and documented, but also allow a credible information database to be established, which is needed for ultimate certification of malaria elimination.

Certification of malaria elimination – the recognition of a considerable operational achievement – is granted by the World Health Organization to countries that have successfully maintained their malaria-free status for at least three consecutive years. Requirements and procedures for certification are described, along with details of the follow-up of certification.
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Technical editor: Dr Aafje Rietveld, WHO Global Malaria Programme
Foreword

Some 35 years after the effort to eradicate malaria worldwide was abandoned, malaria elimination features again on the global health agenda. In recent years, an increasing number of countries with low and moderate transmission areas have decided to eliminate malaria transmission from their entire territory. In January 2007, the United Arab Emirates was the first formerly endemic country since the 1980s to be certified by the World Health Organization (WHO) as malaria-free. Certification of malaria elimination is granted to countries that have successfully maintained their malaria-free status for a period of at least three years. It is recognition of a considerable operational achievement.

In order to provide guidance on the implementation of effective malaria elimination programmes, WHO has produced this manual.

Effective malaria elimination programmes set realistic targets and follow a comprehensive and funded plan of action, backed up by government commitment at the highest levels. Such programmes:

- detect and cure malaria patients;
- interrupt local mosquito-borne malaria transmission;
- identify and clear up residual foci of malaria transmission;
- develop and implement vigilance systems for maintaining the malaria-free status;
- prevent re-establishment of transmission despite continuing importation of parasites;
- collaborate with neighbouring endemic countries to reduce malaria transmission in the region.

Malaria elimination evolves from a successful countrywide malaria control effort that has been able to eliminate malaria as a public health problem. In its early phases, the elimination programme temporarily becomes a specialized vertical programme that focuses on the spatial distribution of malaria, vector control, case-finding and case investigation. When the goal of elimination is almost reached, the focus shifts back to the general health services, which are key to a good vigilance system.
Malaria transmission is particularly difficult to interrupt in areas with efficient mosquito vectors, a long or year-round transmission season, poor state of overall development, marginalized populations and weak health systems with inadequate coverage of health services, as well as in areas with civil unrest, illegal cross-border movement, or areas that border high-burden neighbouring countries and experience intense cross-border population movement. Each of these factors will reduce the feasibility of malaria elimination.

Malaria elimination cannot be detached from overall development efforts, including the 2015 Millennium Development Goals. Most countries that have successfully achieved interruption of malaria transmission have also achieved an improvement in the overall socioeconomic situation, health services coverage and living standards of the population. The malaria-free status adds to these developments by removing barriers to investment and tourism.
Executive summary

The aims of the global fight against malaria are not only to (i) reduce the burden of malaria in endemic areas, but also (ii) reduce and confine the geographical extent of malaria-endemic areas in the world. The latter entails the elimination of malaria from countries and localities where this is feasible. The elimination of malaria is indeed the end goal of the fight against the disease, and is a process which starts with good malaria control.

An increasing number of endemic countries have been successful in interrupting local mosquito-borne malaria transmission – seen as vital for public health, business and tourism. Others have reduced their malaria burden to levels where elimination is a possibility. Of the 107 malaria-endemic countries and areas worldwide, 7 are currently reporting no more locally acquired infections. In January 2007, the United Arab Emirates was officially certified by the World Health Organization (WHO) as malaria-free, a first since Australia and Singapore in the 1980s.

The aim of an elimination programme is to identify and treat all people who carry malaria parasites in their blood and reduce the onward transmission of infection. As part of essential programmatic elimination requirements, malaria transmission hot spots are identified and mapped by the national programme. Targeted, custom-tailored mosquito control interventions are used to reduce the vectorial capacity and human–vector contact in these areas, and eventually halt transmission nationwide.

In the continuum from malaria control to elimination, two important programme reorientations take place. The first starts once high coverage with effective malaria control interventions and overall socioeconomic development are starting to reduce transmission to a marginal level, with a patchy and focalized geographical spread. At that point, coverage of good-quality laboratory and clinical services, reporting and surveillance must be reinforced, followed by other programme adjustments aimed at halting transmission nationwide.

The second programme reorientation starts when locally acquired malaria cases are close to zero, and malaria parasites that are brought into the coun-
try by people who became infected abroad may pose a bigger threat of con-
tinuation or resumption of transmission than the last dwindling local parasite
strains. The prevention of re-establishment of local malaria transmission from
imported cases relies heavily on the watchfulness of the general health serv-
ices, under the guidance of a small group of malaria experts at central level
backed up by national and local authorities, in collaboration with other sec-
tors such as private industry, tourism and foreign affairs. Nationals who plan
to travel abroad are provided with health information, chemoprophylaxis and
measures to protect against mosquito bites, aimed at reducing the importation
of parasites at source. Visitors and migrants from endemic areas are informed
of the risks of malaria and given easy access to free-of-charge diagnostic and
treatment facilities. Vector control is used to contain local outbreaks and pro-
tect areas that are known to be receptive to the resumption of transmission as
well as exposed to frequent importation of malaria parasites.

Once a country is proven to be free from local transmission for at least three
consecutive years, WHO can grant certification of its malaria-free status.

The world is increasingly interconnected. When malaria is eliminated from a
country, it still remains at risk from imported cases. The dedication of both
the government and programme personnel that was necessary to eliminate
malaria must be sustained so that the requisite knowledge and skills are main-
tained and the health service organized in such a way that these attributes
can be used as and when necessary. Continuous active involvement of local
authorities with budget power¹ will be required, as well as engagement from
the tourism and construction industries and other private sectors that employ
immigrants from endemic countries or respond to an influx of refugees, as well
as agricultural businesses and others designing projects that have an environ-
mental impact. It will be the role of the ministry of foreign affairs to increase
intercountry collaboration on malaria and the role of regional political or socio-
economic powers to boost regional approaches for malaria control.

Non-malarious countries, whether previously malarious or not, must be con-
cerned about malarious countries and support their efforts against the disease.

This manual describes the principles, practice, tools and approaches, as well as
monitoring and evaluation requirements, for the elimination of malaria from
countries in the 21st century.

¹ Able to control and allocate financial resources.
Introduction

This manual is intended to inform national governments from endemic countries, partner and donor agencies and field managers about the issues related to malaria elimination. It will serve as a tool in the implementation, monitoring and evaluation of malaria elimination programmes.

Malaria elimination aims at sustainable interruption of local malaria transmission by mosquitoes despite a continued presence of malaria vector mosquitoes and importation of parasites from abroad through international travel and migration.

In areas with intense transmission and extreme poverty, where overall health and development are lagging behind, good malaria control using proven tools, such as case management with efficacious medicines (artemisinin-based combination therapy in the case of *Plasmodium falciparum* and vector control with indoor residual spraying and insecticide-treated mosquito nets, will considerably contribute to improving public health.

In areas where essential clinical services are available, the basic needs of the population are covered, and malaria transmission has been reduced to a level where less than 5% of all febrile patients with suspected malaria actually carry malaria parasites, and case-loads are becoming manageable, programme reorientation towards elimination becomes a possibility. The aim of a pre-elimination programme will be to reduce malaria incidence to less than 1 infection per 1000 people at risk per year, and to set up the quality-controlled systems required for an elimination programme.

The priorities of a malaria elimination programme are: (i) to identify and treat malaria patients and all people carrying parasites, including those carrying gametocytes, ensuring that they become non-infectious as soon as possible; and (ii) to sustainably reduce human–vector contact and the vectorial capacity of the local *Anopheles* mosquito populations to prevent new infections from occurring.

The efforts required for malaria elimination are fundamentally different from malaria control. Some tools and approaches are specific to elimination;
others take on a much more prominent role than in control efforts. The choice is based on an in-depth knowledge of the local epidemiology of malaria parasites, vectors and transmission patterns. Their application is targeted through the identification of transmission foci and geographical reconnaissance. While malaria control assesses accomplishments, malaria elimination assesses what remains to be accomplished (see Table 1).

All countries aiming for elimination will eventually need to create or enhance legislation supporting the identification and notification of malaria cases and mosquito breeding sites, and set up a national malaria case register, intra- and intercountry coordination mechanisms, comprehensive quality control for clinical and laboratory services in public and private sectors, effective surveillance and vigilance systems, and special measures to cope with the continuing importation of parasites by international travellers and migrants.

Solid programme management, adequate resources, responsive and comprehensive information systems and geographical access are required to manage and monitor elimination efforts and achieve targets within realistic timescales that usually stretch over at least 8–10 years. Efforts can be staggered geographically and by *Plasmodium* species, with different phases taking place simultaneously in different parts of the country. Where elimination on a national scale is not deemed feasible, it may still be possible and desirable to create malaria-free zones.

The development of an operational plan for malaria elimination requires a comprehensive national effort. Full support from the highest levels of government to smooth coordination between different government ministries such as agriculture, defence, finance, health and policy and planning is a prerequisite for operational success.

Total budget requirements for achieving elimination depend on the local situation. Stable funding commitment and flexible funding is needed to deal with occasional programme setbacks. Countries that have recently achieved interruption of transmission have done so primarily with national funding or in the context of a locally funded subregional, multicountry initiative. Public-sector funding requirements for health will not dramatically decrease once malaria has been eliminated, due to the increasing requirements of general health services, and the need for vigilance and response capacity to prevent re-establishment of transmission.

The World Health Organization (WHO) grants certification of malaria elimination to countries that have interrupted local transmission for a period of three or more years and have high-quality surveillance systems and data to prove it.
### Table 1. Difference between malaria control and elimination programmes

<table>
<thead>
<tr>
<th>ITEM</th>
<th>CONTROL PROGRAMME</th>
<th>ELIMINATION PROGRAMME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Reduction of the malaria burden</td>
<td>The total and maintained ending of local malaria transmission</td>
</tr>
<tr>
<td>Area of operations</td>
<td>May depend on degree of endemicity, on accessibility and social, political or economic importance</td>
<td>All malaria transmission foci</td>
</tr>
<tr>
<td>Minimum acceptable standard of operations</td>
<td>Good: reduction of transmission to a level at which it ceases to be a major public health problem</td>
<td>Perfect: transmission must be interrupted in the entire area; should new locally acquired infections occur, the cause must be determined and removed</td>
</tr>
<tr>
<td>Duration of operations</td>
<td>Without limit</td>
<td>Country can be considered malaria-free when transmission has been ended for three years in the entire territory</td>
</tr>
<tr>
<td>Economic aspects</td>
<td>Expenditure for malaria interventions constantly recurring</td>
<td>Expenditure will continue after elimination, when the focus will shift to sustaining efficient general health services</td>
</tr>
<tr>
<td>Integration with other health programmes</td>
<td>Often convenient and feasible as an integrated public health programme</td>
<td>Less feasible largely because elimination has a highly specific and usually time-limited objective</td>
</tr>
<tr>
<td>Case-finding</td>
<td>Mainly through passive case detection (people seeking care)</td>
<td>Of primary importance, including through active case detection</td>
</tr>
<tr>
<td>Imported cases</td>
<td>Of minor interest — mostly academic – with the exception of importation of <em>P. falciparum</em> in areas where this does not normally occur</td>
<td>Very important, especially when elimination is achieved</td>
</tr>
<tr>
<td>Epidemiological investigation of individual cases</td>
<td>Of little value, with the exception of <em>P. falciparum</em> cases in areas where they do not normally occur</td>
<td>Of increasing importance and finally essential as elimination is approached</td>
</tr>
<tr>
<td>Epidemiological evaluation</td>
<td>Reduction of parasite indices; reported malaria incidence</td>
<td>Proven disappearance of indigenous malaria cases</td>
</tr>
<tr>
<td>Administrative standard of progress</td>
<td>Measurement of accomplishments</td>
<td>Measurement of what remains to be accomplished</td>
</tr>
<tr>
<td>Unit of intervention</td>
<td>Population, patient</td>
<td>Focus (locality)</td>
</tr>
<tr>
<td>Administration of the programme</td>
<td>May not be the best but is sufficient</td>
<td>Must be fully efficient and speedy; if not, there will be a danger of failure</td>
</tr>
</tbody>
</table>

* Adapted from WHO Expert Committee on Malaria. Sixth report (1).
The initiative for development of this manual was taken at the WHO Global Malaria Programme consultation on malaria elimination, held in Tunis, Tunisia, 25–26 February 2006. The first draft was produced by Dr Anatoli Kondrachine in July 2006, to which parts of the document developed by Dr Andrei Beljaev, *Guidelines on the elimination of residual foci of malaria transmission*, were added (2). The elimination strategy and the manual were subsequently reviewed and adapted during a WHO Global Malaria Programme meeting to finalize the manual, held in Geneva, Switzerland, 14–16 May 2007. A final review took place during a workshop for the WHO Eastern Mediterranean Region on malaria elimination and malaria-free initiatives, in Dubai, United Arab Emirates, 13–14 June 2007. The final manuscript was produced by the WHO Global Malaria Programme.

This manual requires field-testing in a number of different situations. Comments on the document are welcome and should be sent to:

Global Malaria Programme  
World Health Organization  
CH-1211 Geneva 27  
Switzerland  
Fax: +41 (0) 22 791 4824  
E-mail: InfoGMP@who.int
1. Malaria

Malaria remains one of the main global health problems of our time, causing more than 1 million deaths per year, with about 90% of deaths and 60% of cases occurring in Africa south of the Sahara. It is caused by the protozoan parasite *Plasmodium* and transmitted by *Anopheles* mosquitoes, which bite mainly between sunset and sunrise.

There are four species of malaria parasites that infect people – *P. falciparum*, *P. vivax*, *P. malariae* and *P. ovale*. Of these, *P. falciparum* and *P. vivax* are the most common. Falciparum malaria can be fatal. Severe falciparum malaria has a case-fatality rate of around 10% in reasonably well-equipped hospitals. Vivax malaria is an acute but not life-threatening illness and is associated with anaemia and splenomegaly. Like *P. falciparum*, it causes low birth weight in neonates. Unlike *P. falciparum*, *P. vivax* and *P. ovale* can stay dormant in the liver as hypnozoites for up to several months or even years after inoculation by the mosquito. Forms of malaria caused by *P. malariae* and *P. ovale* are less severe and rarely life-threatening; the former can lead to chronic immunopathological sequelae.

The four human malaria species are not evenly spread across the malaria-affected areas of the world, and their relative importance varies between and within different areas, by zoogeographical region. *P. falciparum* is the most common species and predominates across Africa south of the Sahara. *P. vivax* predominates in the subtropics and coexists with *P. falciparum* in tropical Asia, the tropical Americas and the Horn of Africa. *P. ovale* is found in Africa and sporadically in South-East Asia and the western Pacific. *P. malariae* has a similar geographical distribution to *P. falciparum* but its incidence is patchy. Unlike the other malaria parasites, blood infection with *P. malariae* can continue undetected for decades. The risk of contracting malaria is highly variable from country to country and even between areas in a country.

---

1 This chapter is adapted from *Malaria control in complex emergencies: an inter-agency field handbook* (3).
The female *Anopheles* mosquito is the vector of malaria parasites. There are more than 400 different species of *Anopheles* mosquitoes throughout the world, but only some 60 of these are vectors of malaria under natural conditions, of which 30 are vectors of major importance. Each species has a different behaviour pattern. Most areas have multiple species of *Anopheles*, and different ones occur in different parts of the world. Highly efficient species such as *A. gambiae* sensu stricto, *A. arabiensis* and *A. funestus* predominate in Africa south of the Sahara. Less efficient vectors such as *A. stephensi* in urban settings, and *A. minimus* and *A. dirus* in hilly or mountainous zones predominate in Asian countries.

The transmission cycle of malaria is represented in Figure 1. After a human is infected, the parasites pass through the human liver phase and blood cycle onto the next phase, in the mosquito.

*P. falciparum* takes 8–11 days to complete the mosquito phase (sporogony) at an optimal ambient temperature of 28 °C and 22 days at 20 °C. The temperature of the mosquito gut equals the ambient temperature: a low environmental temperature therefore results in a longer development time for the parasite in the mosquito. Below 20 °C, *P. falciparum* is unable to develop. Thus, in mountainous areas of East Africa above 2000 metres, there is little malaria transmission because it is too cold. *P. vivax* can develop in the mosquito at lower ambient temperatures, so *P. vivax* transmission is found in some areas where the average temperature is too low to allow *P. falciparum* transmission (for example, in the Russian Federation). The human liver phase and blood cycle combined take *P. falciparum* 15.5–17 days.

In total, the incubation interval of *P. falciparum* is 23.5–39 days depending on ambient temperatures. The same interval takes *P. vivax* about 20 days, making the control of *P. vivax* more complex than that of *P. falciparum*. The liver-stage hypnozoites of *P. vivax* are responsible for late relapses, which are strain-dependent.

The global distribution of malaria risk areas in 2006 is shown in Figure 2. A total of 107 countries and areas were considered to have malarious zones (see Annex 1). Of these, 15 have never had or no longer have local *P. falciparum* transmission. Seven countries reported no indigenous cases; two of these countries have reported no such cases since 1998. The United Arab Emirates finalized the requirements for certification of malaria elimination in 2006. In January 2007, it was the first formerly endemic country to be certified by WHO as malaria-free since Australia and Singapore in the 1980s.
1. MALARIA

Figure 1. Transmission cycle of malaria*

* Adapted, by permission of the publishers, from *Life cycle of Plasmodium spp.* (4) and Sullivan (5)
Figure 2. Distribution of malaria risk areas in the world

This map is a visual aid only, it is not a definitive source of information about malaria endemicity.

Adapted from International travel and health: situation as on 1 January 2007 (6).
2. Principles and practice of malaria elimination

Malaria elimination is the interruption of local mosquito-borne malaria transmission. It does not require the elimination of disease vectors or a complete absence of reported malaria cases in the country: imported malaria cases will continue to be detected due to international travel, and may on occasion lead to the occurrence of introduced cases in which the infection is a first generation of local transmission subsequent to an imported case.

Elimination of malaria is an option, not an obligation. It can be envisaged when a successful malaria control programme is succeeding in reducing the burden of mortality and morbidity to a marginal level. Not all countries will be able to fully interrupt malaria transmission with currently available tools. Box 1 provides an overview of the continuum from control to elimination, indicating the required programme types by current level of malaria transmission.

2.1 Malaria case definition in elimination programmes

For elimination purposes, a malaria case is a person in whom, regardless of the presence or absence of clinical symptoms, malaria parasites have been confirmed by quality-controlled laboratory diagnosis. Figure 3 gives an overview of the classification of malaria cases by origin of infection, as used in malaria pre-elimination and elimination programmes. A key for the epidemiological classification of cases is included in Annex 2.

2.2 Malaria foci classification for elimination purposes

Interventions during pre-elimination and elimination programmes are based on the concept of a malaria focus, assuming that transmission is focalized and no longer homogeneous across the country. A focus is a defined and circumscribed locality situated in a currently or formerly malarious area and containing the continuous or intermittent epidemiological factors necessary for malaria transmission. Examples are a town, village or other defined geographi-
cal area in which there are *Anopheles* breeding sites, feeding and resting places, and people exposed to biting by the vectors.¹

Figure 4 gives an overview of the transition of the functional status of a malaria focus depending on the local situation. A key for the operational classification of malaria foci is included in Annex 3.

¹ In contrast, evaluation of the progress of pre-elimination and elimination programmes is usually measured by entire districts or other administrative divisions. When defining populations at risk or the percentage of the national territory affected by malaria, it is appropriate to determine, for example, the number of districts with active foci.
2.3 Strategies for malaria elimination

Malaria elimination builds on the foundation laid by intensive malaria control, with universal coverage of intensified, efficacious interventions for vector control and case management. As the malaria programme evolves, the quality and targeting of operations increase, and the area of intervention narrows from the wider population to transmission foci, to individual malaria cases.

Malaria elimination requires:

- evidence-based data on the achievement of successful malaria control;
- sufficient evidence that transmission can be interrupted by scaling up planned interventions;
- clearly defined responsibilities for management, including decentralized authority and enforcement of regulatory and disciplinary measures;
Figure 4. Transition of functional status of a malaria focus depending on the situation* 

* Adapted from Guidelines on the elimination of residual foci of malaria transmission (2).

- effective systems to ensure coordination between public, private and community-based agencies and services, and to implement cross-border programmes;
- intensive joint intersectoral efforts;
- adequate pre- and in-service training of service providers and high-quality supervision/mentoring;
- sustained advocacy, social mobilization, health education and behaviour change communication to support the preparation and implementation of the elimination programme;
- the existence of a monitoring, evaluation and surveillance plan able to timely measure progress, including assessments by independent team(s);
- long-term predictable and sustainable funding available to support planned and unexpected expenses;
- eventually, systems in place for effective vigilance to prevent reintroduction.

Figure 5 gives an outline of the major phases and milestones in malaria programme evolution.1

1 The methodology developed in the 1950s for the Global Malaria Eradication Programme was designed to cover malaria control operations from start (fully endemic) to finish (zero cases), passing from the preparatory phase to the attack, consolida-
The type of organization and the specific measures to be applied in order to achieve malaria elimination will always be governed by local conditions.

The stage of elimination dictates the specific programme interventions for:

- case management,
- vector control and prevention,
- monitoring and evaluation,
- health systems issues.

Based on the findings of an annual assessment by an independent national malaria elimination monitoring committee, the plans of action for the following year are modified. The participation of general health services and the community at large, particularly in case detection, is essential for the success of the programme, as is close interaction with relevant non-health sectors.

The following sections describe the major programme reorientations and approaches from malaria control to elimination to prevention of reintroduction. Tables 2A–2C provide more detail of the interventions, milestones, indicators and programmatic issues for each of these phases.

---

**Figure 5. Malaria programme phases and milestones on the path to malaria elimination**

SPR: slide or rapid diagnostic test positivity rate.

These milestones are indicative only: in practice, the transitions will depend on the malaria burden that a programme can realistically handle (including case notification, case investigation, etc.).

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<table>
<thead>
<tr>
<th>ITEM</th>
<th>CONTROL PROGRAMME</th>
<th>PRE-ELIMINATION PROGRAMME</th>
<th>ELIMINATION PROGRAMME</th>
<th>PREVENTION OF REINTRODUCTION PROGRAMME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main programme goal</td>
<td>Reduce morbidity and mortality</td>
<td>Halt local transmission nationwide</td>
<td>Halt local transmission nationwide</td>
<td>Prevent re-establishment of local transmission</td>
</tr>
<tr>
<td>Epidemiological objective</td>
<td>Reduce burden of malaria</td>
<td>Reduce number of active foci to zero</td>
<td>Reduce number of active foci to zero</td>
<td>Prevent introduced cases and indigenous cases secondary to introduced cases</td>
</tr>
<tr>
<td>Transmission objective</td>
<td>Reduce transmission intensity</td>
<td>Reduce onward transmission from existing cases</td>
<td>Reduce onward transmission from existing cases</td>
<td>Reduce onward transmission from imported cases</td>
</tr>
<tr>
<td>Unit of intervention</td>
<td>Country- or area-wide</td>
<td>Foci, individual cases (locally acquired and imported)</td>
<td>Individual cases (imported cases only)</td>
<td>—</td>
</tr>
<tr>
<td>Milestone for transition to next programme type&lt;sup&gt;+&lt;/sup&gt;</td>
<td>SPR &lt;5% in suspected malaria cases</td>
<td>&lt;1 case per 1000 population at risk per year</td>
<td>Zero locally acquired cases</td>
<td>—</td>
</tr>
<tr>
<td>Data source for measuring progress towards reaching milestones</td>
<td>Proxy data: health facility data, notification reports, genotyping</td>
<td>Proxy data: health facility data, notification reports, genotyping</td>
<td>Notification reports, individual case investigations, genotyping</td>
<td>—</td>
</tr>
</tbody>
</table>

SPR: slide or rapid diagnostic test positivity rate.

* These milestones are indicative only: in practice, the transitions will depend on the malaria burden that a programme can realistically handle (including case notification, case investigation, etc.).
Table 2B. Interventions by programme type

<table>
<thead>
<tr>
<th>INTERVENTION</th>
<th>CONTROL PROGRAMME</th>
<th>PRE-ELIMINATION PROGRAMME*</th>
<th>ELIMINATION PROGRAMME</th>
<th>PREVENTION OF REINTRODUCTION PROGRAMME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Case management</strong></td>
<td>· Update drug policy, use of ACT</td>
<td>· Drug policy change:</td>
<td>· Implementation of new drug policy</td>
<td>· Case management of imported malaria</td>
</tr>
<tr>
<td></td>
<td>· QA/QC of laboratory diagnosis (microscopy/RTD)</td>
<td>- radical treatment for <em>P. vivax</em></td>
<td>· Routine QA/QC expert microscopy</td>
<td>· Awareness of drug resistance patterns</td>
</tr>
<tr>
<td></td>
<td>· Clinical diagnosis sometimes acceptable</td>
<td>- ACT and gametocyte treatment for <em>P. falciparum</em></td>
<td>· Active case detection</td>
<td>· abroad, to formulate prevention</td>
</tr>
<tr>
<td></td>
<td>· Monitoring antimalarial drug resistance</td>
<td>- 100% case confirmation by microscopy</td>
<td>· Monitoring antimalarial drug resistance</td>
<td>guidelines</td>
</tr>
<tr>
<td>**Vector control and malaria</td>
<td>· Transmission reduction through high population coverage of ITN/LLIN and IRS</td>
<td>· Geographical reconnaissnce</td>
<td>· Perfect malaria case detection mechanism</td>
<td></td>
</tr>
<tr>
<td>prevention**</td>
<td>· Entomological surveillance</td>
<td>· Total IRS coverage in foci</td>
<td>· Cluster response and prevention</td>
<td></td>
</tr>
<tr>
<td></td>
<td>· Epidemic preparedness and response</td>
<td>· IVM and ITN/LLIN as complementary measures in specific situations</td>
<td>· Prevention of malaria in travellers, including health education and engagement of travel agencies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>· IPTp in hyperendemic areas</td>
<td>· Epidemic preparedness and response</td>
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<td></td>
<td></td>
<td>· Entomological surveillance</td>
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<tr>
<td></td>
<td></td>
<td>· Prevention of malaria in travellers</td>
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<tr>
<td><strong>Monitoring and evaluation</strong></td>
<td>· Improve surveillance and national coverage</td>
<td>· GIS-based database on cases and vectors</td>
<td></td>
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<tr>
<td></td>
<td>· Country profiles</td>
<td>· Elimination database</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>· Malaria indicator surveys (MIS, MICS, DHS)</td>
<td>· Central records bank</td>
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<td></td>
<td></td>
<td>· Genotyping, isolate bank</td>
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<td></td>
<td></td>
<td>· Malaria surveys</td>
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<td></td>
<td></td>
<td>· Immediate notification of cases</td>
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</tr>
</tbody>
</table>

*Continued on page 16*
**Table 2B. Continued**

<table>
<thead>
<tr>
<th>INTERVENTION</th>
<th>CONTROL PROGRAMME</th>
<th>PRE-ELIMINATION PROGRAMME*</th>
<th>ELIMINATION PROGRAMME</th>
<th>PREVENTION OF REINTRODUCTION PROGRAMME</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Health systems issues</strong></td>
<td>Access to treatment&lt;br&gt;Access to diagnostics&lt;br&gt;Health system strengthening (coverage, private and public sectors, QA)</td>
<td>Engaging private sector&lt;br&gt;Control of OTC sale of antimalarial medicines&lt;br&gt;Availability of qualified staff</td>
<td>Full cooperation of private sector&lt;br&gt;No OTC sale of antimalarial medicines&lt;br&gt;Free-of-charge diagnosis and treatment for all malaria cases</td>
<td>Integration of malaria programme staff into other health and vector control programmes</td>
</tr>
<tr>
<td><strong>Programmatic issues</strong></td>
<td>Procurement, supply management&lt;br&gt;Resource mobilization&lt;br&gt;Regional initiative&lt;br&gt;Pharmacovigilance&lt;br&gt;Adherence to the “Three Ones” principles&lt;br&gt;Integration with other health programmes for delivery of interventions, e.g., ITN/LLIN, IPTp&lt;br&gt;Domestic/external funding</td>
<td>Elimination programme development&lt;br&gt;Legislation&lt;br&gt;Regional initiative&lt;br&gt;Mobilization of domestic funding&lt;br&gt;Establish malaria elimination committee&lt;br&gt;Reorientation of health facility staff</td>
<td>Implementation of elimination programme&lt;br&gt;Implementation of updated drug policy, vector control, active detection of cases&lt;br&gt;Malaria elimination committee:— manage malaria elimination database— repository of information— periodic review— oversight&lt;br&gt;Reorientation of health facility staff</td>
<td>WHO certification process</td>
</tr>
</tbody>
</table>
### Table 2B. Continued

<table>
<thead>
<tr>
<th>INTERVENTION throughout all programmes</th>
<th>CONTROL PROGRAMME</th>
<th>PRE-ELIMINATION PROGRAMME</th>
<th>ELIMINATION PROGRAMME</th>
<th>PREVENTION OF REINTRODUCTION PROGRAMME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case management</td>
<td></td>
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<tr>
<td>Integrated vector management, including monitoring of insecticide resistance</td>
<td></td>
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<tr>
<td>Geographical information collection</td>
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<tr>
<td>Human resources development</td>
<td></td>
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<tr>
<td>Health education, public relations, advocacy</td>
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<tr>
<td>Operational research</td>
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<tr>
<td>Technical and operational coordination, including intra- and intersectoral collaboration, both within the country and with neighbouring countries</td>
<td></td>
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<tr>
<td>Monitoring and evaluation</td>
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<tr>
<td>Independent assessment of reaching milestones</td>
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<tr>
<td>Resource mobilization</td>
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<tr>
<td>Health systems strengthening</td>
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</tbody>
</table>

ACT: artemisinin-based combination therapy; DHS: Demographic and Health Surveys; GIS: geographic information system; IHR (2005): International Health Regulations (2005); IPTp: intermittent preventive treatment in pregnancy; IRS: indoor residual spraying; ITN: insecticide-treated mosquito net; IVM: integrated vector management; LLIN: long-lasting insecticidal net; MICS: Multiple Indicator Cluster Surveys; MIS: Malaria Indicator Survey; OTC: over-the-counter; QA: quality assurance; QC: quality control; RDT: rapid diagnostic test.

The pre-elimination programme is a reorientation phase. The interventions mentioned in this column are introduced during this programme reorientation, to be fully operational at the start of the elimination programme.
### Table 2C. Indicators by programme type

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Control Programme</th>
<th>Pre-Elimination Programme</th>
<th>Elimination Programme</th>
<th>Prevention of Reintroduction Programme</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
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</tr>
<tr>
<td>• Proportion of population at risk targeted for IRS</td>
<td>• % of actual cases reported per year</td>
<td>• % of actual cases reported per year</td>
<td>• % of highly vulnerable foci protected by vector control and environmental management methods</td>
<td></td>
</tr>
<tr>
<td>• Proportion of target population protected by IRS</td>
<td>• % of reported cases investigated per year</td>
<td>• % of reported cases investigated per year</td>
<td>• % of laboratory facilities covered by QA and refresher training system</td>
<td></td>
</tr>
<tr>
<td>• Proportion of population at risk targeted for ITN/LLIN</td>
<td></td>
<td></td>
<td>• % of all health-care providers who participated in the continuing education programme on malaria prevention, case management and notification</td>
<td></td>
</tr>
<tr>
<td>• Proportion of ITNs/LLNs delivered against total needs (target population) per year</td>
<td></td>
<td></td>
<td>• % of medical and nursing schools that included a course on malaria prevention, case management and notification in the annual curriculum</td>
<td></td>
</tr>
<tr>
<td>• Proportion of surveyed households with at least one ITN/LLIN</td>
<td></td>
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<tr>
<td>• Proportion of at risk population, who slept under an ITN/LLIN the previous night</td>
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<tr>
<td>• Proportion of nationally recommended first-line antimalarial treatment courses distributed per total malaria cases reported per year</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>• % of malaria cases confirmed by laboratory test</td>
<td>• % of laboratory facilities covered by QA and refresher training system</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>• % of uncomplicated malaria cases receiving prompt and effective treatment</td>
<td>• % of medical and nursing schools that included a course on malaria prevention, case management and notification in the annual curriculum</td>
<td></td>
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<tr>
<td><strong>Impact</strong></td>
<td></td>
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<tr>
<td>• Number of reported malaria cases per 1000 population per year</td>
<td>• Number of cases by species and classification per year</td>
<td>• Number of cases by species and classification per year</td>
<td>• Number of malaria cases and deaths, by species, classification and country of origin</td>
<td></td>
</tr>
<tr>
<td>• Number of severe malaria cases per 100 000 population per year</td>
<td>• Number of foci by classification and changes in classification per year</td>
<td>• Number of foci by classification, and changes in classification per year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Number of malaria-attributable deaths per 100 000 population per year</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Malaria parasite prevalence rate</td>
<td></td>
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</tr>
<tr>
<td><strong>Programme milestone</strong></td>
<td>• Monthly SPR at health-facility level</td>
<td>• Number of reported malaria cases per 1000 population at risk per year</td>
<td>• Number of locally acquired cases</td>
<td></td>
</tr>
</tbody>
</table>

IRS: indoor residual spraying; ITN: insecticide-treated mosquito net; LLIN: long-lasting insecticidal net; QA: quality assurance; SPR: slide or rapid diagnostic test positivity rate.

* The reaching of these milestones must be confirmed by population-based surveys.
First programme reorientation: the pre-elimination programme

This reorientation starts in areas where:

- health facility data that are representative of the entire target area/country indicate that the monthly slide or rapid diagnostic test (RDT) positivity rate among febrile patients with suspected malaria is consistently less than 5% throughout the year, hence malaria case-loads are becoming manageable;
- population-based surveys in the peak transmission season confirm a malaria parasite rate of less than 5% among people of all ages with current fever or a history of fever in the past 24 hours.

In such areas, it is important that every febrile patient who does not have other obvious causes of fever is laboratory tested for malaria. From the start of the pre-elimination programme onwards, 100% diagnosis by Giemsa-stained microscopy (as opposed to RDT) needs to be phased in, because:

- it is increasingly important to accurately determine parasite species and densities and detect gametocytes;
- some types of RDT can still give positive results for up to two weeks after parasitological cure;
- the RDT for *P. vivax* diagnosis can give false negative results in up to 20% of cases due to the inherent low sensitivity of the test.

Case management should aim to reduce the parasite reservoir through early diagnosis and treatment and use of efficacious medicines. For treatment of *P. falciparum*, the use of artemisinin-based combination therapy is preferable because of its effect on gametocyte-carriage rates. Alternatively, primaquine can be added in a single dose as gametocytocidal treatment. Recent evidence seems to show the benefit of single-dose primaquine even when artemisinin-based combination therapy is used.

During the pre-elimination programme, the following needs to be accomplished:

- strengthening the health information system, including entomological surveillance and immediate notification of all malaria cases;
- improving the effective coverage of good-quality curative and preventive health services in all transmission areas. This implies that the whole population, either nationals or foreigners, is easily accessing and using private and/or public health-care facilities, whatever their citizenship or conditions (refugees, displaced, temporary workers, etc.);
- reorientating public and private health service staff towards the new goals of malaria elimination;
- establishing the national malaria elimination monitoring committee;
- developing the elimination programme;
• setting up the elimination database;
• setting up a national register of foci;
• strengthening the programme in terms of personnel, resources and logistics;
• establishing a programme of joint activities in border areas;
• mobilizing domestic funding and necessary assistance from international and bilateral partners;
• advocacy to assure political commitment and continuous funding for remaining transmission foci (especially in the decentralized political and budget context that many countries are experiencing).

The main activities of the national malaria programme staff include:
• collection of data on the parasites, vectors and human population, to assess and verify previous findings and target interventions;
• epidemiological investigation and case classification;
• detailed assessment of malaria foci;
• geographical reconnaissance and detailed logistic planning;
• drug policy change to include primaquine treatment for \textit{P. vivax} (radical treatment) and artemisinin-based combination therapy plus one day gametocyte treatment for \textit{P. falciparum};
• training and reorientation of personnel;
• setting up of the organization and physical facilities.

Programme reorientation has been achieved when cases are limited to clearly defined foci only, and the following changes have been completed:
• all malaria cases are microscopically confirmed and treated according to national policy, including cases diagnosed and treated in the private sector;
• microscopy quality-assurance systems are fully operational;
• all malaria cases are notified, epidemiologically investigated and centrally registered;
• malarious areas are clearly delimited and an inventory of foci has been made;
• the elimination database has been set up, including geographic information systems-based data on foci, cases, vectors, parasite isolates and interventions.

\textit{Elimination programme}

This phase starts in areas where the first programme reorientation has been achieved, and where health facility data show a malaria incidence of less than 1 infection per 1000 people at risk per year, equal to less than 100 new cases per year in a district with a population of 100 000 people. This is confirmed by:
• population-based reporting from facilities with known catchment areas, very high and reliable case notification and full participation of the private sector (assuming well-developed health services, mandatory reporting of malaria, and a strong conviction that nothing is being missed); and/or
• active case detection at community level among people with current fever (either measured directly or with a history of fever within the past 24 hours) in the expected peak transmission season (“fever survey”).

The goal of the elimination programme is to halt local transmission area- or countrywide, clear up malaria foci, and reduce the number of locally acquired cases to zero. To achieve this, the priority is to prevent onward transmission from existing cases by:

• identifying and treating all malaria cases with efficacious antimalarial medicines against liver stage and blood stage parasites, including gametocytes;
• reducing human–vector contact and the vectorial capacity of the local Anopheles mosquito populations in transmission foci by efficacious vector control, personal protection and environmental management methods.

Where *P. falciparum* is still present, this species is usually targeted first (see Box 2). The operational target for case detection in transmission foci is all febrile patients who do not have other obvious causes of fever. They should

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**BOX 2**

**Why *P. falciparum* is usually targeted first**

*P. falciparum* usually disappears from an area before *P. vivax* because:

- *P. falciparum* has a longer incubation interval than *P. vivax*, making the species more responsive to control measures;
- *P. vivax* strains have a longer incubation period;
- persistent hypnozoites of *P. vivax* prolong the natural lifespan of the parasite;
- people carrying hypnozoites are difficult to detect;
- treatment of hypnozoites is cumbersome, requiring 14 days’ treatment with primaquine.

Current malaria control tools make *P. falciparum* elimination programmes more feasible because:

- rapid diagnostic tests have a higher sensitivity for *P. falciparum* compared with those currently available for *P. vivax*;
- artemisinin-based combination therapy, when given promptly after the onset of symptoms, is highly effective against blood stage asexual and sexual forms of *P. falciparum*;
- the duration of artemisinin-based combination therapy for *P. falciparum* (3 days) is considerably shorter than the 14 days required for radical treatment of *P. vivax* with primaquine.
be tested for malaria, irrespective of their point of contact with the health services.

Routine genotyping of parasite isolates should be introduced early on in this phase (see Annex 4), to build up a local isolate bank (or, as the case may be, a genotypic register or databank), and develop a malaria parasite strain profile for the country, preferably linked to a regional/global database.

In the elimination programme, the concepts of receptivity and vulnerability become important, to minimize the risk of losing recent programme gains and to target interventions at areas at risk of the continuation or resumption of transmission.

- Areas are \textit{receptive} when the abundant presence of vector anophelines and the prevailing ecological and climatic factors favour malaria transmission.
- Areas are \textit{vulnerable} when they are in proximity to malarious areas or are prone to the frequent influx of infected individuals or groups and/or infective anophelines.

Vector control methods have to be selected to suit local conditions.

- Depending on feasibility and availability, indoor residual insecticide spraying, long-lasting insecticidal nets or a combination of both interventions is often the main method to reduce transmission in residual or new active foci. The insecticide and frequency of application of indoor residual spraying are determined by the local epidemiological situation. Up-to-date information is needed on vector resistance to pesticides, especially in conjunction with their continuing extensive use in agriculture. Planning and operations are guided by geographical reconnaissance.
- Larviciding may play an important supportive or even leading role in some special settings such as arid environments where mosquito breeding sites – often a result of human activity – are few and well identified. Larviciding may also be used to reduce receptivity in recent foci.
- Long-lasting insecticidal nets and other insecticide-treated materials play a supportive role as personal protection, including for nationals who travel abroad to endemic areas.

As the parasite reservoir decreases, full surveillance is instituted. Its purpose is to discover evidence of the continuation or resumption of transmission, detect imported cases early and provide a quick, adequate response. The individual functions of surveillance are:

- case detection (including active case detection);
- treatment of positive cases;
- case investigation and follow-up genotyping of local parasite isolates;
• epidemiological investigation of foci to determine their origin, extent and classification;
• parasitological surveys including active case detection;
• entomological surveys;
• meteorological monitoring;
• remedial action to further eliminate foci by vector control and drug treatment;
• community awareness and follow-up;
• political mobilization to support continuous funding and investment.

To reach 100% detection and notification of cases, the following are needed:

• engagement of the population, patients and local authorities;
• full cooperation/integration of the private health sector;
• services to diagnose and treat malaria that are free of charge to patients, whether nationals, temporary or permanent immigrants, people in transit, or residents of neighbouring countries who live in border areas;
• strict monitoring of the national supply of antimalarial medicines;
• a complete stop to the over-the-counter sale of antimalarial medicines;
• maintenance of health personnel skills.

It is an operational challenge to keep microscopists’ skills and interest at a high level when cases are few or zero. As the programme nears the elimination target, laboratory staff may see no positive blood films for months at a time. In such circumstances, all slides may need to be rechecked by a reference laboratory.

The objectives of the elimination programme have been achieved when:

• locally transmitted malaria cases have been reduced to zero;
• the health services and surveillance operation are fully capable of detecting and extinguishing malaria transmission should it occur.

Second programme reorientation: from elimination to prevention of reintroduction of transmission

The second programme reorientation starts in areas where:

• adequate surveillance shows a complete or nearly complete interruption of local transmission;
• there have been no or only very sporadic cases of local transmission in recent years;
• the overwhelming majority of malaria cases can be positively identified as of imported origin.

The orientation of general health service personnel in vigilance activities should be completed during this phase.
Elimination activities including surveillance should not yet be abandoned in areas where the organization of vigilance activities is not sufficiently adequate to prevent the re-establishment of endemicity through imported infection. An independent assessment by the malaria elimination monitoring committee should be undertaken to determine whether areas are ready to enter the next programme phase, based on:

- the status of malaria transmission in the area/country,
- the preparedness of the general health services and other sectors.

**Prevention of reintroduction programme**

Prevention of the reintroduction of malaria is a responsibility of the general health services as part of their normal function in communicable disease control, in collaboration with other relevant sectors (agriculture, environment, industry, tourism, etc.). Chapter 6 describes this programme in more detail.

Continued importation of cases means that the quality of case detection must be high. The patterns of vigilance that need to be applied in order to ensure the successful maintenance of the malaria-free status depend on the vulnerability and receptivity of an area. If the threat of re-establishment of malaria is considerable, the malaria component of the communicable diseases section of the general health services should be large enough to deal with it.

When there is clear and convincing proof of an absence of locally acquired cases for at least three consecutive years, WHO certification of malaria elimination can be requested. Chapter 7 describes this process in more detail.
3. Feasibility of malaria elimination

3.1 Contextual prerequisites for achieving malaria elimination

Gradual achievement of the required epidemiological profile and reaching programmatic milestones for malaria control and pre-elimination programmes may lead to a desire to proceed with complete malaria elimination. The following factors will be important:

- strong political commitment evidenced by a dedicated sustained budget at national and local authority levels, to achieve a greater impact on the malaria situation, and finally interrupt malaria transmission and eliminate the disease from the country;
- established regional/subregional cooperation in the field of malaria control and elimination;
- demonstrated technical feasibility of malaria elimination in similar eco-epidemiological settings in the recent past;
- proven efficacious technologies and tools to eliminate malaria in a given eco-epidemiological setting;
- strong and continued intersectoral collaboration.

3.2 Feasibility assessment

The following questions (requiring qualified yes/no answers) should be answered satisfactorily and, where necessary, problematic issues should be addressed before elimination can be realistically achieved.

- Is the political decision supported by adequate fund allocation?
- Are legislation, environmental codes and regulations in place?
- Are there adequate national health systems and services aimed at achieving total health-care coverage (including private sector involvement)?
- Is malaria elimination a component of the country’s socioeconomic development plan?
- Is there effective central and peripheral government administration over the entire national territory?
- Is there a good communication system and infrastructure that allows transport of staff, supplies and equipment into all areas affected by malaria?
• Is there an established national malaria elimination monitoring committee to decide on steps to be taken and monitor/report on the progress made in malaria elimination?
• Is there a thorough knowledge of local malaria epidemiology, including the history of the problem?
• Is the impact of currently applied interventions (malaria burden, population at risk, updated malaria stratification, case management, vector control and malaria surveillance) well documented?

In addition:

• the country’s elimination efforts should preferably be backed up by a regional policy;
• neighbouring countries should preferably be engaged in the elimination process (with evidence of cross-border cooperation), especially when endemic areas spill over international borders.

3.3 Setting realistic targets and timescales

The pre-elimination programme builds upon successful control of malaria mortality and morbidity. The preparation and planning to reach the first programme reorientation and the subsequent programme stages need to be country- and area-specific.

On the basis of the findings of the feasibility assessment and the pre-elimination programme surveys, countries may opt to set interim targets:

• by parasite species – experience shows that elimination of *P. vivax* transmission is more difficult than elimination of *P. falciparum* transmission (see Box 2);
• by geographical area – most countries approach elimination in stages, with different parts of the country being at different programme stages simultaneously.

Malaria elimination is usually undertaken as a time-limited programme, to minimize the period of intensive field operations. Even in the most ideal operational environments, a minimum period of 8–10 years is required *per programme zone* to achieve elimination. In less ideal circumstances, it will take considerably longer.

Recent experience from countries such as Armenia, the Islamic Republic of Iran, Morocco, Oman, Saudi Arabia, Tajikistan and Turkmenistan shows that the last remaining foci before achieving malaria elimination are, not surprisingly, characterized by some or all of the following:
• more efficient vectors and a longer transmission season than in the rest of the country;
• poor overall development, marginalized populations and weak health systems with inadequate coverage;
• common borders with neighbouring countries with a high burden;
• intense cross-border population movement and a high immigration rate from well-identified endemic countries;
• inaccessibility due to geographical or political constraints.

The duration of the programmes will not abide by any arbitrary time schedule, but will be determined by the epidemiological effect of the measures employed. Programme phases should be planned with sufficient flexibility in the budget. The programme for prevention of reintroduction of transmission has an unlimited duration.
4. Tools and approaches specific to elimination programmes

National expertise in malaria epidemiology and entomology drives the success in elimination. In-depth knowledge of the local epidemiology of malaria parasites, vectors and transmission patterns forms the basis for targeting all interventions.

Some malaria control methods that were applied in the 1950s–1960s during the Global Malaria Eradication Programme have considerably accelerated the development of drug resistance. These include especially the direct or indirect distribution of antimalarial medicines to whole populations irrespective of disease status or history of disease, and the use of medicines in subcurative doses. These obsolete methods should be avoided in modern elimination programmes. For more details, see Annex 5.

The most important tools that are specific to malaria elimination or take on more prominence compared with control programmes are listed below.

4.1 Detection of cases

Tools for the detection of cases include:

- legislation supporting the identification and notification of all malaria cases, irrespective of their place of residence or their first point of contact with public/private health services;
- active case detection though house-to-house visits during the transmission season;
- epidemiological investigation of every confirmed case;
- parasite genotyping and isolate banks;
- national malaria case register;
- continuing education and quality control for all public and private clinical services that diagnose and/or treat malaria;
- quality control of all laboratory services that diagnose malaria;
- use of microscopy only (i.e. not RDT) from the pre-elimination programme onwards, for species identification, detection of gametocytes and determination of parasite densities.
4. TOOLS AND APPROACHES SPECIFIC TO ELIMINATION PROGRAMMES

4.2 Prevention of onward transmission

Tools for the prevention of onward transmission include:

• vector control aimed at reducing human–vector contact and the vectorial capacity of local mosquito vectors;
• case management (radical treatment) aimed at reducing the period of infectivity and the occurrence of secondary infections by:
  – use of artemisinin-based combination therapy and gametocytocidal medicines (e.g. primaquine) for *P. falciparum* infections;
  – primaquine antirelapse treatment for 14 days for all *P. vivax* infections;
  – treatment of uncomplicated malaria on an in-patient basis (an option in the later stages of the elimination programme).

4.3 Management of malaria foci

Tools for the management of malaria foci include:

• vigilance;
• malaria surveys;
• geographical reconnaissance;
• vector control and entomological investigations;
• involvement of local authorities (such as local authorities taking over programme responsibilities for vector control);
• community involvement.

4.4 Management of importation of malaria parasites

Tools for the management of importation of malaria parasites include:

• intercountry coordination mechanisms;
• prevention of malaria in nationals who travel to endemic countries, including chemoprophylaxis, prevention of mosquito bites, standby emergency treatment and case management;
• screening, health education, easy access to free-of-charge diagnosis and treatment and other measures to cope with the continuing importation of parasites by international travellers and migrants.

4.5 Selected interventions

*Vigilance*

At the end of the elimination programme, a malaria alert and response system replaces regular malaria surveillance activities. This vigilance system is

1 Described in more detail in section 4.5.
operated through the general health services. It is the only protection against re-establishment of transmission and the appearance of rebound epidemics. It must be highly efficient and supported by local authorities, health personnel and the general population. Vigilance relies on the early and universal notification of suspected and confirmed malaria cases.

Malaria surveys

Malaria surveys, described below, provide information to guide programme management and programme reorientation.

- Contact surveys and active case detection can provide information for the classification of cases and foci. Contacts are people who share the living and/or working environment with a malaria case, or who have been otherwise potentially exposed to the same sources of infection.
- Clinic-based blood surveys using RDT or thick blood smears can provide information on the proportion of febrile patients who have malaria.
- Population-based blood surveys can provide information on malaria prevalence, the level of endemicity, and high-risk population groups.
- Blood bank safety checks that routinely include testing for the presence of malaria parasites by microscopy or polymerase chain reaction (PCR), or tetravalent antibody detection by enzyme-linked immunosorbent assay (ELISA) for signs of past or current malaria infection can provide information on a wider population group than would be reached by targeted surveys. It should be remembered, however, that:
  - positive ELISA findings do not necessarily indicate continuing local transmission, due to persistence of malaria antibodies in the blood over time, and the possibility that infection has been acquired abroad;
  - negative ELISA findings do not necessarily indicate an absence of continuing local transmission, due to the sampling frame of the blood bank.

Surveys using invasive procedures should be kept to a minimum. All people with positive test results should receive prompt and complete treatment as per the national antimalarial drug policy.

Geographical reconnaissance

Geographical reconnaissance is defined as the operation that provides the basis for the choice of field centres and depots, for detailed schedules and itineraries of spraying and surveillance personnel, for the final deployment of transport, and for the numerical control of the completeness of the work accomplished or reported. It includes collection of information on the number, type, location and means of access to all houses and field shelters, as well as on communica-
tions, health units, vehicle repair facilities, population movements and other relevant factors.

Its objectives are to:

- determine the number of houses in the malaria foci, their characteristics and the materials used in the construction of their walls; and to give them a reference number;
- record the number of inhabitants of the houses;
- map all the houses, health units and other important structures, and show the access route on the map, where relevant.

Current hand-held global positioning system devices, computerized mapping and geographic information systems, including satellite images such as those from Google Earth, facilitate the task of geographical reconnaissance. However, it remains a large and expensive undertaking, needing careful preparation and organization. Its findings must be constantly kept up to date.
5. Monitoring and evaluation of progress towards malaria elimination

5.1 Purpose and objectives

Progress towards elimination of malaria from a country involves two important programme reorientations:
1. from a control programme to an elimination programme;
2. from an elimination programme to a programme focused on prevention of reintroduction of malaria.

In each reorientation, substantial changes in activities, priorities and programmatic focus must take place. During each programmatic reorientation, some strategies, activities and specific interventions will be phased out while new ones are phased in; staff will need to be retrained and new routines established.

The monitoring and evaluation components of the programme have to be developed to:
• document and guide the reorientation process of the malaria programme – from a control programme to an elimination programme, and from an elimination programme to a programme focusing on prevention of reintroduction of malaria;
• document progress towards achievement of goals and objectives to support each programmatic shift;
• establish a credible information database for ultimate certification of malaria elimination.

5.2 Recording and reporting

Good record keeping is an essential element of a successful programme. Completeness, accuracy and timeliness of data are essential because the decisions to change to the next phase of the programme are guided by the progress made in epidemiological indicators. These indicators are initially population- and health facility-based, and narrow down to foci and ultimately to individual cases as the programme evolves from a control programme into an elimination programme.
Key requirements for monitoring this progress are:

- accurate record keeping,
- regular and complete reporting of cases,
- regular data audits to ensure completeness of timely information,
- regular analysis of data,
- regular feedback to all staff involved.

### 5.3 Establishment of a malaria elimination database

Early in the shift to an elimination programme (i.e. during the pre-elimination programme), a malaria elimination database has to be established. This database will serve as the national repository of all information related to malaria elimination, including the following major components.

- **National malaria case register** – a single database of all individual case information from identified sources in the whole country, including unique identifiers (required to allow tracking of subsequent infections in individuals), demographic information (age, sex, occupation and other aspects that may influence a person’s malaria risk) and location (including global positioning system coordinates) (see Annex 6). This register allows detailed analysis and synthesis of epidemiological information and trends that help guide the elimination programme over time.

- **Malaria patient register** – a central repository of all malaria patient records, including copies of public and private health facility/hospital records, case investigation record forms (see Annex 7) and any other pertinent information regarding individual cases.

- **Laboratory register** – a single database, linked to the patient register, which contains all pertinent information regarding malaria diagnosis of the patient (see Annex 8). Comparison of these two registers allows cross-checking for completeness of case data. This register should also be linked to the parasite strain bank.

- **Parasite strain bank** – samples of parasites from individual cases should be stored in a central strain bank. These samples are retained in order to:
  - genetically characterize locally circulating parasite strains, potentially to be used later to differentiate a case probably related to local transmission from a case of imported malaria or related to an imported case;
  - allow genetic comparisons of parasites in an individual, for example, to assist in identifying a potential relapse of *P. vivax* from a new infection in a person with a recent (within three years) history of *P. vivax* infection.

Alternatively, a genotypic register or databank should be established. This is easier to maintain.
• **Entomological monitoring/vector control records** – a central repository of information related to entomological monitoring and application of chosen vector control interventions, including but not limited to breeding site mapping, foci investigation, indoor residual spraying, larviciding and/or stocking of larvivorous fish.

### 5.4 Establishment of a national independent malaria elimination monitoring committee

Ideally, management and maintenance of the malaria elimination database would be the responsibility of a national committee that is independent of the malaria programme. It would ensure proper maintenance and organization of the national database, and perform periodic data audits to ensure completeness and accuracy of records. This is especially useful for countries with a desire for eventual official WHO certification of malaria elimination, because it removes any real or perceived conflict of interest introduced when the entity that is responsible for eliminating malaria is also responsible for maintaining the records by which success will be evaluated.

### 5.5 Monitoring and evaluation – recommended indicators, data sources and methodologies

Monitoring and evaluation concentrate 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;
- documentation of progress towards malaria elimination.

Table 3 presents a monitoring framework of possible indicators to be considered as part of pre-elimination and elimination programmes.

In choosing indicators, emphasis is placed on evaluation of foci, evaluation of case detection and management, and evaluation of entomological monitoring and vector control activities, as outlined below.
### Table 3. Monitoring framework for pre-elimination and elimination programmes

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>ACTIVITY</th>
<th>INDICATOR</th>
<th>METHOD/ DATA SOURCE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enabling environment</strong></td>
<td>Political commitment</td>
<td>Official endorsement</td>
<td>Record review</td>
<td>Describe nature of endorsement (official proclamation, authorizing legislation, etc.)</td>
</tr>
<tr>
<td></td>
<td>Legal/regulatory framework</td>
<td>Record review</td>
<td>Describe nature of framework (malaria is a notifiable disease, legal/regulatory authorities of the malaria programme, etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Specific domestic funding earmarked</td>
<td>Record review</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>Regional/subregional cooperation</strong></td>
<td>Regional/subregional malaria elimination strategy in place</td>
<td>Record review</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cross-border agreement in place</td>
<td>Record review</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Evidence of collaboration (cross-border/regional/subregional)</td>
<td>Record review</td>
<td>Active exchange of information (including on cases and case investigations; joint research/programmatic activities; regular cross-border meetings between malaria programmes; joint training/workshops; etc.)</td>
<td></td>
</tr>
<tr>
<td><strong>Adoption of enabling health policies</strong></td>
<td>Updated treatment policies</td>
<td>Record review</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Malaria diagnosis and treatment available at no charge to patient</td>
<td>Record review</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Regulation of anti-malarial medicines</td>
<td>Record review</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>Epidemiology (geographical information)</strong></td>
<td>Stratification</td>
<td>—</td>
<td>Record review</td>
<td>Detailed stratification maps available</td>
</tr>
<tr>
<td></td>
<td>Number of active foci reported per year</td>
<td>Record review</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proportion of reported foci fully investigated</td>
<td>Record review</td>
<td>Full investigation assumes inclusion of information such as geographical location, additional case detection (active), entomological assessments, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Proportion of reported foci correctly classified</td>
<td>Record review</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

*Continued on page 36*
Table 3. Continued

<table>
<thead>
<tr>
<th>COMPONENT ACTIVITY</th>
<th>INDICATOR</th>
<th>METHOD/DATA SOURCE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases within focus</td>
<td>Record review</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Total population at risk within focus</td>
<td>Record review</td>
<td>Using as elimination definition for denominator: smallest political unit that corresponds to approximately 75 000–150 000 population (e.g. a district)</td>
<td></td>
</tr>
</tbody>
</table>

**Surveillance**

- **National malaria surveillance system (NMSS)**
  - **Timeliness:** time between diagnosis, reporting and investigation
    - Standardized assessment
    - Would expect decrease in time between diagnosis, reporting and investigation
  - **Completeness:** proportion of cases reported to surveillance system
    - Standardized assessment, special study (e.g. capture–recapture)
    - —

- **Inclusion of private sector**
  - **Protocol for private clinics**
    - Record review
    - —
  - **Proportion of private facilities reporting to NMSS**
    - Survey of private facilities
    - Pre-elimination programme: assumes a census of private health providers exists and malaria is a reportable disease. Zero reporting should be used where possible
    - Elimination programme: assumes complete integration of private-sector health facilities in NMSS

- **Tracking of malaria burden**
  - **Total number of cases reported per year**
    - NMSS annual reports
    - Would expect consistent decline in number of cases reported over time
  - **Proportion of reported cases that are fully investigated**
    - Record review
    - Pre-elimination programme: would expect proportion of reported cases fully investigated to increase to be maintained at high level (>90%)
    - Elimination programme: would expect proportion of reported cases fully investigated to be maintained at high level (100%)
  - **Number of cases by classification**
    - NMSS annual reports
    - —

---

4 In the pre-elimination programme, the national malaria surveillance system transitions from aggregate reporting to increasing use of case-based surveillance, with increasing reporting and investigation of individual cases. In the elimination programme, surveillance should be fully case-based, with complete reporting and investigation of all cases.
### Table 3. Continued

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>ACTIVITY</th>
<th>INDICATOR</th>
<th>METHOD/ DATA SOURCE</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluation of population at risk</td>
<td>Total population at risk within country</td>
<td>NMSS annual reports</td>
<td>Would expect consistent decline in total population at risk over time</td>
<td></td>
</tr>
<tr>
<td><strong>Case management</strong></td>
<td>Diagnosis</td>
<td>Proportion of cases confirmed by microscopy</td>
<td>Clinic reports, case investigation reports</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Microscopy QA/QC in place</td>
<td>QA reports</td>
<td>Describe how the QA/QC system works, which laboratories are participating, level of expertise of reference laboratories, etc.</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>Proportion of cases treated according to guidelines</td>
<td>Case investigation reports</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>Vector control</strong></td>
<td>IRS</td>
<td>Number and proportion of at-risk households that have been sprayed</td>
<td>Vector control records</td>
<td>In the pre-elimination programme, this refers to area-wide vector control activities. As the programme progresses towards elimination, would expect number of households at-risk to decrease and proportion covered to increase to/be maintained at high level (&gt;90%)</td>
</tr>
<tr>
<td></td>
<td>Number and proportion of reported active foci that were sprayed</td>
<td>Vector control records</td>
<td>Refers to the situation late in the pre-elimination programme when transmission has been reduced to occurrence primarily in discrete foci. As a programme progresses towards elimination, would expect the number of active foci to decrease and the proportion sprayed to increase to/be maintained at high levels (&gt;90%)</td>
<td></td>
</tr>
<tr>
<td>Larval control</td>
<td>Proportion of known/potential breeding sites treated with chemicals/fish</td>
<td>Vector control records</td>
<td>Assumes the malaria programme has investigated and mapped breeding sites throughout receptive areas. Would expect high proportion covered (&gt;90%)</td>
<td></td>
</tr>
<tr>
<td><strong>Entomological surveillance</strong></td>
<td>Larviciding</td>
<td>Proportion of breeding sites positive for mosquito larvae</td>
<td>Entomological surveillance records, vector control records</td>
<td>Assumes the malaria programme has investigated and mapped breeding sites throughout receptive areas. Would expect an effective programme to achieve/maintain very low levels of breeding sites positive for mosquito larvae (&lt;5%)</td>
</tr>
</tbody>
</table>

QA: quality assurance; QC: quality control; IRS: indoor residual spraying.
Evaluation of foci

Transition of the functional status of foci should be monitored, with an emphasis on detection of new potential or new active foci. Regarding the quality of information on foci, the following questions (requiring yes/no answers) should be answered satisfactorily.

- Is the national register of foci complete?
- Are visits to the foci regular (i.e. every two weeks or as locally appropriate)?
- Are all the foci completely and regularly covered by case detection?
- Are all the cases completely and rapidly investigated?
- Is this investigation conducted correctly?
- Is the characterization of foci correct?

An example of information to be included in a malaria foci investigation record form is included in Annex 9. The evaluation of foci is discussed in more detail in the *Guidelines on the elimination of residual foci of malaria transmission* (2).

Evaluation of case detection and management

The following questions (requiring qualified yes/no answers) should be answered satisfactorily for evaluation of case detection and management.

- Are all fever cases who do not have other obvious causes of fever tested for the presence of malaria parasites?
- Does the quality of the laboratory examination meet the accepted norms and is there an organized quality-control/quality-assurance system?
- Is the detection and reporting of the cases timely?
- Was the quality of the treatment, in terms of dosage, regimen, completeness, supervision and follow-up, in accordance with current established guidelines?

Detailed analysis of the timeliness of case detection will allow calculation of the average delay between the onset of symptoms and inactivation of the source of infection by treatment, and identification of bottlenecks. Analysis of the time spans of possible patient, doctor and laboratory delays is important. These delays are indicated in Figure 6.
5. MONITORING AND EVALUATION OF PROGRESS TOWARDS MALARIA ELIMINATION

Evaluation of entomological monitoring and vector control activities

The following questions (requiring qualified yes/no answers) should be answered satisfactorily for evaluation of entomological monitoring and vector control activities.

- Are suitable vector control interventions being applied completely, appropriately and in a timely fashion?
- Are vector control interventions effective?
- Is transmission under full control?
6. Prevention of the re-establishment of malaria

During the advanced stages of the programme, when the complete interruption of malaria transmission has been achieved, the activities will be directed at preventing any re-establishment of malaria in the area covered by the programme. The essential activities include the continuous reduction of vulnerability by the universal access of the whole population, including visitors, to diagnostic and treatment facilities. Under exceptional circumstances, especially when importation of malaria is intensive, the activities may include the screening of immigrants for malaria and the use of radical treatment.

Increasing numbers of imported cases of malaria result in an increasing threat to those countries that have eliminated malaria and still remain receptive to the disease. Contributing factors include:

• increasing number of international travellers;
• increasing exposure of travellers to infection as a result of locally deteriorating malaria situations and changing patterns of travel;
• immigration flows from various places of origin.

Migrants and refugees arriving in large numbers from malarious countries or areas may present a severe threat to the maintenance of malaria elimination. If possible, they should be directed to areas of zero receptivity. If not, energetic measures may be required to prevent onward transmission, including indoor residual spraying and mosquito-proofing of reception areas and living quarters.

The dedication of both the government and programme personnel that was necessary to eliminate malaria must be continued so that the requisite knowledge and skills are maintained and the health service so organized that these attributes can be used as and when necessary.

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The world is increasingly interconnected. Non-malarious countries, whether previously malarious or not, must be concerned about malarious countries and support their efforts against the disease.

6.1 Probability of malaria becoming re-established

The probability of malaria becoming established or re-established in a malaria-free area varies with the product of the degrees of receptivity and vulnerability of the area. If either of these factors is zero, the probability of malaria becoming re-established is zero even if the other factor has a high value. Both factors may change. For example, vulnerability may increase with the arrival of a group of refugees, migrant workers, international civil servants, exchange students, etc. from a malarious country. Receptivity will be increased by developmental projects that create favourable conditions for the vectors and increase human–vector contact. Large development projects usually also attract external workers, thus possibly increasing vulnerability simultaneously. Irrigation projects, mining and clearing of forests for agriculture are typical examples. Receptivity may have seasonal and cyclic variations.

An indication of the degree of receptivity of an area may be derived from its malaria history:

- original degree of endemicity;
- vectorial capacity before the implementation of intensive control measures;
- response of vector to withdrawal of insecticide spraying after the application of intensive control measures;
- environmental changes as a result of developments, which may affect the vector population.

Particular attention would need to be paid to areas with appreciable degrees of vulnerability.

An indication of the degree of vulnerability will be available from knowledge of traditional patterns of travel into the area as well as recent changes that will be apparent from the epidemiological investigation of cases in the recent past. The number of people arriving, their origin, the categories of people involved as well as their local destination and length of stay are factors that are relevant to estimating future changes in vulnerability.

---

1 There are as yet no definite criteria for establishing the exact levels of vulnerability and receptivity of an area.
6.2 Patterns of vigilance

After having achieved the complete interruption of malaria transmission, the objective of the ensuing phase is the prevention of the re-establishment of malaria in an area from which the disease and the parasites have been eliminated.

Except in the rare situation where the vector has been eliminated, the area under consideration will still be receptive to malaria. The source of parasites is another area or another country; the parasites usually arrive as liver or blood stage parasites of people entering the given area.

Because the probability of malaria becoming re-established varies from area to area, a pattern of vigilance appropriate to each particular area will be necessary. In the absence of appropriate action, the area is likely to become malarious again and the time until this happens is determined by the levels of receptivity and vulnerability.

- **At low levels of receptivity and vulnerability**, early case detection by a vigilant general health service, complemented by epidemiological investigation of every case and focus and appropriate curative and preventive measures, may be sufficient to prevent re-establishment of transmission.

- **At increasing levels of receptivity and vulnerability**, it may be necessary to supplement these activities by active case detection, which may possibly be combined with other regularly repeated health activities involving house visits.

- **In localities of high vulnerability**, it may be possible or even necessary to reduce receptivity by the use of appropriate vector control measures such as indoor residual spraying, long-lasting insecticidal nets or larviciding, based on continued updating of the information on the local situation.

6.3 Organization of the health service

Freedom from malaria may have two important consequences.

- **Lack of an enabling environment** – there will be increasing reluctance to commit personnel, time and expenditure to a disease that does not occur anymore. The general public and politicians forget about malaria and the ravages it caused in the past.

- **The disease is no longer recorded** – the absence of cases may result in loss of skills in clinical and microscopy diagnosis of malaria and epidemiological investigation of cases. There may be little opportunity for training based on actual cases.
The situation will be particularly precarious and harbour a high risk of resumption of malaria transmission in receptive areas exposed to a massive influx of imported malaria cases from abroad.

Resistance to a continued effort against malaria can be expected both within the health services and among the general population. For this reason, a high-level technical nucleus where knowledge and skills are maintained must be kept up in the country. This nucleus should:

- consist of the central office of the former malaria control programme and its specialized technical sections;
- function in the framework of the directorate of preventive health services and thereby have free lines of communication with the general health services at central and intermediate levels;
- exercise overall oversight of the country’s vigilance activities and case notification, and maintain the national malaria case register;
- be responsible for quality control and quality assurance of diagnostic laboratory operations as well as the regular updating of the antimalarial drug policy for:
  - the management of malaria cases,
  - chemoprophylaxis for residents travelling to endemic areas;
- be responsible for planning and quality control of entomological investigations and essential vector control operations directed at reducing the receptivity of an area for malaria.

A highly practical way of maintaining the technical nucleus and its competence is the extension of its responsibilities to the control of other vector-borne infectious diseases, e.g. dengue, Japanese B encephalitis, leishmaniasis, Rift Valley fever, chikungunya, etc.

The maintenance of the malaria-free status will depend increasingly on the local authorities (who control the resources), the general health services including the private sector of health care, and other sectors such as environment, industry, agriculture, etc. Necessary activities may vary in different areas and over time, as determined by the epidemiological situation. The health service must be organized in such a way that appropriate activities can and will be carried out rapidly, with adequate skilled guidance from and supervision by the technical nucleus at the central level. Adequate supplies and equipment must be maintained and kept in good order.

As an example of the organization and operations involved in securing a malaria-free status, the appropriate plan for the United Arab Emirates is included in Annex 10.
6.4 Training

Within the health service itself, it is necessary to maintain adequate levels of malaria training, which can be guided by the technical nucleus. Such training is aimed at:

- all relevant personnel in areas where there is a possibility of re-establishment of the disease; the training focuses on the technical aspects related to maintaining the malaria-free status;
- all relevant personnel in the public health service; the training raises awareness of factors that are likely to cause increases in vulnerability and receptivity, so that appropriate measures can be taken to lessen their effects on an eventual re-establishment of malaria;
- the general medical profession and undergraduate medical students; they require continued education in:
  - the diagnosis and treatment of malaria,
  - prevention measures, including those for international travellers.

It is also necessary to maintain an adequate level of competence in the laboratory diagnosis of malaria. The technical nucleus can play a part in the relevant teaching and training and also by acting as the cross-checking centre for blood films; this can identify personnel who need re-training.

Some of this training can be done locally, some at academic institutions or a school of public health, but key personnel will require experience in malarious countries. The malaria epidemiology courses conducted by WHO have been particularly useful in this last category. In return, areas where malaria elimination has been successfully maintained can be used for training in vigilance activities. Regional malaria courses and institutions can help in maintaining the required academic standard and stimulating operational research.

The publication of an annual report on the national malaria situation will stimulate and maintain interest and will also be a useful educational medium.
7. WHO certification of malaria elimination

7.1 Requirements – burden of proof

When a country has zero locally acquired malaria cases for at least three consecutive years, it can request WHO to certify its malaria-free status. Certification of malaria elimination requires proving beyond reasonable doubt\(^1\) that the chain of local human malaria transmission by *Anopheles* mosquitoes has been fully interrupted in the entire country. The burden of proof of elimination falls on the country requesting certification. The bolder a claim of malaria elimination appears to be, the higher the standard of proof that will be required and the less it will be taken for granted or assumed to be true without additional investigation.

Absolute mathematical certainty of elimination can never be obtained. Thus, a defensible, plausible argument must be made that, beyond reasonable doubt, malaria transmission has ended in a given place and at a given time. This implies that all the available evidence has been evaluated and has been found to be consistent with the assertion that malaria elimination has been achieved and that good-quality surveillance systems are in place that would be capable of detecting local transmission if it were occurring.

In order to be confident that interruption of transmission has been achieved, a number of preconditions must be met. These include:

- a good surveillance mechanism with full coverage of all geographical areas;
- a national malaria case register, notification and full immediate reporting by public and private health services;
- adequate health services for early detection and effective treatment and follow-up of imported malaria cases;
- high-quality laboratory services to diagnose malaria, based on microscopy;
- epidemiological investigation of every malaria case;
- a national, comprehensive plan of action with continued political and finan-

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1 Reasonable doubt is defined as actual and substantial doubt reasonably arising from evidence, from the facts or circumstances shown by the evidence, or from the lack of evidence.
cial support to carry out activities needed to prevent re-establishment of transmission;
• a system for awareness, prevention of mosquito bites and chemoprophylaxis for travellers to prevent imported malaria;
• a central computerized geo-referenced database of cases and latest foci;
• entomological surveillance and monitoring of insecticide resistance in areas with high receptivity;
• a functional border coordination system, wherever relevant;
• capacity for early detection of and rapid response to epidemics.

Sero-epidemiological surveys to detect malaria antibodies can support validation of the interruption of local transmission.
• In situations where elimination was achieved at least eight years previously, people’s malaria antibodies could be expected to have disappeared. Surveys among local stable populations (who have no history of travel to endemic areas abroad in the period since elimination was achieved) should be negative.
• In situations where elimination was achieved more recently, sero-epidemiological surveys among children aged three months and older who were born after the interruption of transmission should be negative.

The value of sero-epidemiological surveys is limited by the sensitivity of the test methods available. It is also not 100% certain when malaria antibodies are no longer detectable among populations who have previously been exposed to local transmission. All people with positive test results during sero-epidemiological surveys should be fully assessed, including diagnosis by microscopy, treated for current infection, and a full case investigation carried out.

Details of the aspects to be covered by the evaluation teams are provided in the chapter on assessment of malaria elimination in Informal consultation on malaria elimination: setting up the WHO agenda (8), pp. 38–39 (see Box 3). The parameters that will be verified by the evaluation teams are also of interest to national staff in the later stages of the elimination programme.
Assessment of malaria elimination

The following criteria for achieving and maintaining malaria elimination should be assessed:

- extensive coverage by high-quality public and private curative and preventive health services,
- a high-quality surveillance system,
- direct measurements of potential local transmission,
- supportive operational research activities.

Assessing coverage by high-quality public and private curative and preventive health services

Core demographic indicators can provide a good idea of the overall health situation and coverage by high-quality public and private curative and preventive health services. These include the crude mortality rate, the mortality rates for infants and for children aged under five years, and the maternal mortality rate. Coverage by health services with specific capacity for malaria diagnosis and treatment and the proportion of the population covered by those facilities (living within a distance of less than 5 km or 1 h by foot) and by antimalarial interventions (such as indoor residual spraying, larviciding and adequate treatments) should be known, especially in former transmission foci and newly receptive areas.

Assessing the quality of a surveillance system

Recognized methods for assessing the quality of a surveillance system are based on criteria such as usefulness, simplicity, flexibility, data quality (completeness and validity of data collected by the surveillance system), acceptability, sensitivity (proportion of cases detected by the system; ability to monitor changes in the number of cases over time), positive predictive value (proportion of cases reported by the surveillance system that actually have the disease), representativeness (ability of the system to describe the occurrence of a health-related event accurately over time and its distribution in the population by place and person), timeliness (ability of the system to identify and investigate or intervene quickly) and stability.

Proxy indicators to monitor the quality of surveillance systems are used, for example, in the poliomyelitis eradication programme, which relies on the ability of the system to detect at least one case of acute flaccid paralysis that is not poliomyelitis per 100,000 population under 15 years of age. Another proxy indicator might be the proportion of reporting units supplying surveillance reports on a regular basis even when no cases are reported. Special efforts should be made to cross-check surveillance reports with health facility records and antimalarial drug supply figures in former or current areas of transmission. Special attention should be paid to the assessment of laboratory and diagnostic quality-assurance systems for microscopy, serology, molecular assessment,

Continued on page 48
and clinicians’ knowledge and practices. The assessment should also include the proportion of reported cases and foci fully investigated.

An indicator of timeliness of diagnosis and treatment specific for malaria is the proportion of cases of \( P. falciparum \) infection with gametocytes. Gametocytes usually do not appear if cases are treated within six days of the onset of symptoms. To use this indicator, a laboratory must specify the stage of \( P. falciparum \) diagnosed, which is in any case good practice.

**Direct measurements of potential local transmission**

Direct measurements of potential local transmission include entomological monitoring activities, such as the abundance of vector species, proportion of nulliparous mosquitoes (or other measures indicating physiological age), mapping of risk areas and monitoring resistance of vectors to insecticides. Other direct measurements are specific parasitological surveys with blood slides or rapid diagnostic tests; sero-epidemiological surveys to evaluate the size of the risk for importation, to identify high-risk immigrants and to evaluate former foci of transmission; and genetic characterization to distinguish single-source local infection from imported sources as well as searching for the origin(s) of parasites.

**Supportive operational research activities**

The priorities for supportive operational research activities depend on the phase of the programme, as shown in the following examples.

*Elimination programme:*
  - vector classification
  - suitable malaria survey methodologies
  - early detection of importation of parasites.

*Prevention of reintroduction programme:*
  - development or selection of effective methods to improve use of preventive measures, including chemoprophylaxis among residents travelling abroad to endemic countries;
  - improving prevention in recent immigrants travelling to their country of birth to visit friends and relatives;
  - quantification of the risk of reintroduction of malaria from individual imported cases and determining whether expensive screening programmes are justified and cost effective;
  - validation of rapid methods for screening immigrants and temporary workers on arrival.

*General:*
  - validation of molecular tools for genetic characterization and verification of local transmission.
7.2 Procedures for certification

The general principles of certification are:

1. certification is for a country as a whole and for all four human malaria species;
2. inspection and evaluation are carried out by a team led by WHO, which then recommends certification, if appropriate;
3. the final decision rests with the WHO Director-General;
4. certification is published in the *Weekly Epidemiological Record*.

On the basis of the experience with certification of malaria elimination in the United Arab Emirates (9) and in line with the draft WHO criteria and procedures for certification of malaria elimination, which still need to be officially endorsed by the World Health Assembly, eight steps need to be taken to reach the final stage of recognition and certification of malaria elimination by WHO.

1. **Request sent to WHO**: the national government sends a request for certification to the WHO Regional Director. WHO responds by communicating the elimination criteria, certification process and the documents necessary to provide clear and convincing evidence that malaria transmission has been interrupted throughout the country (see Annex 11).

2. **Formulation of a plan of action**: the WHO Secretariat, external experts and the national government jointly prepare a plan of action for certification.

3. **Implementation of the plan and submission of the supporting documentation**: the national government prepares the necessary documentation.

4. **Evaluation visit(s)/development of the evaluation report**: a WHO-led evaluation team, which is preferably made up of experts from WHO headquarters and regional offices as well as experts from outside WHO, visits the country, verifies the documents, makes site visits and examines anything else of relevance. The evaluation team prepares a final report with a recommendation to WHO on the possible granting of certification (see Annex 12 for an outline of the content of the final report).

5. **Final report review by a wider group of experts**: the WHO Secretariat shares the final report with WHO and non-WHO experts on malaria elimination for critical review.

---

1 This section is adapted from the chapter on administrative procedures and criteria for certification of malaria elimination by WHO in *Informal consultation on malaria elimination: setting up the WHO agenda* (8), pp. 40–41.
6. **Final review by the WHO Expert Committee on Malaria**: the outcome of the wider review is compiled by the WHO Secretariat and sent with a recommendation for certification, along with the accompanying documents, to the Chairman of the most recent meeting of the WHO Expert Committee on Malaria. The Chairman communicates directly with the national government for further clarifications on the dossier if needed and consolidates a recommendation to the Director-General of WHO for a final decision.

7. **Final decision**: the Director-General of WHO takes the final decision on granting malaria-free status and communicates this in an official letter to the national government.

8. **Publication of certification in the WHO Weekly Epidemiological Record**: the WHO Secretariat publishes positive decisions in the *Weekly Epidemiological Record*.

### 7.3 Follow-up of certification

Certification of malaria elimination is based on an assessment of the current situation and the likelihood that elimination can be maintained. Countries are requested to continue reporting on an annual basis to WHO on the maintenance of their malaria-free status. Information to be included in the annual report to WHO is included in Annex 13.

Outbreaks of falciparum malaria in a normally or recently malaria-free country should be reported to WHO immediately, so that WHO can provide assistance where needed and can alert international travellers visiting the affected areas that they should take suitable preventive measures. In certain circumstances, malaria may be notifiable under the International Health Regulations of 2005 (see Box 4).

Because certification is the recognition of a considerable operational achievement, countries will remain listed as having achieved malaria elimination even if they subsequently suffer a temporary occurrence of local transmission.

An indication of the re-establishment of transmission would be the occurrence of three or more introduced and/or indigenous malaria infections linked in space and time to local mosquito-borne transmission in the same geographical focus, for two consecutive years for *P. falciparum*, and for three consecutive years for *P. vivax*.

Re-establishment of transmission will be reported in the annual updates of the WHO publication *International travel and health*. To protect international travellers, reports of falciparum malaria outbreaks in “malaria-free” countries will be posted on an ad hoc basis in the *Weekly Epidemiological Record*. 
**International Health Regulations (2005)**

On 15 June 2007, the International Health Regulations (2005) or IHR (2005) entered into force. The IHR (2005) are the world’s first legally binding agreement in the fight against public health emergencies of international concern, such as those caused by new and re-emerging diseases with epidemic potential, as well as those associated with acute chemical or radionuclear events.

The 2005 revision of the 1969 version of the IHR broadens the scope of notification of cases of cholera, plague and yellow fever to all events that may constitute public health emergencies of international concern and the reporting of other serious international health risks, irrespective of origin or source.

The main aims of the IHR (2005) are to prevent, protect against, control and respond to the international spread of disease while avoiding unnecessary interference with international traffic and trade.

Under the IHR (2005), States are required to notify WHO of all events that may constitute public health emergencies of international concern, based on the following criteria.

- Is the public health impact of the event serious?
- Is the event unusual or unexpected?
- Is there a significant risk of international spread?
- Is there a significant risk of international restriction(s) to travel and trade?

*For further information, see [http://www.who.int/csr/ihr/en/](http://www.who.int/csr/ihr/en/)*
References


Bibliography


- The WHO African Region and the southern WHO Eastern Mediterranean Region: http://whqlibdoc.who.int/hq/1984/VBC_84.6_eng.pdf;
- The WHO European Region and the WHO Eastern Mediterranean Region I: http://whqlibdoc.who.int/hq/1988/VBC_88.2_eng.pdf;
- The WHO European Region and the WHO Eastern Mediterranean Region II: http://whqlibdoc.who.int/hq/1990/VBC_90.1_eng.pdf;
- The WHO European Region and the WHO Eastern Mediterranean Region (the Mediterranean Basin): http://whqlibdoc.who.int/hq/1990/VBC_90.2_eng.pdf;
- The WHO European Region and the WHO Eastern Mediterranean Region (Asia west of India): http://whqlibdoc.who.int/hq/1990/VBC_90.3_eng.pdf;
– The WHO South-East Asia Region and the WHO Western Pacific Region I: http://whqlibdoc.who.int/hq/1994/CTD_MAL_94.1.pdf;

### ANNEX 1

**Countries and areas with malarious zones**

The following list shows all countries and areas where malaria occurs. In some of these countries, malaria is present only in certain zones or up to a particular altitude. In many countries, malaria has a seasonal pattern.

<table>
<thead>
<tr>
<th>Country</th>
<th>Country</th>
<th>Country</th>
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</thead>
<tbody>
<tr>
<td>Afghanistan</td>
<td>Congo</td>
<td>Haiti</td>
</tr>
<tr>
<td>Angola</td>
<td>Côte d’Ivoire</td>
<td>India</td>
</tr>
<tr>
<td>Argentina*</td>
<td>Democratic People’s</td>
<td>Indonesia</td>
</tr>
<tr>
<td>Azerbaijan*</td>
<td>Democratic Republic</td>
<td>Iraq*</td>
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<tr>
<td>Bangladesh</td>
<td>of the Congo</td>
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<td>Belize</td>
<td>Djibouti</td>
<td>Kenya</td>
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<tr>
<td>Benin</td>
<td>Dominican Republic</td>
<td>Kyrgyzstan*</td>
</tr>
<tr>
<td>Bhutan</td>
<td>Ecuador</td>
<td>Lao People’s</td>
</tr>
<tr>
<td>Bolivia</td>
<td>Egypt (1998)</td>
<td>Democratic Republic</td>
</tr>
<tr>
<td>Botswana</td>
<td>El Salvador</td>
<td>Republic</td>
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<tr>
<td>Brazil</td>
<td>Equatorial Guinea</td>
<td>Liberia</td>
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<td>Burkina Faso</td>
<td>Eritrea</td>
<td>Madagascar</td>
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<td>Burundi</td>
<td>Ethiopia</td>
<td>Malawi</td>
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<tr>
<td>Cambodia</td>
<td>French Guiana</td>
<td>Malaysia</td>
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<tr>
<td>Cameroon</td>
<td>Gabon</td>
<td>Mali</td>
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<tr>
<td>Cape Verde</td>
<td>Gambia</td>
<td>Mauritania</td>
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<tr>
<td>Chad</td>
<td>Ghana</td>
<td>Mayotte</td>
</tr>
<tr>
<td>China</td>
<td>Guinea</td>
<td>Morocco* (2005)</td>
</tr>
<tr>
<td>Colombia</td>
<td>Guinea-Bissau</td>
<td>Mozambique</td>
</tr>
<tr>
<td>Comoros</td>
<td>Guyana</td>
<td>Myanmar</td>
</tr>
</tbody>
</table>

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1. The countries where there is *P. vivax* risk only are marked *.* The year in parentheses indicates the point since when no more indigenous malaria cases have been reported. Adapted from *International travel and health: situation as on 1 January 2007* (1).
### ANNEX 1. COUNTRIES AND AREAS WITH MALARIOUS ZONES

<table>
<thead>
<tr>
<th>Name</th>
<th>Name</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>Saudi Arabia</td>
<td>Turkey*</td>
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<tr>
<td>Nepal</td>
<td>Senegal</td>
<td>Turkmenistan* (2006)</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>Sierra Leone</td>
<td>Uganda</td>
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<tr>
<td>Niger</td>
<td>Solomon Islands</td>
<td>United Republic of</td>
</tr>
<tr>
<td>Nigeria</td>
<td>Somalia</td>
<td>Tanzania</td>
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<tr>
<td>Oman (2000)</td>
<td>South Africa</td>
<td>Uzbekistan*</td>
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<tr>
<td>Pakistan</td>
<td>Sri Lanka</td>
<td>Vanuatu</td>
</tr>
<tr>
<td>Panama</td>
<td>Sudan</td>
<td>Venezuela (Bolivarian</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>Suriname</td>
<td>Republic of)</td>
</tr>
<tr>
<td>Paraguay*</td>
<td>Swaziland</td>
<td>Viet Nam</td>
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<tr>
<td>Peru</td>
<td>Syrian Arab</td>
<td>Yemen</td>
</tr>
<tr>
<td>Philippines</td>
<td>Republic* (2005)</td>
<td>Zambia</td>
</tr>
<tr>
<td>Republic of Korea*</td>
<td>Tajikistan</td>
<td>Zimbabwe</td>
</tr>
<tr>
<td>Rwanda</td>
<td>Thailand</td>
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<tr>
<td>Sao Tome and Principe</td>
<td>Timor-Leste</td>
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<td>Togo</td>
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</tbody>
</table>

### References

ANNEX 2

Key for epidemiological classification of cases

1. How was the case contracted?
   • By blood  Induced case
   • By mosquito  Go to 2

2. Where was the case contracted?
   • Outside this place  Imported case
   • In this place  Go to 3

3. Which parasite causes the case?
   • P. vivax or P. ovale  Go to 4
   • P. falciparum or P. malariae  Go to 5

4. When was the case contracted?
   • Long ago (e.g. from 6 months to 3 years ago) Relapsing case
   • Recently (e.g. up to 6 months ago)  Go to 5

5. From whom was the case contracted?
   • From an imported case  Introduced case
   • From any other case  Indigenous case

References


1 Adapted from Guidelines on the elimination of residual foci of malaria transmission (1).
2 The exact duration of the period should be decided by the programme.
3 Relapsing cases cannot be distinguished from indigenous cases in areas with continuing local transmission and epidemiologically linked cases in the vicinity: recent infection or reinfection has to be assumed.
ANNEX 3

Key for operational classification of malaria foci

1. Are the conditions suitable for the transmission of malaria?
   • No, none throughout the year  Pseudo-focus
   • Yes, for a period that is sufficient for the maturation of sporozoites  Go to 2

2. Is there a history of recent transmission (e.g. during the past two years)? 1
   • No  Go to 3
   • Yes (presence of introduced and/or indigenous cases)  Go to 7

3. Are cases present?
   • Yes  Go to 4
   • No  Cleared-up focus

4. Is effective infection of mosquitoes possible?
   • Yes  Go to 5
   • No (e.g. an imported case arrived during a seasonal break of transmission and received an antigametocyte treatment before the onset of effective infectivity)  Cleared-up focus

5. Which categories of cases are present?
   • Only induced or imported or relapsing cases  New potential focus
   • Other categories also present  Go to 6

Continued on page 60

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1 Adapted from Guidelines on the elimination of residual foci of malaria transmission (I).
2 The exact duration of the period should be decided by the programme.
### MALARIA ELIMINATION: A FIELD MANUAL FOR LOW AND MODERATE ENDEMIC COUNTRIES

6. Are indigenous cases present?
   - No
     - New active focus
       - only introduced cases present
   - Yes
     - New active focus
       - indigenous cases present

7. Are indigenous cases present?
   - No
     - Residual non-active focus
   - Yes
     - Go to 8

8. How effectively is transmission controlled?\(^1\)
   - Transmission is effectively controlled
     - Residual active focus
   - No effective control
     - Endemic focus

### References


\(^1\) Criteria for the effectiveness of control should be specified by the programme.
ANNEX 4

Laboratory techniques for parasite strain identification

Advanced molecular biology leading to fingerprinting of malaria parasites can help elimination programmes towards more precise classification of malaria cases based on geographical origin. Ideally, in a context of absence of local transmission, the programme should be in a position to check any suspected new indigenous cases against preserved, pedigree isolates of previous indigenous infections. This would allow a judgment to be made on whether the origin of any new infection is local and thus whether there may be (previously undetected) continuing local transmission.

There are several direct and indirect approaches or methods to determine genotype differences in malaria parasites. Parasitic genotype characteristics are expressed or revealed through specific phenotypes, for example, in protein composition, drug susceptibility pattern and isozymes. The parasitic genotype can also be directly investigated thanks to specific genetic markers linked to parasite clones. Several molecular biology tools have been developed for and might contribute to this purpose, including the analysis of simple sequence repeats, microsatellites, amplified fragment length polymorphisms and single nucleotide polymorphisms.

The malaria parasite is a fast-evolving organism due to the sexual reproduction stage in the mosquito. Two or more molecular techniques may be needed either in parallel or in sequence to cope with its highly polymorphic population structure.

At present, the preferred methodology or agreed-upon combination of techniques for identifying the geographical origin of malaria parasites has not been established. Also, before selecting laboratory methods to be used systematically across countries for phenotypic or genotypic characterization, there are several factors to be taken into account. These include the complexity and number of steps of laboratory procedures, cost per analysed sample, informativeness, sensitivity, reproducibility, complexity of equipment, and time needed. Moreover, in the near future, some of the existing molecular techniques could be further developed into more efficient automated silicon-based chips.
The following actions relating to the molecular characterization of parasite strains in the context of malaria elimination are recommended.

• National malaria programmes should start to develop a parasite strain bank at the planning stage of elimination, as a future reference point on the characteristics of local parasite strains. The parasite samples in such a strain bank can be cryopreserved or preserved on filter paper (properly dried and stored with desiccants) or electronically stored as fully sequenced genomes.

• National and regional laboratories need to collaborate on establishing and maintaining common databases to store, manage and analyse isolate banks, and allow standardized comparison over time and by geographical area.

• WHO should stimulate the development of a global collaborative network of laboratory networks for molecular subtyping of malaria parasites. This would:
  – provide a framework for real-time sharing of molecular epidemiological information;
  – enhance the capacity of countries to detect, respond to and prevent outbreaks of malaria in areas where the disease has been eliminated.
A5.1 Mass drug administration

During mass drug administration (MDA), every individual in a given population or geographical area was treated with antimalarial medicines regardless of whether they had a current or recent malaria infection or not. MDA can be direct, giving antimalarial tablets to every individual. MDA can also be indirect through medicated salt programmes (“Pinotti’s method”) and similar schemes.

WHO does not recommend direct or indirect MDA because:

• previous experience does not point to a clear benefit. MDA may result in an important short-term reduction in the parasite reservoir but has little impact on transmission rates over time;

• primaquine, which was often employed in MDA, carries a risk of life-threatening haemolysis in people who have the genetic trait of glucose-6-phosphate dehydrogenase deficiency, which is particularly prevalent in malaria-endemic regions;

• the indiscriminate use of medicines in MDA increases the risk of the parasite developing drug resistance.

A5.2 Presumptive treatment

During presumptive treatment, the patient was given medicines in a subcurative dose, usually chloroquine in a single dose (as opposed to the full doses over three days), before the results of the blood examination were available. Its principle objectives were to relieve clinical symptoms and prevent transmission. The term was used in contrast to full treatment, which was given to patients with positive test results.

WHO does not recommend presumptive treatment with subcurative doses of antimalarial medicines, because of the risk of:

• inducing or enhancing drug resistance

• rapid progression of clinical symptoms.
If laboratory test results cannot be obtained in a timely manner (within three to six hours), suspected malaria patients should be treated with full curative doses of effective antimalarial medicines while the test is being processed. If the test is negative and another cause for the fever has been diagnosed, malaria treatment can be stopped.
Most countries keep partially overlapping registers of malaria cases, for example, at the ministry of health malaria programme and statistics office, the notification office, clinic/hospital registrations, laboratory records including those from the reference laboratory, research institutes and surveys.

A national malaria case register serves to centralize information about all malaria cases detected in the national territory, irrespective of their location or source of diagnosis and treatment. At the same time, it allows all investigation reports related to a single occurrence of malaria infection to be linked together (patient records, laboratory register entry, case investigation, foci investigation).

The national register allows detailed analysis and synthesis of epidemiological information and trends, to guide the malaria elimination programme. Completeness of the register can be periodically assessed with standard capture–recapture methods.

An example of the type of information that can be included in the register is shown on the next page.
**Sample of a national malaria case register**

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Date of first positive slide</th>
<th>Case category (indigenous, introduced, imported, etc.)</th>
<th>Plasmodium species</th>
<th>Age</th>
<th>Sex</th>
<th>Occupation or other aspects that may have influenced malaria risk</th>
<th>Malaria infection acquired at (include GPS coordinates if possible)</th>
<th>Treatment</th>
<th>Treatment outcome</th>
<th>Transmission control measures taken, if any</th>
<th>Follow-up measures taken, if any</th>
<th>Name (including rank/title) of responsible officer who investigated the case</th>
<th>Reference to physical location of detailed reports/information about the case and any follow-up</th>
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</table>

* Global positioning system.
ANNEX 7

Sample malaria case investigation record form

Case no.

Case history

Date history taken .......................................................... Location history taken ..........................................................

History provided by (name, relation to patient) ...........................................................................................................

Name of patient ...............................................................................................................................................................

Sex ........................................... Age ........................................... Current nationality ..........................................................

Full present home address (including global positioning system coordinates) ...........................................................

.......................................................................................................................................................................................

To answer the questions: WHERE, HOW and FROM WHOM did the infection possibly take place?

Length of residence at present home address ..............................................................................................................

If residence at present home is less than one year: previous home addresses within past year, including dates ......

.......................................................................................................................................................................................

Current occupation and place of work ..........................................................................................................................

Recent travel history to known endemic area (including residual active or new active foci) in the country, in as far as this included possible dusk–dawn exposure to mosquito bites ..............................................................................

.......................................................................................................................................................................................

Travel to foreign endemic country (provide details) ....................................................................................................

• within the past three years (for P. vivax infection) YES □ NO □
• within the past year (for P. falciparum infection) YES □ NO □

Type of preventive measures taken during above-mentioned travel to endemic areas/countries .................................

.......................................................................................................................................................................................

Blood transfusion within past three months YES □ NO □

Recent contact with known imported malaria cases (provide details) .................................................................

.......................................................................................................................................................................................

Preliminary conclusion: Malaria infection likely acquired at (specify locality and source) ...........................................

......................................................................................................................................................................................
To summarize the clinical and diagnostic history of this malaria episode and answer the question: **WHEN did the infection possibly take place?**

**Current clinical episode**

**Reason for diagnostic test**
- [ ] Passive case detection
- [ ] Active case detection
- [ ] Contact survey
- [ ] Population-based survey

**Symptoms** ....................................................................................................................................................................

**Date of onset of first symptoms of current clinical episode** ..........................................................................................

**Diagnosis**

**Method** ........................................................................................................................................................................

**Date** ...............................................................................................................................................................................

**Place** ..............................................................................................................................................................................

**Name of health facility and clinician (if applicable)** .....................................................................................................

**Slide taken by (name)** ....................................................................................................................................................

**Rapid diagnostic test**

**Performed by (name)** ....................................................................................................................................................

**Type of test** .......................................................................................................................................................................

**Batch no.** ........................................................................................................................................................................

**Result** ...............................................................................................................................................................................

**Laboratory examination of blood slide**

**Date** ...............................................................................................................................................................................

**Performed by (name)** ....................................................................................................................................................

**Staining method** ............................................................................................................................................................

**Plasmodium species** ........................................................................................................................................................

**Parasite density** ............................................................................................................................................................

**Gametocytes present** [ ] YES [ ] NO

**Polymerase chain reaction results**

**Geographical origin of infection** ....................................................................................................................................

**Link to previous attacks** ..................................................................................................................................................

**Antimalarial treatment provided**

**Type of medicine** ...........................................................................................................................................................

**Doses** ...............................................................................................................................................................................

**Dates** ...............................................................................................................................................................................

**Treatment outcome** ..........................................................................................................................................................
Previous clinical episodes

Date .................................................................  Locality .................................................................
Symptoms .................................................................................................................................
Laboratory test results ................................................................................................................

Antimalarial treatment
Type of medicine ........................................................................................................................
Doses ..............................................................................  Dates ..............................................................................
Outcomes ......................................................................................................................................

Possible onward transmission

Information for planning the management of possible onward spread of the current malaria infection
Did the patient travel overnight away from home since the onset of the current clinical episode and before completion of treatment?  YES ☐  NO ☐
(If yes, provide exact places visited, dates) .......................................................................................
..............................................................................................................................................................

House of patient (type of construction, indoor residual spraying) .......................................................
..............................................................................................................................................................

Entomological studies
Carried out  YES ☐  NO ☐
By (name) ...............................................................................................................................................

Remarks .............................................................................................................................................
..............................................................................................................................................................
..............................................................................................................................................................
..............................................................................................................................................................

History taken by (name, rank/title, signature)
..............................................................................................................................................................
..............................................................................................................................................................
### Classification of the case

**Date of onset of symptoms**

**Plasmodium species**

**Case category**

**Classified by (name, including rank/title)**

**Reviewed by (name, including rank/title)**

### Follow-up actions

**Actions taken**

**Date form completed**
## Sample laboratory register form

<table>
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<tr>
<th>Incoming sample</th>
<th>Test</th>
<th>Follow-up</th>
<th>QC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory serial no.</td>
<td>Patient ID</td>
<td>Date blood sample was taken</td>
<td>Health facility where blood sample was taken</td>
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</table>

ID: identification; QC: quality control; RDT: rapid diagnostic test.

* Unique personal number and/or full details.

* For polymerase chain analysis or isolate bank.

* This code should link this test to earlier and later malaria test results from the same patient.
The following information will be useful for the classification of malaria foci and for planning the interventions needed to interrupt transmission.

**Geographical location**

**Description of locality**
Type of environment in relation to possible receptivity (e.g. urban/rural, altitude, main geographical features) and vulnerability (e.g. in close proximity to endemic area across international border)...

Type of population in relation to possible vulnerability (e.g. migration patterns, presence of relatively large numbers of temporary workers, typical travel histories, etc.)...

**Map available**
Geographical map of focus and its limits...

Location of health facilities...

Vector species – possible breeding sites marked for presence/absence of vector larvae...

Location of households with malaria cases during past three years...
ANNEX 9. SAMPLE MALARIA FOCI INVESTIGATION RECORD FORM

Geographical reconnaissance information

Total no. of houses and their inhabitants ........................................................................................................................................................................................................

Map with houses, health units and other important structures as well as access routes .......................................................................................................................................................................................................................................................

Vector control interventions applied

Type of intervention ..................................................................................................................................................................................................................

Date carried out ..................................................................................................................................................................................................................

Results of surveys, including active case detection .......................................................................................................................................................................................................................................................

Number of reported malaria cases during past five years .......................................................................................................................................................................................................................................................

Relationship of locality to the malaria case that prompted focus investigation (in time, space and circumstances, e.g. the person's place of residence, work, etc.) .......................................................................................................................................................................................................................................................

Status of focus

Operational classification of focus using foci classification key .......................................................................................................................................................................................................................................................

Names (including rank/title) of responsible officers (vector control, epidemiology) .......................................................................................................................................................................................................................................................

Follow-up actions taken .......................................................................................................................................................................................................................................................

Date form completed .......................................................................................................................................................................................................................................................

Name (including rank/title) of principal investigator .......................................................................................................................................................................................................................................................

Signature of principal investigator .......................................................................................................................................................................................................................................................
ANNEX 10

Recommendations for the United Arab Emirates malaria programme, post-certification period

A10.1 Surveillance of malaria cases

Surveillance of malaria cases should be continued by including early detection of malaria cases, prompt treatment and case management.

Early detection of malaria cases

Early detection of malaria cases should be strengthened by the following.

Case notification

All cases of suspected malaria should continue to be mandatorily notified to the Central Malaria Control Department (CMD) from both the private and the government sectors. The notifications for suspected malaria cases should reach the CMD from the district preventive medicine departments, which in turn will be receiving notifications from the government and the private sector. These notifications can be done via fax/telephone or e-mail.

Toll-free helpline number and web site

It will be useful to establish a 24-hour, toll-free notification/helpline phone line at the CMD to provide counselling, guidance and referral to suspect cases of malaria and provide more information to the public regarding malaria case management.

The case notification form should also be hosted on the web site of the CMD so that the public and private health providers can obtain the form for notification to the CMD.

Private sector involvement

It is important to involve the private sector in notification, reporting and referral of all suspected malaria cases to the CMD for case management, which

1 Adapted, by permission of the publisher, from Recommendations for malaria program in United Arab Emirates (post malaria-free certification) (1).
includes confirmation of the diagnosis and receiving the proper treatment from the CMD.

**Selective screening of migrants**
Since malaria continues to be endemic in many parts of the world, travellers coming from endemic areas should be provided with health education materials at immigration desks in airports, seaports, etc., regarding symptoms of malaria and contact information of the CMD.

**Prompt treatment and case management**

**Free-of-charge (to the patient) case management**
The management of malaria should continue to be free of charge, which should include laboratory confirmation of diagnosis and treatment of cases.

**Free-of-charge chemoprophylaxis**
Chemoprophylaxis for the type of malaria, depending on the place of travel, should be provided free of charge at travellers’ clinics to people going to endemic areas.

**Antimalarial medicines available only at government health facilities**
To ensure that malaria treatment is completed and the surveillance system remains effective, antimalarial medicines should be available only in government facilities. Therefore, all cases of malaria should be treated in the government sector so that the diagnosis is confirmed in a timely manner to ensure that proper treatment is administered and that appropriate measures are initiated to prevent renewed continued transmission.

**National Malaria Register and Annual Reports**
All cases of malaria should be reported in the National Register and followed up until cure is ascertained. Each year, the CMD should continue to publish an annual report of all the activities conducted for maintaining the malaria-free status of the country.

**Laboratory support for correct diagnosis of cases**
Strengthening the diagnostic tools in all government health institutions – primary health centres, hospitals, etc. – is essential for correct diagnosis of cases.
Drug policy
The drug policy for antimalarial medicines should be revised every two years so that it remains updated with the epidemiology of the disease and as per global standards. Adequate stock of medicines for the treatment of malaria should be maintained, keeping in mind possible emergency situations.

Epidemiological investigation
After a case of malaria has been confirmed by blood smear and the history suggests no alternative explanation, full investigation of a locally acquired mosquito-transmitted case should be conducted. The investigation should include an epidemiological, environmental and laboratory component. This should be the responsibility of the CMD, Ministry of Health.

A10.2 Surveillance of vector
To maintain the malaria-free status, the vector surveillance activities should continue. These should include monitoring of breeding sites for larvae, surveying the presence of adult mosquitoes (both indoors and outdoors), regular performance of insecticide susceptibility tests and recording of any major changes in environmental parameters, especially meteorological features that may favour malaria transmission, such as rainfall and temperature.

A10.3 Vector control
Chemical and biological control with other sectors
Vector control activities as per the National Malaria Plan should be continued in the form of chemical and biological larval control in coordination with other sectors, such as municipalities.

Mobile survey teams
Entomological mobile teams should continue monitoring the breeding sites and inform the relevant department of the results regularly.

International Health Regulations guidelines for fumigation of aircraft and ships to prevent port malaria
A remote possibility of a source of malaria is an infective mosquito transported on an aircraft, ship or in baggage that arrived from an area where malaria is endemic. Thus, for this, fumigation of aircraft and ships should be done as per the International Health Regulations issued by WHO to prevent transmission of malaria and other mosquito-borne diseases.
A10.4 Health education

The role of health education should be enhanced after the malaria-free certification of the country. Leaflets/brochures regarding signs and symptoms of malaria, availability of treatment and chemoprophylaxis free of charge to the patients/travellers, publicity of toll-free helpline numbers and web site, etc. should be available for distribution in travellers’ clinics at government health facilities and immigration desks of airports, seaports, etc.

A10.5 Expanding the Malaria Control Department to become a vector-borne disease control department

After the successful achievement of malaria-free status for the country, the Ministry of Health of the United Arab Emirates should consider the expansion of the responsibilities of the CMD to cover the control of vector-borne diseases in general (and particularly in view of the recent westward movement of dengue and Japanese B encephalitis from affected areas in Southern Asia) as a logical consequence.

A10.6 Regional training and demonstration centre for malaria

Considering the achievement of the country and the steps taken to maintain the status, it shall be useful to demonstrate the process of obtaining malaria-free status by establishing regular training programmes for the WHO Eastern Mediterranean Region. An annual training calendar can be prepared by the CMD in consultation with the WHO Malaria department to showcase the United Arab Emirates’ systems and establish the regional training hub for malaria control activities.

References

ANNEX 11

Key documents to be prepared by the national government for the certification evaluation team

1. Plan of action for the prevention of reintroduction of malaria.
2. Organizational structure of the malaria department/malaria activities in general health services, with detailed budget and staff information.
3. Annual malaria surveillance reports over the past 10 years.
4. Full information about active malaria foci in the five years before the last indigenous case, with supporting maps.
5. National malaria case register with case investigation forms for the past three years.
6. Reports of quality-assurance activities for diagnosis.
7. Recent antimalarial drug policy.
8. Detailed entomological and vector control activities.
9. Reports of independent committees on malaria, surveillance system, entomological and vector control activities.
10. Recent published/unpublished research reports on malaria epidemiology and malaria vectors.
11. Legislation/regulations related to malaria and vector control.
12. Reports of intersectoral collaboration.
13. Reports of border coordination activities, if relevant.
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ANNEX 13

Information to be included in annual report for follow-up of WHO certification

1. Confirmed malaria cases discovered during the reporting period
   • by species and case classification
   • imported cases by species and country of origin.

2. Brief histories on all reported malaria deaths and other unusual events
   (congenital malaria, transfusion malaria, etc.)

3. Brief report on preventive measures carried out
   • to reduce importation of parasites
   • to reduce receptivity in recent transmission foci.
Active case detection: operation carried out by surveillance agents who visit every locality in a defined area at regular intervals (usually monthly during the transmission season), in order to enquire for fever cases through individual house visits, and to test for malaria (and treat if positive) each suspected person so discovered.

Case, imported: a case, the origin of which can be traced to a known malarious area outside the country in which the case was diagnosed.

Case, indigenous: a case, the origin of which from local transmission cannot be disproved. It includes delayed first attacks of *P. vivax* due to locally acquired parasites with a long incubation period.

Case, induced: a case, the origin of which can be traced to a blood transfusion or other form of parenteral inoculation, but not to normal transmission by a mosquito.

Case, introduced: a case in which it can be proved that the infection is a first step (first generation) of local transmission subsequent to a proved imported case, i.e. in which the mosquito was infected from an imported case.

Case investigation: gathering enough information to allow classification of a malaria case by origin of infection. It includes, but is not limited to, administration of a standardized questionnaire to a person diagnosed with a malaria infection.

Case, malaria (as defined in elimination programmes): a person in whom, regardless of the presence or absence of clinical symptoms, malaria parasites have been confirmed by quality-controlled laboratory diagnosis.

Case management: diagnosis, treatment, clinical care and follow-up of malaria cases.

Case notification (compulsory): reporting of detected cases of malaria by all medical units and medical practitioners, to either the health department or the malaria elimination service (as laid down by law or regulation).
Case, relapsing: case shown by the history of the patient to be a probable relapse if careful epidemiological investigation shows that the infection was contracted before interruption of transmission was claimed in the locality and if there are no epidemiologically related malaria cases in the neighbourhood.

Certification of malaria elimination: granted by WHO after proving beyond reasonable doubt that the chain of local human malaria transmission by *Anopheles* mosquitoes has been fully interrupted in an entire country for at least three consecutive years.

Elimination: reduction to zero of the incidence of infection caused by a specified agent in a defined geographical area as a result of deliberate efforts. Continued measures to prevent re-establishment of transmission are required.

Endemic: applied to malaria when there is a constant measurable incidence of cases and mosquito-borne transmission in an area over a succession of years.

Epidemic: occurrence of cases in excess of the number expected in a given place and time period.

Eradication: permanent reduction to zero of the worldwide incidence of infection caused by a specific agent as a result of deliberate efforts. Intervention measures are no longer needed once eradication has been achieved.

Evaluation: a process that attempts to determine as systematically and objectively as possible the relevance, effectiveness and impact of activities in relation to their objectives.

False negative (or false positive): when a test shows a negative (or positive) result, despite the opposite being true.

Focus: a defined and circumscribed locality situated in a currently or former malarious area and containing the continuous or intermittent epidemiological factors necessary for malaria transmission. Foci can be classified as residual active, residual non-active, cleared up, new potential, new active, endemic or pseudo-foci.

Gametocytes, person carrying: person who has malaria gametocytes in the peripheral blood, making him or her a potential source of infection.

Geographical reconnaissance: the operation that provides the basis for the choice of field centres and depots, for detailed schedules and itineraries of spraying and surveillance personnel, for the final deployment of transport, and for the numerical control of the completeness of the work accomplished or reported. It includes collection of information on the number, type, location and means of access to all houses and field shelters, as well as on communications, health units, vehicle repair facilities, population movements and other relevant factors.
**Health services coverage:** use of the health services by those who need it.

**Incubation interval:** the period between the occurrence of infective gametocytes in the primary case and their reappearance in a secondary case.

**Incubation period:** the time between infection (by inoculation or otherwise) and the first appearance of clinical signs, of which fever is the most common.

**Intensity of transmission:** rate at which people in a given area are inoculated with malaria parasites by mosquitoes (usually expressed by the annual entomological inoculation rate).

**Local mosquito-borne malaria transmission:** occurrence of human malaria cases that are acquired in a given area through the bite of infected *Anopheles* mosquitoes.

**Malaria elimination:** a reduction to zero of the incidence of infection caused by human malaria parasites in a defined geographical area as a result of deliberate efforts. Continued measures to prevent re-establishment of transmission are required.

**Malaria-free:** an area where there is no continuing local mosquito-borne malaria transmission, and the risk of acquiring malaria is limited to introduced cases only.

**Malaria incidence:** the number of newly diagnosed malaria cases during a specified time period in a specified population.

**Malaria prevalence:** the number of malaria cases existing at any given time in a specified population, measured by positive laboratory test results.

**Monitoring (of programmes):**

- episodic measurement of the effect of an intervention on the health status of a population or the environment; not to be confused with surveillance, although surveillance techniques may be used in monitoring;
- the process of collecting and analysing information about the implementation of a programme for the purpose of identifying problems, such as non-compliance, and taking corrective action;
- in management, this refers to the episodic review of the implementation of an activity, seeking to ensure that inputs, deliveries, work schedules, targeted outputs and other required actions are proceeding according to plan.

**National foci register:** centralized computerized database of all malaria foci in a country.

**National malaria case register:** centralized computerized database of all malaria cases registered in a country, irrespective of where and how they were
diagnosed and treated. It allows detailed analysis and synthesis of epidemiological information and trends, to guide the malaria elimination programme.

**Parasite strain:** subtype of parasites with similar properties. Properties that are strain-specific include immune response in the human host, infectiousness for a given species of vectors and antimalarial drug resistance.

**Passive case detection:** detection of malaria cases among patients who on their own initiative went to a health post to get treatment, usually for a febrile disease.

**Population at risk:** population living in a geographical area where locally acquired malaria cases occurred in the current and/or previous year. The measurement unit for elimination milestones among populations at risk is a political unit corresponding to approximately 75 000–150 000 people (e.g. a district).

**Population-based blood survey:** survey in which a blood slide is prepared for every individual in a given population (i.e. irrespective of history of fever) once or more, for the thorough assessment of the prevailing conditions in the area, to provide additional proof of the interruption of transmission. The goal is to detect asymptomatic infections usually associated with low parasite densities.

**Rapid diagnostic test (RDT) positivity rate:** the proportion of RDTs found positive among RDTs performed.

**Receptivity:** the abundant presence of anopheline vectors and the existence of other ecological and climatic factors favouring malaria transmission.

**Re-establishment of transmission:** renewed presence of a constant measurable incidence of cases and mosquito-borne transmission in an area over a succession of years. An indication of the possible re-establishment of transmission would be the occurrence of three or more introduced and/or indigenous malaria infections in the same geographical focus, for two consecutive years for *P. falciparum* and for three consecutive years for *P. vivax*.

**Relapse:** renewed manifestation (of clinical symptoms and/or parasitaemia) of malaria infection separated from previous manifestations of the same infection by an interval greater than that related to the normal periodicity of the paroxysms. The term is used mainly for renewed manifestation due to the survival of hypnozoites (exo-erythrocytic forms) of *P. vivax* or *P. ovale*.

**Sensitivity (of a test):** the proportion of true positives among all the positives it detects.

**Slide positivity rate:** the proportion of slides found positive among the slides examined.
Specificity (of a test): the proportion of true negatives among all the negatives it detects.

Surveillance: that part of the programme aimed at the discovery, investigation and elimination of continuing transmission, the prevention and cure of infections, and the final substantiation of claimed elimination.

Transmission season: period of the year during which mosquito-borne transmission of malaria infection can normally take place.

Vector control: measures of any kind directed against a vector of disease and intended to limit its ability to transmit the disease.

Vector efficiency: ability of a mosquito species, in comparison with another species in a similar climatic environment, to transmit malaria in nature.

Vectorial capacity: number of new infections the population of a given vector would distribute per case per day at a given place and time, assuming conditions of non-immunity. Factors affecting vectorial capacity include: (i) the density of female anophelines relative to humans; (ii) their longevity, frequency of feeding and propensity to bite humans; and (iii) the length of the extrinsic cycle of the parasite.

Vigilance: a function of the public health service during the programme for prevention of re-introduction of transmission, consisting of watchfulness for any occurrence of malaria in an area in which it had not existed or from which it had been eliminated, and the application of necessary measures against it.

Vulnerability: either proximity to malarious areas or resulting from the frequent influx of infected individuals or groups and/or infective anophelines.