Prevention of re-establishment of malaria transmission

Global guidance

World Health Organization

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Abbreviations

CHW	community health worker
EPHF	essential public health function
G6PD	glucose-6-phosphate dehydrogenase
IRS	indoor residual spraying
ITN	insecticide-treated net
pfhrp2/3	*Plasmodium falciparum* histidine-rich protein 2/3
PHC	primary health care
RDT	rapid diagnostic test
WHO	World Health Organization

Glossary

basic reproduction number	The number of secondary cases that a single infection (index case) would generate in a completely susceptible population (referred to as R_0) *Note: The "adjusted reproduction number", R_c, is the reproduction number in the presence of a range of interventions, e.g. insecticide-treated nets, indoor residual spraying and access to treatment.*
case, imported	Malaria case or infection in which the infection was acquired outside the area in which it is diagnosed
case, index	A case of which the epidemiological characteristics trigger additional active case or infection detection The term "index case" is also used to designate the case identified as the origin of infection of one or a number of introduced cases.
case, indigenous	A case contracted locally with no evidence of importation and no direct link to transmission from an imported case
case, induced	A case the origin of which can be traced to a blood transfusion or other form of parenteral inoculation of the parasite but not to transmission by a natural mosquito-borne inoculation *Note: In controlled human malaria infections in malaria research, the parasite infection (challenge) may originate from inoculated sporozoites, blood or infected mosquitoes.*
case, introduced	A case contracted locally, with strong epidemiological evidence linking it directly to a known imported case (first-generation local transmission)
focus, malaria	A defined circumscribed area situated in a currently or formerly malarious area that contains the epidemiological and ecological factors necessary for malaria transmission *Note: Foci can be classified as active, residual non-active or cleared.*
importation rate	Rate of influx of parasites via infected individuals or infected *Anopheles* spp. mosquitoes *Note: "Infected individuals" includes residents infected while visiting endemic areas as well as infected immigrants.*
importation risk	Probability of influx of infected individuals and/or infective *Anopheles* mosquitoes

infectivity	Ability of sporozoites of a specific strain of *Plasmodium* to be injected by *Anopheles* mosquitoes into susceptible humans and develop through the liver stage to infect red blood cells ("infectivity to humans") and the ability of competent *Anopheles* mosquitoes to ingest human *Plasmodium* gametocytes, which undergo development until the mosquito has infective sporozoites in its salivary glands ("infectivity to mosquitoes")
malaria elimination	Interruption of local transmission (reduction to zero incidence of indigenous cases) of a specified malaria parasite in a defined geographical area as a result of deliberate activities Continued measures to prevent re-establishment of transmission are required. *Note: The certification of malaria elimination in a country will require that local transmission is interrupted for all human malaria parasites.*
malaria eradication	Permanent reduction to zero of the worldwide incidence of infection caused by human malaria parasites as a result of deliberate activities Interventions are no longer required once eradication has been achieved.
malaria receptivity	Degree to which an ecosystem in a given area at a given time allows for the transmission of *Plasmodium* spp. from a human through a vector mosquito to another human
malaria reintroduction	The occurrence of introduced cases (cases of first-generation local transmission that are epidemiologically linked to a confirmed imported case) in a country or area where the disease had previously been eliminated *Note: Malaria reintroduction is different from re-establishment of malaria transmission.*
malaria risk stratification	Classification of geographical areas or localities according to factors that determine malaria receptivity and risk of importation
malaria stratification	Classification of geographical areas or localities according to epidemiological, ecological, social and economic determinants for the purpose of guiding malaria interventions
malariogenic potential	Potential level of transmission in a given area arising from the combination of malaria receptivity and importation risk of malaria parasites *Note: The concept of malariogenic potential is most relevant for elimination and prevention of re-establishment when indigenous transmission is mostly or entirely eliminated.*

primary health care
: A whole-of-society approach to health that aims to maximize the level and distribution of health and well-being through three components: (a) primary care and essential public health functions as the core of integrated health services; (b) multisectoral policy and action; and (c) empowered people and communities

public health
: All organized efforts (whether public or private) to prevent disease, promote health and prolong life among the population as a whole

Public health focuses on the entire spectrum of health and well-being from health promotion and prevention of disease, to early identification and management, to rehabilitation and end-of-life care.

re-establishment of malaria transmission
: The occurrence of indigenous malaria cases (cases of second-generation local transmission) in a country or area where the disease had previously been eliminated.

WHO's operational definition of re-establishment of malaria transmission is the occurrence of at least three indigenous cases of the same species in the same focus for three consecutive years.

vectorial capacity
: Average number of new infections in humans that the population of a given vector would induce from one index case per day at a given place and time, assuming that the human population is fully susceptible to malaria

Executive summary

Malaria is a significant public health problem globally, with an estimated 263 million cases and 597 000 deaths in 2023. However, many countries have achieved malaria elimination over the past decades, with over 40 countries certified as malaria-free. After malaria elimination, the continuous importation of malaria cases into malaria-free countries or areas poses a risk of local transmission resuming. Prevention of re-establishment focuses on preventing introduced cases (first-generation local transmission) and indigenous cases (second-generation local transmission) to ensure that malaria-free status is maintained. In addition, malaria-free countries must have systems in place for reducing malaria importation and for ensuring early detection and prompt treatment of all malaria cases. All countries should continue to prevent re-establishment until global malaria eradication – the complete interruption of transmission of all forms of human malaria worldwide – is achieved.

The guiding principles for the prevention of re-establishment include the following:

- Early detection, notification and a rapid response to every malaria case are the cornerstone activities of preventing re-establishment. Malaria-free countries and regions must maintain fully functional surveillance and response systems across all territories.
- Effective prevention of re-establishment requires proper management of the risk, which is a combination of receptivity (the ecosystem's ability to support malaria transmission) and importation risk (the likelihood of parasite importation). The levels and dynamics of the risk determine the response and guide planning and management.
- An effective system for early detection, epidemiological investigation and rapid response to malaria outbreaks must be established and functional, which could be integrated with broader emergency response mechanisms.
- Early detection and response to the risk of re-establishment requires a competent and collaborative health workforce, supported by multisectoral collaboration, community

engagement and strong public health leadership. Maintaining expertise in malaria diagnosis, treatment, entomology and epidemiology is critical.

- Planning and management should ensure the delivery of essential functions and services for prevention of re-establishment, balancing short-term gains with long-term impact and sustainability. Monitoring and evaluation activities are essential to ensure the quality of implementation.
- Research and operational studies are important to generate evidence and knowledge to guide responses to the risk of malaria re-establishment.
- Governments at all levels bear the responsibility for maintaining malaria-free status. Sustained political commitment must translate into adequate human and financial resources to prevent re-establishment of malaria transmission.

1 Introduction

Malaria is a parasitic disease caused by protozoan parasites of the genus *Plasmodium* and transmitted by female *Anopheles* mosquitoes. It remains a significant global public health problem, affecting 83 countries and territories, with an estimated 263 million cases and 597 000 deaths in 2023 *(1)*. Over the past few decades, many countries have achieved malaria elimination, with over 40 countries certified as malaria-free by the World Health Organization (WHO) and entered into the Official *Register of areas where malaria elimination has been achieved*. The register was established by WHO during the Global Malaria Eradication Programme (1955–1969), following a request from its Member States through a World Health Assembly resolution (WHA 13.55) *(2)*. It provides information on places where there is no danger of acquiring and exporting malaria parasites in order to guide individual travellers and support the prevention of re-establishment efforts by malaria-free countries and regions. Only countries that have eliminated malaria through specific measures and completed a certification process can be entered into the Official Register. Countries where malaria disappeared without implementation of specific measures and those that have not completed a certification process are entered into the supplementary list. In these countries, malaria is considered eliminated and they are also not regarded as posing any risk of acquiring or exporting malaria parasites to other countries *(3)*.

Most malaria-free countries have been able to sustain malaria elimination. Many of these countries, situated in mild and temperate climatic zones, achieved elimination during the Global Malaria Eradication Programme led by WHO. In recent years, more countries in tropical and subtropical regions have made significant strides towards eliminating malaria, with some successfully achieving this goal. In many of these countries, malaria transmission is perennial. With this new trend and a more connected world characterized by increasing travel and migration, the challenges to sustaining malaria elimination are likely to be greater than in the past. Furthermore, countries are facing increasingly complex public health challenges. The coronavirus disease (COVID-19) pandemic tested the capacity of health systems globally. Regardless of the sociopolitical and economic context, every country was challenged to respond to emergent pandemic requirements while maintaining essential health services, against a background of persistent underinvestment in public health capacity and a shortfall in global health workforce. These new experiences have led to a renewed commitment to, interest in and focus on the primary health care (PHC) approach since the Declaration of Alma-Ata in 1978 *(4)*. The renewed focus on PHC and the integration of essential public health functions (EPHFs) into PHC provide opportunities to sustain malaria elimination *(5)*.

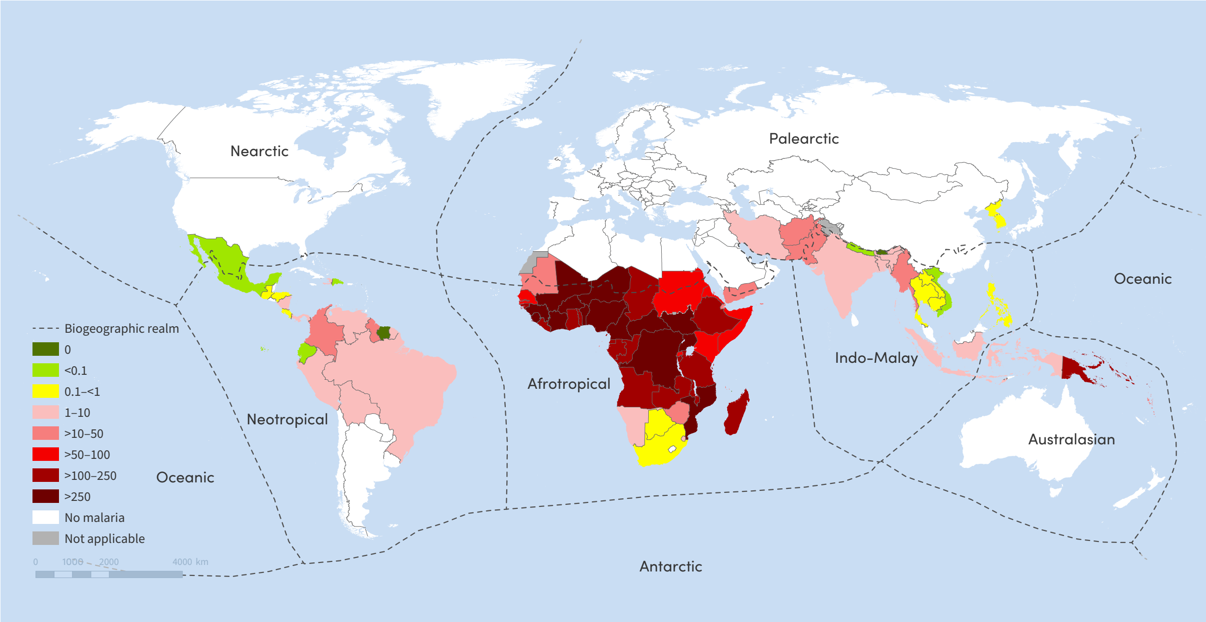
The *Global technical strategy for malaria 2016–2030 (6)*, endorsed by the World Health Assembly in 2015 and updated in 2021, reaffirms the vision of a world free of malaria. For the first time, the prevention of re-establishment in all malaria-free countries has been defined as a global malaria goal. This document was developed to support countries and areas that have eliminated malaria or are nearing elimination in planning and implementing programmes to prevent re-establishment. It illustrates the key concepts and principles of prevention of re-establishment and their application, provides guidance on interventions and strategies, and offers planning and management advice. Country examples are incorporated to highlight good practices and illustrate specific points. The target audience of this document includes programme managers and coordinators, public health policy-makers, and public health staff working at national and subnational levels. It is targeted to all malaria free countries but primarily to those situated in tropical and subtropical climatic zones where malaria elimination has been (or has almost been) achieved nationwide or in subnational areas. The process followed to develop this document, and the evidence reviewed are summarized in Annex 1.

2 Biological and epidemiological basis

Globally, malaria is transmitted in 83 countries and territories (including the territory of French Guiana, France) (Fig. 1). At least 26 known *Plasmodium* species are transmitted among non-human primates *(7),* and four parasite species – *Plasmodium falciparum, P. vivax, P. malariae and P. ovale* – are transmitted nearly exclusively among humans. These four species are often referred to as human malaria parasites. The relative importance of these species varies by biogeographic realm, region and subregion. *P. falciparum* is responsible for over 90% of malaria cases and malaria-related deaths globally, with sub-Saharan Africa bearing the greatest burden of disease *(1, 8).* Outside of sub-Saharan Africa, *P. vivax* malaria accounts for about half of all malaria cases and is predominant in countries approaching malaria elimination *(9). P. malariae* is found worldwide but has become relatively rare in recent years *(10). P. ovale* is present in most of Africa and occasionally in Asia and in non-human primates, but not in the Americas *(11).* Recently, a notable rise in human infections due to *P. knowlesi has* been reported in South-East Asia, particularly in Malaysia *(12).* In nature, most *P. knowlesi* infections in humans are likely transmitted from macaques to humans. Human-to-human transmission of *P. knowlesi has* been demonstrated under laboratory conditions and is likely to occur in nature, though probably uncommon.

Malaria parasites are transmitted by female mosquitoes belonging to the genus *Anopheles*. The genus is divided into several subgenera, including *Anopheles*, *Cellia* and *Nyssorhynchus*, and comprises around 500 species. Only 30–40 species are considered important human malaria vectors. Each species has colonized certain types of ecological niches. The distribution of malaria vectors is characterized by the biogeographic realm, region or subregion. For example, *Anopheles quadrimaculatus* and *An. freeborni* are typically found in the Nearctic realm, whereas *An. atroparvus* and *An. labranchiae* are common vectors in the Palearctic realm. In the Neotropical realm, *An. darlingi* and *An. albimanus* are important vectors (Fig. 1). *An. gambiae*, *An. arabiensis* and *An. funestus* are the dominant species in the Afrotropical realm. These species are highly efficient malaria vectors that are responsible for transmission in the sub-Saharan region, which shoulders 90% of the malaria burden globally.

Fig. 1. **Biogeographic realms and malaria transmission in 2023**



The map displays the biogeographic realms and malaria status of countries and territories in 2023. Countries in white are malaria-free or reported zero indigenous cases for at least three years, while those in dark green reported zero cases for fewer than three years. Other colors indicate countries with varying annual parasite incidences *(1)*.

For further details on the biology of malaria, both the parasitological and entomological aspects, reference is made to the WHO publication *A framework for malaria elimination (13)*.

2.1 The concept of prevention of re-establishment

Malaria elimination is defined as the interruption of local transmission (reduction to zero incidence of indigenous cases) of a specified malaria parasite in a defined geographical area as a result of deliberate activities. A country's malaria-free status is officially recognized through the process of WHO certification of malaria elimination. Certification is only granted once interruption of transmission of all human malaria parasites in a country has been achieved and sustained for at least three consecutive years and the country demonstrates capacity to prevent re-establishment. At the subnational level, governmental authorities can verify malaria elimination in an area through subnational verification *(14)*.

Travellers from endemic countries or areas can import parasites into malaria-free countries/areas. When the malaria infection is acquired outside the area where it is diagnosed, it is defined as an **imported case**. Because malaria elimination normally does not imply the elimination of vectors, imported *Plasmodium* parasites can infect local *Anopheles* vectors, which can then go on to infect a human residing in the area; this is referred to as an introduced case (also called a first-generation case), as illustrated in Fig. 2. If **introduced cases** are not detected in a timely manner, or if the response is inadequate, subsequent transmission can lead to **indigenous cases**. The occurrence of indigenous malaria cases following malaria elimination is called **re-establishment**. WHO's operational definition of re-establishment of malaria transmission is three indigenous cases of the same species detected in the same focus (e.g. one village) for three consecutive years after transmission was fully interrupted (Fig. 2). Re-establishment is different from reintroduction, which is the occurrence of introduced cases in a country or area where the disease has been eliminated.

Fig. 2. Imported, introduced and indigenous cases

2.2 Receptivity, risk of importation and malariogenic potential

Preventing re-establishment requires understanding and proper management of the risk of re-establishment. The risk of renewed transmission after elimination, or the potential for transmission, is termed the **malariogenic potential,** which is the product of two concepts: **receptivity** and **importation risk.**

Receptivity refers to the degree to which an ecosystem supports the transmission of *Plasmodium* species in a given area at a given time. The bionomics of *Anopheles* vectors present are critical components in determining receptivity. In areas where *Anopheles* vectors are absent or development of the malaria parasite in the mosquito (sporogony) cannot be completed, receptivity is effectively zero. In other settings, receptivity is determined by vectorial capacity (the number of new infections induced per case per day by an insect vector, see Glossary). However, estimating vectorial capacity is challenging, costly and fraught with uncertainty, as several parameters of its formula cannot be numerically estimated. The first step in defining receptivity is to evaluate factors such as altitude, temperature and landscape, as has historically been done to exclude areas unsuitable for malaria transmission. Historical malaria maps from periods when transmission occurred can provide valuable insights into the natural extent of malaria transmission and help to differentiate receptivity levels across regions, although ecological changes should be considered. Developing and maintaining up-to-date, spatially defined inventories of vector presence and composition is beneficial for assessing receptivity and should be an essential component of vector surveillance. The various types of data that can be used to estimate receptivity are summarized in Table 1.

Table 1. Information that may be used to assess and monitor receptivity and risk of importation

Receptivity	Importation risk
• Presence of malaria vectors, species composition, adult density, behaviour • Presence of actual or potential larval habitats of competent malaria vectors • Historical epidemiological data (prevalence, incidence, mortality) • Stability of transmission and length of transmission seasons in the past • Number and distribution of local cases (indigenous and introduced cases) before interruption of transmission and comparison of numbers of imported and local cases within defined areas • Topography • Climatic conditions including trends and extreme weather events • Environmental changes including development projects, changes in land use, irrigation, deforestation, reforestation, etc. • Housing types, urbanization	• Imported malaria cases • Influx of potentially infected individuals from endemic countries (migrants, labourers, refugees, displaced persons, camps, etc.) • Travellers returning from endemic countries • Communities or localities where residents have relatives in endemic countries or members working in endemic countries • Importation of infective vectors
The performance of a health system (or programmatic factors) can directly or indirectly influence receptivity and risk of importation. For example, the withdrawal or degradation of vector control measures increase receptivity while declining vigilance on malaria increases the risk of re-establishment.	

Infectivity, also referred to as susceptibility or compatibility, is an important component of receptivity. Infectivity describes the ability of a given vector species or strain to support the development of a given *Plasmodium* species (or strain or population). It reflects the coadaptation between the malaria parasites and *Anopheles* mosquitoes through the evolution process. Many Palearctic *Anopheles* species (those found in Europe, northern Africa and temperate parts of Asia, ↗ Fig. 1) do not appear able to transmit Afrotropical *P. falciparum*. In central China, *An. sinensis* was the main vector of *P. vivax*, but it was never incriminated as a vector of *P. falciparum* in any region *(15)*. More generally, mosquito vectors from different continents, such as *An. gambiae* from Africa, *An. dirus* from Asia and *An. albimanus* from the Americas, are highly compatible with *P. falciparum* isolates from their respective regions but show limited competence to transmit *P. falciparum* isolates from other continents *(16)*. Fig. 3 illustrates the differences in infectivity of *P. falciparum* of different origins to malaria vectors, as reported in the literature.[1] Laboratory research has identified some molecule targets that appear to be critical in determining the infectivity of *P. falciparum* to different *Anopheles* vectors *(17)*. Such geographical differences are also seen with *P. vivax*, but they generally appear to be less significant.

Importation risk (also called vulnerability) refers to the actual and potential importation of malaria parasites into a country or area. Surveillance, including epidemiological investigation of cases, is important for gathering information with which to estimate the risk of importation. As noted above, importation risk is one of the two factors determining malariogenic potential. Countries are advised to monitor the importation risk, rather than just the number of imported cases, and prepare to mount a response if necessary. The movements of populations that are at risk for malaria may be clandestine, making it challenging to obtain the relevant information. Information from sectors such as migration, travel and labour, and those related to conflict, military activities, rapid urbanization and economic opportunities may be helpful, along with intelligence from communities (Table 1). Malaria may also be imported by mosquitoes that carry parasites. This can occur either through vectors flying across land borders or through passive transportation, typically via aircraft or ships.

In addition, the performance of the health system (or programmatic factors) can influence receptivity and importation risk directly or indirectly. For example, shortages in the supply of commodities, the loss of clinical vigilance towards malaria, lack of training on malaria among health professionals, inadequate programme monitoring and supervision, poor programme management, lack of financing, absence of public health leadership, ineffective coordination, deteriorated quality of intervention implementation, and withdrawal of interventions such as vector control can increase the risk. Identifying programmatic factors that contribute to a low-performing health system is crucial to mitigate the risk.

Receptivity and risk of importation are usually poorly correlated, if at all. Areas where the two factors overlap have a risk of re-establishment of transmission. If the value of one factor is and remains zero, the possibility of malaria re-establishment is null, even when the value of the other is high.

[1] Cohuet A, Morlais I, White G, A review of literature on the susceptibility/refractoriness of the main malaria vectors to local or potentially imported *Plasmodium* parasites. In preparation, 2025.

Fig. 3. Differences in infectivity in pairs of *P. falciparum* and *Anopheles* vectors

Celia sub genus	*local P. falciparum*	*non-local P. falciparum*
An. gambiae	Consistent infectivity	Consistent infectivity
An. coluzzi	Consistent infectivity	Consistent infectivity
An. arabiensis	Consistent infectivity	Consistent infectivity
An. merus	Consistent infectivity	No data
An. melas	Consistent infectivity	No data
An. funestus	Consistent infectivity	No data
An. nili	Consistent infectivity	No data
An. moucheti	Consistent infectivity	No data
An. aconitus	Consistent infectivity	No data
An. annularis	Consistent infectivity	No data
An. balabacensis	Consistent infectivity	Consistent infectivity
An. culicifacies	Consistent infectivity	Consistent infectivity
An. dirus	Consistent infectivity	Consistent infectivity
An. farauti	Consistent infectivity	Consistent infectivity
An. flavirostris	Consistent infectivity	No data
An. fluviatilis	Consistent infectivity	No data
An. koliensis	Consistent infectivity	No data
An. maculatus	Consistent infectivity	Consistent infectivity
An. minimus	Consistent infectivity	No data
An. punctulatus	Consistent infectivity	No data
An. stephensi	Consistent infectivity	Consistent infectivity
An. subpictus	Consistent infectivity	No data
An. sundaicus	No data	No data

Nyssorhyncus sub genus	*local P. falciparum*	*non- local P. falciparum*
An. albimanus	Consistent infectivity	Mixed results
An. albitarsis	Consistent infectivity	No data
An. aquasalis	No data	No data
An. darlingi	Consistent infectivity	Consistent infectivity
An. marajoara	Consistent infectivity	No data
An. nuneztovari	Consistent infectivity	No data

Anopheles sub genus	*local P. falciparum*	*non-local P. falciparum*
An. barbirostris	Mixed results	No data
An. lesteri	No data	No data
An. freeborni	Consistent infectivity	Consistent infectivity
An. pseudopunctipennis	Mixed results	No data
An. quadrimaculatus	Consistent infectivity	Consistent infectivity
An. atroparvus	Consistent infectivity	Consistent non-infectivity
An. labranchiae	Consistent infectivity	Mixed results
An. messeae	No data	Consistent non-infectivity
An. sacharovi	Consistent infectivity	Consistent infectivity
An. superpictus	Consistent infectivity	No data
An. plumbeus	Consistent infectivity	Consistent infectivity
An. sergentii	Consistent infectivity	No data
An. sinensis	Mixed results	Consistent non-infectivity

Consistent non-infectivity observed across studies | Consistent infectivity across studies | Mixed results | No data

The colours illustrate the infectivity of *P. falciparum* to the malaria vectors in three subgenera of the *Anopheles* genus: *Cellia*, *Nyssorhynchus* and *Anopheles*. Red indicates consistent non-infectivity observed across studies. For example, no studies found that *An. atroparvus* mosquitoes exposed to *P. falciparum* from Africa and India developed sporozoites. Green indicates consistent infectivity across studies. Yellow indicates mixed results, meaning some studies observed infectivity, whereas others did not. Grey indicates no data. Note that within a pair of *P. falciparum* and *Anopheles* species, different studies might use parasites and mosquitoes of various geographical origins. Some studies were carried out many years ago, and the parasites may have evolved since then.

Source: Cohuet A, Morlais I, White G, unpublished data, 2025.

3 Applying receptivity and importation risk concepts to prevent malaria re-establishment

The transition from malaria control to elimination and the prevention of re-establishment is a continuum without a clear-cut starting point. In most countries, malaria elimination is first achieved in certain areas, where efforts to prevent re-establishment of transmission should begin. Some countries have undergone processes such as subnational verification and certification to confirm elimination, whereas others have not. Regardless of the situation, the concepts and principles of preventing re-establishment should already have been applied.

This transition requires a shift in mindset and strategy. While malaria elimination focuses on reducing and interrupting transmission, often within known foci, prevention of re-establishment emphasizes proactively designing and implementing interventions and activities to reduce the risk so that mosquito-borne cases do not occur. Intervention packages for elimination depend largely on transmission intensity *(13)*, whereas those for prevention of re-establishment are guided by the level of risk. Both stages share a common foundation: the early detection, management and reporting of malaria cases. Efforts to eliminate malaria and prevent its re-establishment must go hand in hand to achieve and sustain malaria elimination. However, the metrics used to measure elimination outcomes, such as reduction of transmission foci or local cases, are no longer applicable during the stage of prevention of re-establishment. After elimination, imported cases can occur anywhere, whereas introduced cases can theoretically occur in any area with suitable ecological conditions; this poses challenges for planning and management. Countries are recommended to apply the concepts of receptivity and risk of importation to prevent re-establishment. This includes:

- continuously assess levels of receptivity and importation risk, identify and monitor risk factors, and tailor interventions and responses accordingly;
- use risk stratification for both macro- and micro-level planning; and
- analyse factors contributing to the "stability" of malaria elimination and challenges in maintaining elimination in order to inform management and medium- to long-term planning.

3.1 The "stability" of malaria elimination

Many countries and regions have maintained their malaria-free status for decades after interrupting transmission, without re-establishment of transmission, thereby demonstrating a certain level of "stability" of malaria elimination *(18)*. This stability can be attributed to several factors:

- Receptivity is generally low in most malaria-free countries, as these countries are primarily located in the Nearctic and Palearctic biogeographic realms (↗ Fig. 1). Only a few are located in tropical regions where receptivity is higher, owing to more efficient vectors, more favourable climate and longer transmission seasons. The decades-long elimination process often coincides with social and economic development, environmental changes and urbanization, which significantly reduce vectorial capacity. After elimination, the overall trend of receptivity continues to decline in most countries, contributing to the long-term stability of elimination.
- In many malaria-free countries, imported cases often occur in urban areas where breeding sites are few and/or where water bodies are polluted due to industrialization, and housing conditions have improved, resulting in significantly reduced human–vector contact.
- In some regions, the majority of imported parasites are due to Afrotropical *P. falciparum*, which may have low infectivity to local vectors.
- Many malaria-free countries maintain robust surveillance and response systems that enable timely detection and rapid response to the first few local cases before transmission is re-established.

Non-programmatic factors contribute to the sustainability of malaria elimination. In circumstances where malaria elimination was achieved through large-scale interventions such as indoor residual spraying (IRS), and the process of elimination has not coincided with or been followed by significant industrialization and urbanization, maintaining malaria-free status is a long-term, ongoing effort. Furthermore, malaria-free status does not necessarily imply that the health system functions optimally. Case fatality rates in malaria-free countries could be higher than those in endemic countries (refer to section ↗ 4.2) due to suboptimal case detection or case management practices. Analysing the local conditions and factors contributing to the "stability" of malaria elimination is essential for programme action, management and planning.

3.2 Sustaining elimination in areas with high malariogenic potential

Achieving and sustaining malaria elimination is more challenging in areas with high malariogenic potential. Many malaria-eliminating countries have their last few transmission foci in the vicinity of international land borders shared with endemic countries (refer to ↗ box 1 on border malaria) *(19)*.

The following factors contribute to high malariogenic potential in border areas, but most of these factors are also applicable to non-border areas:

- There is high receptivity due to the presence of efficient vectors and favourable climatic and ecological conditions. For example, Saudi Arabia's border areas with Yemen have more efficient vectors than the rest of the Kingdom, while Bhutan's border areas with India are low-lying compared to its mountainous interior. Many border areas are remote, hard to reach and poor. Slow economic development negatively impacts the health system and hinders the decline in receptivity. In addition, as the parasites and vectors are often shared across a land border, the infectivity of the imported parasites from the other side of the land border to the local vectors is significant.
- The risk of importation is high due to the frequent movement of people from neighbouring endemic countries.
- The implementation of interventions is often suboptimal, which directly or indirectly contributes to a higher receptivity and risk of importation. This could be due to a generally weaker health system in remote areas; conflict and security issues; lack of effective health services and interventions targeting at-risk population such as migrants; and unequal implementation of interventions in a shared transmission focus or transmission zone that straddles an international land border *(19)*.

Interruption of transmission and maintaining malaria-free status in border areas with high malariogenic potential requires a holistic approach. The first step is to analyse the situation and define the problem, which must include defining the geographical boundaries of malaria transmission (or potential for transmission) and the origin and destination of imported cases. The following actions may be required:

- Implement effective interventions that reach sufficient coverage: High-quality surveillance and response remain the key to maintaining elimination. Effective surveillance requires strategies tailored to local epidemiological and operational contexts. Vector control, such as insecticide-treated nets (ITNs) or IRS, and additional preventive measures may be necessary to mitigate the receptivity, risk of importation and risk of re-establishment.
- Ensure sustained investment in human and financial resources to maintain the high quality of surveillance and response alongside other interventions.
- Strengthen community engagement and multisectoral collaboration.
- Invest in and work towards strengthening EPHFs.
- Address social determinants of health, such as working and living conditions, education and poverty, to achieve a long-term impact on malaria risk reduction.
- Leverage opportunities for environmental management to reduce receptivity wherever relevant.
- Ensure functional cross-border coordination and collaboration to improve the effectiveness of implementation across shared transmission foci or zones (section ↗ 4.3.3).

3.3 Estimating receptivity and risk of importation

Receptivity is affected by many factors influencing the density and longevity of competent vectors, mosquito breeding habitats and human–mosquito contact. The relevance and respective importance of the different types of information listed in Table 1 (section 2.2) depend on the local context. For example, rainfall is an important factor that increases receptivity in Cabo Verde, as the climate is generally very dry. Industrialization processes that pollute water bodies usually reduce receptivity, while urbanization and land use changes can either increase or decrease it.

Mapping the distribution of malaria vectors and local malaria cases over the last few decades can help to differentiate levels of receptivity, as done in Argentina. In Azerbaijan, malaria vectors are widespread, but the central plains between the Araks and Kura rivers are more receptive because of the high groundwater levels, creating potential mosquito breeding sites for *An. maculipennis sacharovi*. In Malaysia, routinely collected entomological data, such as *Anopheles* spp. detected and their density are used to calculate the index of receptivity for each locality *(20)*. This method does not require case data but needs strong capacity in entomology and resources. It may also be possible to estimate the basic reproductive number (R_0) or reproductive number in the context of control (R_c) using imported and local malaria cases detected in the final stage of malaria elimination *(21)*.

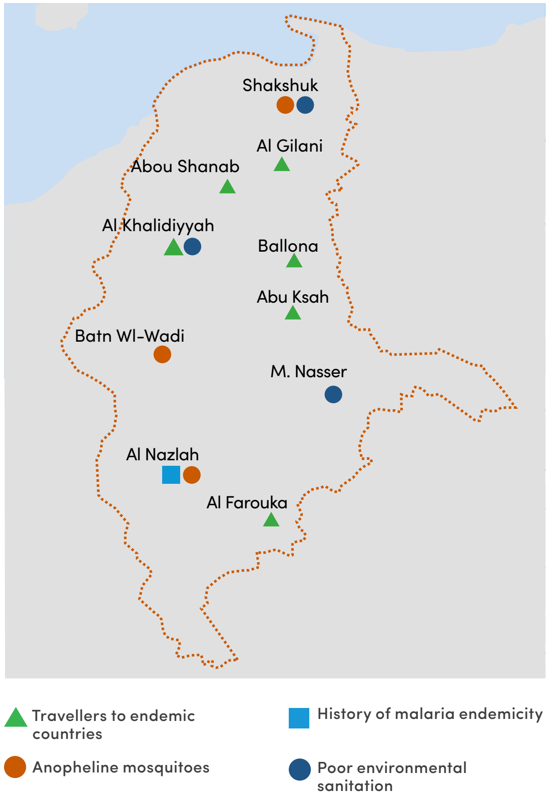
The risk of importation in malaria-free countries is affected by a variety of factors, as listed in Table 1 (section 2.2), which are largely related to population movements. For instance, in the southern regions of Algeria and Egypt, where they share borders with endemic countries, the risk of importation is high due to the presence of migrants and nomads.

Along the path to national malaria elimination, countries have gained knowledge on how to deal with malariogenic potential, receptivity, and cases imported from the last domestic endemic areas or from foreign countries. This knowledge should inform the selection of data and information to be collected to estimate receptivity and risk of importation. Maintaining the capacity to collect the required information and act on it is a common challenge and requires a strong monitoring framework with sustained human and financial resources.

3.4 Risk stratification and targeted interventions

The risk of malaria re-establishment is heterogeneous within a country. Risk stratification, based on receptivity and risk of importation, is part of the process to tailor the response and prioritize resources, identifying suitable intervention mixes at the subnational level *(22)*. Macro-stratification for resource allocation may use a province or region as a unit, while micro-stratification should consider the smallest unit, e.g. focus/village. Visualizing and regularly updating the factors influencing receptivity and risk of importation in each locality can guide actions in the field. (Fig. 4 provides an example from Egypt.)

Fig. 4. Vigilance map in Ibshway District, Fayoum, Egypt, illustrating the risk factors in each village



Both receptivity and risk of importation are dynamic, although receptivity is relatively more stable compared to risk of importation. Stratification should be performed regularly to reflect changes in receptivity and risk of importation. In general, in areas with no malariogenic potential, such as in areas with no vectors, passive case detection and high-quality case management should be guaranteed to identify and cure patients. Wherever transmission is likely to occur, epidemiological and entomological investigations are required to determine the source of infection, investigate the cause and rule out local transmission. Large-scale vector control should not be a routine intervention, except in areas where the malariogenic potential is very high and there is a need to mitigate the risk. Border areas should normally be a separate stratum, especially when there is a transmission focus or zone shared with neighbouring countries. Annex 2 presents an example of the intervention packages for such situation.

To measure receptivity numerically is challenging. The level of receptivity and the risk of re-establishment cannot be easily compared across countries and regions. Intervention mixes for areas classified as high-risk are likely to be different in different countries. It is essential to identify risk factors in order to develop targeted interventions and response. For example, in Tamanrasset, Algeria, the influx of migrants from Mali and the Niger poses a significant importation risk. Algeria addresses this risk by providing free health care to all, including undocumented migrants, and by maintaining robust surveillance through passive case detection and active case detection in migrant communities. Collaboration with border security in planning vector control and assuring adequate supplies for diagnosis and treatment in anticipation of the influx of migrants has been crucial for an effective response to its border situation.

3.5 Analysis of factors contributing to renewed local transmission

When multiple factors converge, local transmission can occur, resulting in introduced and indigenous cases. Understanding the causes and contributing factors is important for the prevention of local transmission. Available data suggest that imported parasites causing one or a few introduced cases are common in malaria-free countries, more frequently caused by *P. vivax*.[1] In some circumstances, introduced or indigenous cases can occur frequently. For instance, the tropical country Singapore reported 29 outbreaks with 196 local cases from 1983 to 2007 due to rapid urbanization and the deployment of large numbers of migrant workers from endemic countries *(23)*. Although malaria appears to be more easily reintroduced in tropical and subtropical regions due to more favourable ecological conditions, malaria epidemics causing hundreds or thousands of local cases have been seen in temperate regions after interruption of transmission (Table 2).

The most common cause of renewed transmission after elimination is delayed diagnosis or misdiagnosis of imported malaria cases (Table 2), often due to the loss of awareness of malaria risk in the health workforce. In some cases, a collapsed or overwhelmed health system, or a sudden surge in imported cases that exceeds the surveillance system's capacity to respond, has contributed to the re-establishment of transmission. Some of the episodes given in Table 2 came as a surprise to the antimalarial workforce, highlighting the need to improve early detection of risk factors, act on them, and the need to conduct regular assessments of outbreak preparedness and response.

[1] Li, unpublished data, 2023.

Table 2. Selected examples of re-establishment of malaria transmission in countries and regions and contributing factors *(24–30)**

	Name of country (region)	Last indigenous case	Outbreak	Factors		
				Receptivity	Importation risk	Programmatic factors
1	Armenia	1962	The first indigenous case was reported in 1994, rising to 149 in 1996 and 567 in 1997.	Collapse of irrigation and drainage systems, resulting in creation of numerous malaria vector breeding sites.	Massive importation of malaria infection into the country; cases increased sharply from a few sporadic cases to more than 500 from 1993 to 1995.	• Collapse of the health system, shortages in supply, equipment, drugs, insecticides
2	Cabo Verde	1966; 1982; 2018	Malaria transmission was re-established twice. The recent epidemic in 2017 resulted in 446 cases in Praia.	New construction sites and private agricultural activities created temporary breeding sites Slow in cleaning up the temporary breeding sites created by rainfall.	No significant change was reported.	• Suboptimal vector control • Inadequate case surveillance; lack of regular analysis and use of surveillance data
3	Yongcheng, China	1992	Local cases started being detected in 2003, reaching 2890 cases in 2006.	Climate change; remarkable drop in the number of large livestock, resulting in increased human biting by local vectors.	Outbreaks in neighbouring regions that share provincial borders with Yongcheng resulted in an increase in imported infections.	• Lack of preventive measures when the neighbouring regions were having malaria outbreaks (border malaria situation) • Reduced clinical alertness to malaria after no cases were detected for 10 years • Inadequate and delayed case detection • Lack of qualified personnel for microscopic diagnosis due to lack of training • Closure of the malaria unit may have contributed to a decline in quality of surveillance
4	Greece	1974	65 local cases of *P. vivax* were detected in Evrotas in 2009–2012.	Evrotas is traditionally a highly receptive area. Migrant workers reside in poor housing conditions, often located in close proximity to permanent mosquito vector breeding sites.	Increased influx of immigrants; significant shift in the agricultural workforce from mainly Eastern European farm workers to undocumented migrant workers from Asian endemic countries.	• Limited access for undocumented migrants to health care services • Reduced vigilance in health care providers, shortage of staff, inadequate case detection • Suboptimal case investigation • Economic crisis led to the reduction of public health expenditures, which may have indirectly affected the efficiency of response

	Name of country (region)	Last indigenous case	Outbreak	Factors		
				Receptivity	Importation risk	Programmatic factors
5	Jamaica	1962	404 *P. falciparum* local cases were detected in 2006–2009.	No significant change was reported.	Sudden increase in arrivals from neighbouring endemic country Haiti due to political instability.	• Lack of awareness of the risk of malaria and absence of a programme for prevention of re-establishment 40 years after elimination • Slow detection of cases, particularly for patients with no travel history • Capacity for diagnosis and treatment was not maintained and resources had to be mobilized from neighbouring endemic countries for response
6	Mauritius	1969	41 local cases were detected in 1975, reaching 668 in 1982.	Cyclone created ubiquitous breeding sites.	Migrant workers from India arrived to repair the infrastructure destroyed by the cyclone; increased migration of workers and other individuals.	• A relaxation in case detection, likely due to the lack of cooperation with health workers and a significant reduction of staff working in surveillance and laboratories after integration in 1969 • Reduced vector control
7	Moscow, Russian Federation	1950s	405 local cases were detected in Moscow region from 1999 to 2008.	Favourable meteorological conditions from 1999 to 2002; construction of cottages and summer houses created breeding sites.	Highly intensive importation from endemic countries in central Asia.	• Decrease in epidemiological awareness • Incomplete detection of cases partly due to self-medication or hesitance in health care-seeking by migrant workers and low clinical vigilance and knowledge of malaria in health workforce

* Only key references were listed. Key informants such as retired malaria programme managers, former WHO staff or consultants who experienced the respective outbreaks were interviewed to verify the contributing factors wherever possible.

4 Strategies and interventions for the prevention of re-establishment

Strategies and interventions for the prevention of re-establishment depend primarily on the level of receptivity and risk of importation (see section 3.4). As receptivity declines and the health system strengthens following elimination, some interventions aimed at mitigating risk may be gradually scaled down and eventually withdrawn. In the absence of transmission (zero introduced and indigenous cases), the impact and cost-effectiveness of the interventions cannot be directly measured. The decision to implement, scale down or withdraw interventions should consider not only the level or change in receptivity and risk of importation, but also the level of risk that can be tolerated and the resources available.

Analysing and using data is essential to tailor the interventions and response at subnational levels, and this process may be supported by modelling approaches. Previous experience in implementing interventions, as well as considerations of environmental impact and sustainability, should also inform decision-making. Importantly, decisions should not be based solely on cost but should prioritize the well-being of people and communities to ensure equity and equality.

Maintaining malaria expertise – for example, in the areas of diagnosis, treatment and vector control/entomology – is critical for the quality of implementation. Achieving the effectiveness and sustainability of these interventions requires multisectoral collaboration and community engagement.

4.1 Surveillance

Understanding the dynamics of malaria risk to prevent re-establishment requires multidisciplinary data, including epidemiological surveillance, entomological monitoring, and environmental and sociodemographic analyses. Some of the data and information can be gathered through intersectoral information-sharing and community engagement.

Malaria surveillance should leverage existing epidemic disease surveillance systems where available. This section focuses on disease and entomological surveillance.

4.1.1 Disease surveillance

Early detection, prompt notification, timely treatment and response to every malaria case form the foundation for preventing re-establishment. Detailed guidance on malaria surveillance is provided in the WHO publication *Malaria surveillance, monitoring and evaluation: a reference manual (31).* Surveillance for the prevention of re-establishment should be adapted to local contexts, such as the effectiveness of the general health services, and the risk factors affecting malariogenic potential. Surveillance practices implemented in the final years before interruption of transmission, such as mandatory real-time notification and stringent case classification, should be continued. If not already done, general health services should be empowered and capacitated to take responsibility for case detection. As the general health service is not ready to take on full responsibility for malaria surveillance in many malaria-free countries, it will be necessary to maintain a national unit (also refer to section ↗ 5.5) to review the timeliness and completeness of case notification, identify under-reporting, ensure the quality of diagnosis and verify the reliability of case classification. This unit should also analyse data, monitor the performance of the general health service and guide the response to situations where there is a risk of transmission or an active focus. However, this unit does not need to be dedicated solely to malaria.

One of the most common causes of malaria re-establishment is delayed or incomplete detection of infections. This is because the main symptom of malaria, fever, is more likely to be caused by another pathogen when malaria is largely or fully eliminated in a country. With few malaria cases detected annually, clinicians may not include malaria in their differential diagnosis. Deliberate efforts, such as training and refresher training, are required to maintain the clinical awareness of health care providers. The performance of case detection, including the use of suspected case definitions by health practitioners, should be monitored. Additionally, multisectoral collaboration and community engagement are crucial strategies to enhance case surveillance. For instance, in Belize, many agricultural enterprises employ workers from neighbouring endemic regions. Consequently, the programme uses community health workers (CHWs) stationed at plantation companies to provide malaria testing for these migrant workers. In Sri Lanka, partnerships with medical associations promote travel history-taking and malaria testing for febrile patients. Cabo Verde's national malaria programme collaborates with migrant associations to guide active case detection among returnees from endemic countries. In Timor-Leste, community leaders inform the national malaria programme about gatherings that migrants from endemic areas may attend.

As in elimination settings, the private sector plays a crucial role in disease surveillance. Exploring strategies to engage the private sector (e.g. providing incentives) can ensure effective referral of suspected cases, mandatory reporting, collaboration in epidemiological investigations and follow-up. In addition, frontline health workers (in both public and private sectors) and volunteers responsible for identifying suspected cases, managing patient care and reporting data should feel valued through regular feedback, training and effective staff management.

4.1.1.1 Ensuring high performance of passive case detection

Passive case detection begins with identifying suspected malaria cases, that is, patients who need to be tested for malaria. The case definition of suspected malaria should be sensitive and easy to apply. Typically, most malaria cases can be captured by identifying individuals with fever or a history of fever who have been in a malaria-endemic area or country. After elimination, introduced cases, relapses, and induced or recrudescence cases can occur, and these patients usually do not have a travel history. Moreover, fever is not the only symptom of malaria. Migrants from high-transmission countries may have partial immunity to malaria, resulting in mild or no symptoms. Therefore, cases of fever, anaemia or splenomegaly without a clear cause should also be considered suspected malaria. Good surveillance should study the entire population, rather than just a sample. Passive case detection should cover entire territories, including areas where the risk of re-establishment is considered null.

To monitor the performance of passive case detection, countries should systematically (and, ideally, electronically) record demographic information and data relevant to the case definition of suspected malaria (e.g. travel history, history of malaria) in health information systems. This information enables monitoring whether those individuals who meet the criteria for suspected malaria have been tested, as was done in Argentina.

If such information is not systematically recorded, countries might consider using the annual blood examination rate coupled with the test positivity rate to monitor malaria surveillance. The numerator should preferably include the number of tests from passive case detection only, and benchmarks may be established based on programmatic experiences from the final stages of elimination (for example, some countries use one test/1000 or 10 000 population as a benchmark). Note that the use of a set benchmark for annual blood examination rate is not justified from an epidemiological perspective. Instead of using annual blood examination rate, the average number of tests from passive case detection over the previous three years may be used as a benchmark. In strata with varying levels of risk, different benchmarks for the test positivity rate may be applied. For instance, a test positivity rate above 20% in receptive areas may be considered an indicator of overly narrow testing criteria, which warrants further investigation. Extremely high test positivity rate values (e.g. greater than 80%) should be avoided, even in regions with zero receptivity, as such values suggest that the testing criteria may be too restrictive, which could hinder early detection efforts and lead to severe clinical consequences.

In addition, reviewing medical records in sampled health facilities can provide valuable insights by calculating the proportion of suspected malaria cases that were tested *(32)*. Another approach is the simulated patient method, in which trained individuals act as malaria patients to assess health care providers' performance in recognizing and managing suspected cases. An online tool has been developed by researchers *(33)*.

In the event of heightened risk of re-establishment, health services may need to use broad criteria to test for malaria (sometimes called activated passive case detection). For example, in Paraguay, the detection of an imported case in a receptive area triggers an alert to all health facilities and providers in the area to test all fever cases for malaria, regardless of travel history or symptoms.

4.1.1.2 Active case detection

Active case detection can be planned when there is a significant risk of importation, for example, during religious events or agricultural seasons, in areas where migrants from endemic countries or regions are present. Active case detection can improve the timeliness of diagnosis and treatment of imported cases and reduce the risk of local transmission. For example, in Evrotas, Greece, a proactive case detection programme was implemented among migrants in response to local *P. vivax* transmission. This approach improved the timeliness of case detection *(34)*.

The following considerations could help to determine whether reactive case detection should be continued in response to imported cases after reporting zero indigenous cases for three years (see also section 4.1.3):

- whether the imported cases occurred in receptive areas and during transmission season(s);
- the presence of factors such as delayed diagnosis that might increase the probability of transmission;
- the yield of cases identified through this case detection strategy; and
- the available resources.

The detection of an imported case might trigger testing of people who travelled with the index case, as they might have had similar exposure to mosquito bites. Reactive case detection should be implemented when introduced or indigenous cases are detected to ascertain whether there are additional cases in the focus. When there is uncertainty over case classification or when several cases are detected that are clustered in time and space, reactive case detection can help to confirm/rule out the possibility of local transmission. During the first three years of reporting zero indigenous cases, reactive case detection is implemented to ensure that transmission is cleared in a focus, even if no additional cases are found.

4.1.1.3 Case and focus investigation and classification

The quality of case investigation is crucial for reliable case classification. Case investigation should collect all the necessary information to support case classification. Because delayed diagnosis and treatment are common in malaria-free countries, recording all health-seeking events in a case investigation form will enable countries to monitor the time taken from symptom onset to a malaria diagnosis, which can help to elucidate the causes of delay. Case investigation is also an important opportunity to identify changes in risk of importation.

Case investigation may not always involve a site visit if it is certain that the case was imported and the risk of onward transmission is minimal. For example, in Algeria, malaria cases are hospitalized and cases are investigated by an epidemiologist based in the hospital. In some situations (e.g. an imported case detected in a receptive locality during a transmission season), the in-hospital epidemiologist requests the field team to visit the patient's residential address to confirm the case classification. However, in highly receptive provinces, all case investigations involve field visits. When local transmission is confirmed or suspected, a thorough investigation involving a site visit should be carried out and an alert sent to decision-makers accordingly. Such situations might include:

- detection of introduced or indigenous cases;
- uncertainty over the source of infection;
- uncertainty over the case classification based on the information collected;
- identification of a case in a border area and the initial classification was that it was imported by an infected *Anopheles* mosquito flying across the border;
- presence of a number of imported cases clustered in time and space; and
- any other unusual situation that warrants field investigation.

A high level of certainty in case classification requires an understanding of parasite biology, and good knowledge of the malaria epidemiology and vector in the vicinity of the patient's residence. Furthermore, there is often a tendency to classify cases as imported after elimination. Therefore, countries should establish a group of experienced epidemiologists or an independent technical group (see also section ↗ 5.7) to regularly review case classifications, or at least a sample if the number of imported cases is large, to assess their reliability. The detection of one or a few sporadic introduced cases should not be seen as a failure of the system. Rather, health workers should be encouraged to report introduced cases in a timely manner and to investigate them thoroughly, as an introduced case is a precursor to indigenous cases. Focus information compiled in a register during malaria elimination should be maintained. Upon detecting an indigenous or introduced case, the focus should be re-classified as active and follow-up actions should be taken to ensure that it is completely cleared, as done during malaria elimination *(13)*. In preventing re-establishment, focus investigation is similar to an outbreak investigation aimed at determining why local cases occurred. Key considerations should include:

- reviewing historical and recent data on epidemiology, especially the focus register, including entomological information if available;
- assessing the adequacy and the quality of surveillance in the area;
- performing an entomological assessment to ascertain the *Anopheles* species responsible for transmission if entomological data are outdated;
- examining any changes in the risk of importation to identify potential sources of infection; and
- evaluating changes in receptivity (Table 1), including assessing the quality of recent vector control implementation, if applicable.

4.1.1.4 Role of CHWs or volunteers in surveillance

In some countries, the role of CHWs or volunteers in malaria surveillance should be reviewed based primarily on the number of cases they have detected in recent years. If the PHC system in rural areas has improved its ability to detect malaria cases, CHWs' functions may shift from performing tests or collecting blood smears to referring suspected cases to health facilities. Alternatively, their roles could expand to address other diseases, integrating them into the broader health workforce in line with the agenda for strengthening PHC and EPHFs.

Regardless of these workers' evolving roles, it is crucial to define clear responsibilities and ensure continuous training and supervision by malaria or public health service staff. This is especially important for CHWs or volunteers in high-risk areas, such as border regions adjacent to endemic countries, to maintain their proficiency in detecting cases among migrants, itinerant workers and other mobile populations. Where applicable, their role might also include accurate diagnosis, treatment and investigation of identified cases. As during the elimination stage, ensuring the means for rapid communication of detected cases is critical. Depending on the country's context, sustaining a CHW network may require financial resources that could be secured from local administrative offices to support malaria programmes integrated with other health initiatives.

4.1.2 Entomological surveillance

Entomological surveillance involves the systematic collection, analysis and interpretation of entomological data. These data provide information on the level of receptivity, ascertain whether transmission has occurred and guide vector control when/if vector control is implemented *(31).*

A priority entomological activity for prevention of re-establishment is the monitoring of the composition of vector species, as the invasion of new species could result in a significant increase in receptivity. For example, in 1930, *An. gambiae* from West Africa invaded Brazil, and in 1942, it spread in Upper Egypt, possibly via the Nile Valley connecting sub-Saharan and North Africa *(35)*. Both events resulted in an unprecedented surge in malaria cases. A more recent example is that of *An. stephensi*, originally from South Asia and the Arabian Peninsula, which has been found in eight African countries in the past decade *(36)*. However, the introduction and establishment of new *Anopheles* mosquito species is rare due to barriers such as ecological constraints and competition from locally established species. Long-distance transport of adult *Anopheles* mosquitoes is rare because they need to lay eggs frequently and most species do not breed in small containers. Accidental transport of aquatic stages is unlikely because larvae are prone to drowning if the water is disturbed.

Countries should maintain entomological capacity for early detection and identification of new *Anopheles* species and assessment of the associated malaria risk so that strategies can be developed and implemented to mitigate that risk. For example, *An. stephensi* was detected in Sri Lanka in 2016, four years after the last indigenous case was reported. This risk was addressed through a large-scale programme using larvivorous fish, which led to the successful elimination of the vector in four of the six affected districts. Monitoring insecticide resistance is also critical to ensure the effectiveness of vector control measures when they are needed, for example, during outbreaks, even if routine vector control is no longer implemented. In addition, tracking the density of malaria vector species and changes in their bionomics supports the characterization of receptivity, monitoring of trends and stratification efforts.

Gathering the needed entomological intelligence may take different forms, depending on the context. Sentinel surveillance sites that were established long before elimination should be reviewed during the transition to a prevention of re-establishment strategy to ensure that they remain relevant. Sentinel sites may not work well in some situations due to the dynamics of the risk, the capacity and resources available. Ad hoc spot checks may work better than sentinel surveillance, especially in areas where risk may increase due to vector reintroduction, land use changes, environmental shifts or population movements. Surveillance of breeding sites or potential breeding sites may be a practical and effective strategy in some settings, e.g. in Azerbaijan, Chile, Tajikistan and Uzbekistan where breeding sites are identifiable, and could be a component of entomological surveillance.

Systematic monitoring of disease vectors at points of entry, such as ports, airports and land crossings, should be continued *(37)*. In the event of detection or suspicion of local transmission, an entomological assessment must be carried out to ascertain the *Anopheles* species that is responsible for transmission and to support the planning of appropriate reactive control actions (section 4.1.3). The detection of imported cases in receptive areas might warrant entomological investigation, depending on the need to reassess the receptivity level and inform the response, particularly if the entomological data available are outdated.

As systematic collection of entomological data is costly, countries should set priorities for entomological surveillance activities, depending on the need, capacity and resources available. Once the priorities have been set, resources should be allocated to maintain essential entomological surveillance (i.e. insecticide resistance testing) in alignment with the *Global vector control response 2017–2030 (38)*. Countries facing challenges with vector-borne diseases should at minimum retain the post of chief entomologist at the national level, and at the subnational level when appropriate. Depending on the country's burden of other vector-borne diseases, it may be necessary to maintain a dedicated vector control team with a budget to oversee the implementation of entomological surveillance and integrated vector management *(38)*. Collaboration with other departments or sectors, such as the ministries of agriculture, water resource management and housing, can further enhance efforts to reduce vector breeding habitats and human–vector contact and decrease the malaria risk.

4.1.3 Analysis and use of data

Disease surveillance and entomological surveillance work together to monitor a range of malaria-related factors and guide the response. Additionally, information on climatic, environmental and social determinants (Table 1) are valuable for assessing and monitoring the risk of malaria re-establishment. Guidance to strengthen information systems is provided in the WHO surveillance, monitoring and evaluation manual *(31)*.

As in burden reduction and elimination settings, data should be analysed and used at all levels of the health system to support decisions for the prevention of re-establishment. For example, achieving a tailored response to imported cases requires a thorough analysis (Fig. 5). Decisions on interventions and response should be based on the objectives, resources and level of risk, and often revolve around certainty on the adequacy of the surveillance and the probability of re-establishment, informed by data. For example, reactive vector control may be implemented as a response to imported cases if receptivity and risk of re-establishment are high. Reactive case detection may be phased out if the purpose is to identify additional cases and no cases are being found using this approach. For instance, in Sri Lanka, a reactive case detection strategy was employed around the index case household soon after transmission was interrupted. Data analysis from subsequent years revealed that few cases were found through reactive case detection, which indicated that local cases were unlikely to have originated from imported cases. This analysis informed the decision to scale back reactive case detection to optimize the use of resources *(39)*. Over time, the response to imported cases might need to be adjusted depending on changes (i.e. decrease or increase in receptivity, strength of the health system), informed by data.

Countries may consider epidemiological classification of the different types of imported cases for a tailored response (Fig. 5). For example, imported cases in a border malaria situation (section 3.2 & 4.3.3) require joint preventive activities such as vector control; imported *P. knowlesi* cases detected in forest areas where the *An. leucosphyrus* group

Fig. 5. Key considerations for assessing the risk of imported cases and decisions on response

Objectives

Objectives may include to cure patients; to identify additional cases; and to prevent introduced and indigenous cases.

Questions for analysis

Where were the imported cases detected?	From where were the parasites imported?	When were the imported cases detected?	Who are the patients (and how many)?	What are the options for response?
This is to determine the level of receptivity of the locality where the imported case was found. For example, the type of malaria vector present and its bionomics.	The infectivity of the imported parasites in local vectors should be considered if data and evidence are available. Case management should pay attention to cases imported from places where drug resistance has developed.	An imported case detected outside transmission seasons might not require an additional response other than case management.	Delay health seeking might happen in foreign visitors from endemic countries due to mild symptoms or other reasons. An analysis should also include how the patients arrived at the destination (locality) and where they stayed during their journey.	The immediate response is to cure patients. Other responses might include activated passive case detection, reactive case detection, entomological investigation, reactive vector control and health education.

Decisions

As a response to imported cases, entomological investigation, reactive case detection, or reactive vector control may or may not be needed. Decision should be based on the above analysis, informed by available data, evidence or experiences in implementing these interventions, as well as available resources.

is present require aggressive and timely response to minimize any risk of onward transmission. A cluster of imported cases may or may not imply an outbreak and field investigation may be necessary (section ↗ 4.1.1.3) to rule out local transmission. For example, in some countries in Asia, Europe and the Americas, a cluster of imported cases of *P. falciparum* of African origin might not pose a problem epidemiologically, but this requires analysis.

Mapping the data at a granular level using GIS technologies will help the analysis and guide the response. Regular surveillance assessments and programme reviews allow for the evaluation of existing systems and the identification of any systemic weaknesses *(40)*. Documenting, publishing and communicating the results of programme reviews and surveillance assessments with all relevant stakeholders will facilitate improvements to the system.

4.2 Delivering quality clinical care

Delivering quality clinical care is critical not only for preventing re-establishment, but also for avoiding unnecessary deaths. Case fatality rates in malaria-free countries can be higher than in endemic countries. Several studies have shown that the loss of alertness to malaria, especially among PHC providers, is one important reason for malaria deaths *(41, 42)*.

Maintaining alertness and knowledge among health care providers requires continuous training. For example, malaria training is included in the accreditation programme for family doctors in Tajikistan. The performance of general health care providers in recognizing suspected cases and/or detecting malaria cases must be monitored to ensure a high-performing passive case detection system (section ↗ 4.1.1.1). Engagement with the medical association helps to maintain clinical vigilance. In addition, countries may establish standards to monitor the quality of malaria clinical care.

Timely diagnosis and prompt treatment of malaria cases should be available to everyone, but this does not mean that diagnostics and antimalarial medicines should be stored at every health facility. A referral system should be established to direct suspected cases to designated diagnostic/treatment sites. It is essential to ensure that the primary-level health care providers, particularly those in the private sector, are well informed of where to refer patients. It may be necessary to map the health facilities where malaria diagnosis and treatment are provided and share the map with all concerned, particularly when there are changes in the provision of malaria tests and treatment after elimination.

Decisions about where to stock malaria diagnostics and medicines should consider the level of malaria risk, capacity of the referral system and available resources. Strong referral networks can centralize supplies, whereas areas with a substantial risk of importation should maintain adequate stock to deal with an influx of importation, health emergencies or outbreaks. Collaboration with transportation services and the establishment of subnational hubs can facilitate rapid transportation and delivery throughout the country. A WHO-managed regional hub can assist with supply chain management for both emergency and routine procurement of medicines and commodities *(43)*.

4.2.1 Diagnosis

Both WHO-prequalified rapid diagnostic tests (RDTs) and light microscopy are recommended for malaria diagnosis *(13)*. Diagnosis by microscopy is prone to many errors related to overload and fatigue of laboratory technicians, the quality of microscopes, the competence of the microscopists, poor quality and transport of blood slides, and gaps in the network of field evaluators. Maintaining the competence of microscopists requires regular training and supervision, which could incur significant costs. RDTs are user-friendly, and the costs of training and supervision are minimal. However, the cost of procuring RDTs may be significant. Countries should carefully weigh the pros and cons of retaining light microscopy and implementing RDTs. In general, high-quality microscopic diagnosis is essential in referral hospitals and clinics where changes in parasite density are measured to monitor treatment efficacy. Certain species, such as *P. malariae*, *P. ovale* and even zoonotic *Plasmodia*, are not identifiable by RDT. Therefore, the presence of experienced microscopists is crucial. Wherever RDTs are used, consideration must be given to the possibility of *P. falciparum* histidine-rich protein 2/3 (*pfhrp2/3*) gene deletions, which may make RDTs based on detection of histidine-rich protein inaccurate and warrant a change to alternative RDTs. Health clinics where treatment is provided should have the capacity to test for glucose-6-phosphate dehydrogenase (G6PD) deficiency.

As in elimination settings, countries should maintain a national reference laboratory, which can be integrated with other diseases programmes that are diagnosed microscopically *(44)*. The national reference laboratory should participate in an international certification programme and has the duties of establishing national standards for malaria diagnosis, developing standard operating procedures for laboratory testing, conducting training courses, and assessing and certifying microscopists. At least one of the following approaches should be used for external quality assessment *(44)*: regular on-site supportive supervision, proficiency testing or direct evaluation, and blinded cross-checking of slides. National standard operating procedures should be aligned with WHO recommendations *(44)* and should be applied at all levels of the health care system in both public and private sectors. A national focal point should be appointed to oversee the implementation of the quality assurance programme. Many countries have equipped their national reference laboratory to perform molecular diagnosis. Molecular methods can be used at the national reference laboratory to help confirm species and detect species such as *P. knowlesi*.

Health care providers dealing with case detection and diagnosis must be aware that in places with some prevalence of G6PD deficiency and thalassaemia, malaria cases could be asymptomatic (e.g. some districts in Azerbaijan, Fayoum Oasis in Egypt).

4.2.2 Treatment

Countries should consult the WHO website regularly to ensure that their national treatment guidelines are updated *(45)*. Integrated clinical guidelines, which include malaria treatment guidelines, are recommended, as they promote integrated training and ease of use by clinicians. Maintaining stocks of parenteral artesunate is crucial, as severe malaria cases may arise, and the availability of this drug is essential for saving lives. The potential for treatment failure due to antimalarial resistance in the country of origin should be considered, so second-line treatment should be available in the main referral hospitals. The WHO Malaria Threats Map *(46)* provides comprehensive information on various biological threats to malaria control and elimination, including antimalarial drug efficacy and parasite *pfhrp2/3* gene deletions. Establishment of an expert group to support severe case management through hotlines or other means of rapid communication is a good practice. For example, the United States of America has a hotline for health care providers to support the management of severe malaria cases, offering diagnosis and treatment guidance.

Severe and fatal cases should be investigated to identify systemic weaknesses. The outcome of the investigation and assessment should be distributed and communicated with all health practitioners.

4.3 Other interventions and strategies to mitigate the risk of re-establishment

4.3.1 Vector control

In most malaria-free countries, routine vector control interventions such as ITNs and IRS are generally unnecessary and should be phased out after malaria elimination. However, in focal areas with high malariogenic potential, such as border regions with ongoing transmission from neighbouring countries, maintaining vector control may be crucial.

Before withdrawing vector control, it is essential to assess the quality of surveillance and response systems. Changes in receptivity should be monitored through entomological surveillance to guide programme actions to ensure that the risk remains low. The decision to use ITNs or IRS in response to imported cases should be based on the receptivity levels and informed by data (e.g. whether introduced cases occur if vector control is not implemented; section ↗ 4.1.3). The insecticide resistance status of local vector populations in areas with a risk of re-establishment should be kept up to date.

Other interventions, such as the use of larvivorous fish for larval source management, should be continued if they have been used successfully during malaria control and elimination. Long-term sustainable approaches to mitigate receptivity should consider environmental management practices through multisectoral collaboration. These can involve improved drainage and water storage, elimination of stagnant water bodies, housing improvements with screens, and agriculture without surface water pooling, such as intermittent irrigation in rice fields *(47)*. Regardless of the vector control intervention, it is important to monitor its coverage, quality and effectiveness, focusing on its impact on adult mosquitoes.

Legislative measures can further support vector control efforts. For example, in Egypt and some Central Asian countries, laws are in place to prohibit growth of rice and other crops within a 1 km radius of residential areas to reduce the risk of vector-borne diseases. Singapore's vector control law requires licensing for vector control personnel and prohibits conditions that promote vector breeding. The National Environment Agency enforces these regulations, ensuring effective monitoring and control of vector-borne diseases through strict measures and penalties.

Maintaining the capacity to deploy quality-assured vector control, such as IRS, is essential for outbreak preparedness. Strengthening vector control efforts involves maintaining integrated vector management capacity and coordinating actions across sectors and diseases *(38)*. For instance, Cabo Verde established an Interministerial Commission for vector control, chaired by the Prime Minister, to coordinate resources and efforts.

4.3.2 Addressing social determinants

Addressing social determinants such as social protection for migrants and other marginalized populations at risk, education, unemployment, working and living conditions, and access to quality health services contribute to mitigating risk *(48)*. For example, in 2015, Greece implemented regulations to provide free access to care for suspected and confirmed malaria cases among uninsured individuals (including undocumented immigrants) following the malaria outbreak in 2009–2011. In addition, broader development initiatives, such as housing projects and urban planning, should consider areas with high malariogenic potential to reduce the risk in the long term.

4.3.3 Inter-country/-region information-sharing and cross-border collaboration

Managing malaria importation is the responsibility of the respective governments. However, inter-country information-sharing can enhance preparedness, especially when there is significant population movement. The arrival of a substantial number of migrants or refugees from specific malaria-endemic regions may be predicted considering the historical, cultural, economic and political bonds between countries. Key information that should be obtained includes the migrants' country of origin, transit routes and journey duration *(49)*. National ministries of interior affairs, governmental agencies related to immigrants and refugees, security services and local governments play crucial roles in informing and alerting the Ministry of Health of changes in malaria importation risk (Table 3). For large, organized migrations involving *P. falciparum* infections, pre-departure screening from the countries of origin can mitigate the risk of imported malaria.

Inter-country collaboration is an important component to address border malaria (section ↗ 3.2 and Annex 2) *(19, 50)*. For example, a malaria outbreak on one side of the border should trigger immediate coordination with neighbouring districts, prompt enhanced surveillance and activate an outbreak preparedness plan. Recommendations and operational considerations for cross border collaboration are provided in Box 1.

Box 1: Differentiating border malaria from malaria importation for cross-border collaboration

Definition: Border malaria refers to malaria transmission or potential for transmission across adjacent administrative areas sharing an international land border, where at least one area has ongoing transmission. Border malaria often involves a transmission focus or zone shared between two countries (refer to Annex 2 for an example).

Features: The contiguous areas share a common malaria ecosystem, with the same (or very similar) parasites and vectors. The populations are related, often sharing ancestral, ethnic, cultural, or economic ties. Cross-border movement is frequent, cyclical, short-term, and uncontrolled.

Geographical scope: Border malaria typically occurs near international land borders. A shared transmission focus could be a village or township straddling the border. Defining a shared transmission zone should consider the geographical boundaries of transmission (or potential for transmission), the origin and destination of imported cases, and the pattern of cross-border movement among at-risk populations.

Distinguishing border malaria from malaria importation: Malaria cases imported from other countries do not necessarily constitute border malaria. For instance, malaria importation to interior areas far from the border — via sea borders, airports, or into island countries — does not qualify as border malaria.

The importance of inter-country coordination when addressing border malaria: Unequal implementation of interventions across a shared transmission focus or uncoordinated actions within shared transmission zones can compromise the effectiveness of interventions. Countries involved in a shared transmission focus or zone must ensure access to diagnosis, treatment, and prevention, including within border areas. Cross-border collaboration should support the malaria goals on both sides of the border. Joint situational analyses can help inform agreements. Strong partnerships between countries, effective coordination and necessary resources may be required for successful implementation. Coordination support from international organizations or neutral bodies may be necessary depending on the context. In addition, the following should be considered:

- Informal information-sharing and local-level collaboration (e.g. in border districts/ counties) are most efficient, which should be encouraged within the framework of national agreements.
- Regular and timely information-sharing across transmission foci and zones is important, especially during outbreaks or events that may increase importation risk.
- Synchronization of vector control across shared transmission foci is essential for effective malaria prevention.

4.3.4 Travellers' health

In a country where malaria has been eliminated, the population has little to no immunity against the parasites. Consequently, citizens face an elevated risk of severe illness and mortality if they contract the disease while travelling to malaria-endemic countries. Lack of or inappropriate use of chemoprophylaxis was found to be a main risk factor associated with malaria deaths in travellers *(51)*.

To minimize the potential for severe illness and importation of the disease, countries should develop a comprehensive programme aimed at reducing the risk of malaria among travellers, which should encompass both citizens travelling to endemic regions and those returning from endemic areas. Collaboration with tourism agencies, companies, employment agencies and community leaders is important in raising awareness about preventive measures before travel and appropriate actions in case of fever after returning from endemic countries. In Tajikistan and Uzbekistan, citizens returning from endemic regions are subject to a three-year follow-up by departmental clinics and health care institutions.

Some countries have travel clinics or designated health facilities where residents can obtain information about the disease risks associated with their travel and receive chemoprophylaxis. For example, in Algeria, chemoprophylaxis is provided free of charge at the International Vaccination and Travel Advice Centre, whereas in Egypt, it is available at no cost in community health centres located in areas with large traveler populations. In many countries, family doctors or primary care physicians are the first line of contact for pre-travel consultation, as well as the preferred source of care for travellers returning from endemic countries. Including travel medicine in the training curricula for PHC physicians is important to improve their knowledge, attitude and practice *(52, 53)* (see section ↗ 5.5). A list of WHO-recommended antimalarial medicines for chemoprophylaxis in travellers is provided in Annex 3.

The Ministry of Health should provide updated information on the geographical distribution of malaria caused by different *Plasmodium* species to health care professionals. The most updated and comprehensive information on malaria, including the situation in endemic countries and the distribution of antimalarial drug resistance, is published annually by WHO in the World Malaria Report *(1)*. Health professionals should educate travellers about the importance of chemoprophylaxis, personal protection against mosquito bites, and the importance of early diagnosis and appropriate treatment. Non-adherence is a major obstacle to effective chemoprophylaxis that has been repeatedly identified as a risk factor for developing clinical malaria. Anyone experiencing a fever one week or more after entering an area with malaria risk should promptly consult a physician or a qualified laboratory for an accurate diagnosis and safe and effective treatment. If travellers are staying in remote locations where prompt access to medical care may be difficult, in addition to chemoprophylaxis, it is advisable for them to carry antimalarial drugs for self-administration. For more details, readers can consult the WHO publication *International travel and health (54).*

WHO recommends that travellers and their advisors observe the five principles of malaria protection, which benefit travellers and contribute to reducing the risk of importing malaria *(54)*.

- Be **A**ware of the risk, the incubation period, the possibility of delayed onset and the main symptoms of malaria.
- Avoid being **B**itten by mosquitoes, especially between dusk and dawn.
- Take antimalarial drugs (**C**hemoprophylaxis) when appropriate, at regular intervals to prevent malaria attacks.
- Immediately seek **D**iagnosis and treatment if a fever develops one week or more after entering an area where there is a malaria risk and up to three months (or, rarely, later) after departure from a risk area.
- Avoid outdoor activities in **E**nvironments that are mosquito breeding places, such as swamps or marshy areas, especially in the late evenings and at night.

4.4 Outbreak detection, preparedness and response

In malaria-free countries, a single introduced or indigenous case should, as a general rule, be considered an outbreak. Some countries use two or more cases as a threshold with the justification that one introduced case does not carry a substantial risk of local transmission; this argument holds if a thorough investigation has shown that indeed there is only one case. For example, in Singapore, an outbreak is defined as a cluster of two or more epidemiologically related cases linked by place of residence, work or school within 800 m of each other and within one incubation period of the malaria species involved. A less stringent definition may be more economical, but could make the system less sensitive and result in a delayed response. Regardless of the definition, thorough epidemiological investigation of any locally transmitted case is the principle to be upheld, whether cases are introduced or indigenous. A cluster of imported cases (clustered in time and space) may imply an outbreak, particularly when case classification is of low certainty. An analytical system needs to be in place in order to detect such clusters.

In epidemic-prone areas, malaria outbreaks (epidemics) seldom pose problems of recognition at the local level, where lay persons often recognize them. However, in areas that are considered free from transmission, it is common for individual malaria cases to be misdiagnosed and for the initial stages of a malaria epidemic to not be recognized as such. Therefore, in receptive areas with a previous history of malaria transmission, malaria should be suspected as the cause of any outbreak of febrile disease (any clustering or increase in fever cases). Health workers in areas with high malariogenic potential should be trained to recognize epidemic indicators such as significant increases in the number of acute febrile episodes.

To ensure a prompt response, countries should develop an outbreak preparedness plan (or contingency plan) as an integral part of the national plan for the prevention of re-establishment, and disseminate it to the entities responsible for outbreak preparedness and response *(31)*. Malaria outbreaks might come under a health security/emergency framework, particularly when the outbreaks involve a large number of malaria cases and it is necessary to rapidly mobilize resources. In Malaysia, the response to malaria outbreaks typically falls under the responsibility of the vector-borne disease team. However, when an outbreak becomes significant based on predefined criteria, a broader response involving wider resource mobilization and coordination of multisectoral action is triggered under a general emergency response mechanism.

The interventions to respond to a malaria outbreak are similar to those in malaria elimination settings and may include active case detection, vector control and chemoprevention. Guidance on the use of these interventions is found in other WHO publications *(13, 45)*. In many circumstances, IRS is used in response to an outbreak (section ↗ 4.3.1). Its successful implementation requires maintaining cadres of trained technicians, careful logistical planning, and community engagement supported by strong leadership.

To launch a rapid response, it is necessary to maintain emergency stockpiles of diagnostics, medicines and vector control commodities, ensure that equipment is in working order, and establish efficient delivery channels. For example, in the island country of the Philippines, each malaria-free province has established a hub equipped with the needed supplies to provide rapid access to resources at the local level. If countries face challenges in the procurement and storage of these commodities, coordination through a WHO regional hub could be explored *(43)*. Simulation exercises might be necessary as part of outbreak preparedness, particularly in high-risk areas. Resources should be invested to improve skills and systems for managing disease outbreaks effectively and cultivating public health leadership.

5 Planning, management and oversight

Planning and management for prevention of re-establishment can be complex for several reasons. After elimination, traditional metrics, such as the numbers of transmission foci and local cases, are no longer useful. Planning must rely on risk, which changes over time and is hard to measure numerically. In addition, while integrating the programme into the general health service or other vector-borne disease programmes may enhance efficiency and sustainability, it could also dilute the focus on malaria and create coordination challenges. Monitoring and oversight are therefore essential to ensure the continuity and quality of services, refine and optimize strategies, and address emerging challenges.

Moving from malaria elimination to prevention of re-establishment often requires countries to strengthen or establish specific systems and functions. Countries should use the results from previous assessments, such as those generated by certification or subnational verification processes to identify the gaps. The WHO checklist of the minimum requirements for prevention of re-establishment can also guide these efforts *(14)*. Addressing the challenges requires both short- and long-term planning. For example, immediate actions to address delayed case detection may include providing malaria training for all health practitioners, including those in the private sector. Mid- to long-term plans may focus on optimizing training curricula, developing new policies, enhancing information systems, establishing or improving pre- and post-travel medicine services, strengthening public–private partnerships and enforcing regulatory measures. Similarly, short-term receptivity reduction might involve ITN distribution, IRS or larviciding. Long-term national strategies that may benefit prevention of re-establishment include efforts in environmental management, housing project development and poverty reduction.

Planning for prevention of re-establishment is, therefore, an integral part of health and development planning. It must address immediate needs while being designed for long-term impact. While prevention of re-establishment planning aligns with the principles embedded in the PHC approach and the EPHF framework, it also contributes to broader health and development goals.

5.1 Integrating malaria services

"Vertical" and "integrated" are terms used frequently in health service delivery, but they lack a single accepted definition. During the Global Malaria Eradication Programme, many national malaria programmes operated vertically as standalone entities. Historically, vertical malaria programmes played a pivotal role in establishing public health systems and rural health services in many countries. As malaria transmission declined and health systems evolved, countries progressively integrated malaria interventions into broader health services for sustainability.

Integration is an approach but not an end. Careful planning and rigorous monitoring are essential to ensure service coverage, continuity and quality throughout the process. It must be implemented with strong oversight, ensuring sufficient resources for planning, execution and continuous monitoring. The PHC approach, which strengthens health systems through integrated health services, multisectoral policies and community engagement, provides a valuable framework for malaria integration. Some countries have fully integrated malaria activities after elimination, but in most countries, it will be necessary to maintain a specialized national-level structure to oversee programme quality and efficiency.

Malaria integration might take different forms in different contexts. For example, malaria programmes may evolve into broader epidemic control programmes, expanding their functions to other diseases; programmes for malaria and other vector-borne diseases (or parasitic diseases) can merge into one, sharing administrative functions such as information systems, budgeting and logistics. In addition, integration could mean that certain malaria functions are transferred to the general health service. For example, in Paraguay, case diagnosis and treatment were transferred from the vertical malaria programme to the clinical care system. There is no evidence suggesting that one integration approach is superior to another. Integration is a context-specific balance between horizontal and vertical planning and implementation, and should therefore follow a pragmatic approach. Key elements to consider in vertical and integrated approaches include governance, institutional structure, funding and service delivery. Successful integration ensures uninterrupted malaria programme operations while maintaining high-quality essential services.

The following are key considerations for integrating malaria activities:

- Assess malaria risk factors (receptivity, risk of importation, risk of re-establishment) and general health service capacity when designing the integration process, including the timeline for completion.
- Develop a monitoring and evaluation system with key performance indicators (e.g. timelines for diagnosis and treatment, see ↗ Annex 4) to ensure the quality of service delivery.
- Establish a phased approach for integration, ensuring continuity of key personnel and stakeholder engagement.
- Designate a dedicated management structure to oversee the integration process.
- Support the integration process through competency-based education, training and supportive supervision and periodic assessments of workforce capacity.

5.2 Leadership

Sustained political commitment is critical in maintaining malaria elimination. Inadequate governance, financial instability and ineffective leadership can increase the risk of re-establishment and jeopardize efforts to prevent the re-establishment of malaria.

Governments at all levels bear the responsibility of preventing malaria re-establishment. This effort should be guided by key principles, including universal health coverage *(55)*, PHC *(56)* and the Sustainable Development Goals *(57)*. Strong leadership is critical to preventing re-establishment, as illustrated in Box 2. Effective leadership enables multisectoral collaboration – often through centralized coordination – supported by sustained political commitment and strategic oversight. For example, the National Environment Agency in Singapore oversees and coordinates the monitoring and control of vector-borne diseases (section ↗ 4.3.1).

Box 2. Case study: public health leadership in prevention of re-establishment

In the 1980s, Shenzhen, a city in south-east China, experienced a significant malaria epidemic after it became the first Special Economic Zone of China in 1979. Formerly a small county, Shenzhen experienced rapid urbanization and saw rapid population expansion due to an influx of migrant workers. By 1983, migrants constituted more than a quarter of the population, and by 1984, the total population reached 670 000, with migrants outnumbering residents. In 1979, malaria was virtually eliminated with only eight sporadic cases. Three small outbreaks were detected in 1980, but they were not successfully contained. This was followed by a sharp increase in cases to over 4000 in 1983 and nearly 7500 in 1984, with the continuous influx of migrant workers. There were nearly 800 foci and 72 outbreak sites. The sudden expansion of the population and vast area affected overwhelmed the capacity of a malaria team of only 20 personnel.

The city government established steering committees at all levels to manage the situation and allocated specific funds to do so. Stakeholder meetings were convened to define roles and responsibilities across various departments (e.g. labour, urban management, agriculture, private industries). This was followed by routine and ad hoc meetings to jointly plan and coordinate actions across sectors and to support the implementation of interventions. To ensure quality and accountability, government authorities led monitoring and supervisory visits, and a reward and punishment mechanism was established. Numerous training courses were organized to build capacity among health professionals. Recognizing the long-term malaria risk, the city government recruited malaria and public health specialists from across the country to rapidly boost the workforce. In addition, laws and regulations were enacted to manage malaria among migrants. The number of cases began to decline rapidly from 1986 with the introduction of ITNs (then a new tool) in 1984, which was a game changer. However, the government's leadership and management were instrumental in the success of responding to this complex outbreak, which was unprecedented in the country.

5.3 Multisectoral collaboration and community engagement

Multisectoral collaboration and community engagement are integral parts of leadership (section 5.2) and must be included in strategic and work plans for prevention of re-establishment to ensure effectiveness and long-term sustainability. Formalized commitments and joint planning, monitoring and reporting are necessary to ensure accountability. For example, in Azerbaijan, Tajikistan and Uzbekistan, the water resource management sector routinely monitors and clears unwanted water bodies to reduce receptivity. These activities are part of the national prevention of re-establishment plan, jointly approved by the relevant ministries. In China, national plans for malaria elimination and prevention of re-establishment were launched jointly by 13 ministries, ensuring formalized commitment, information-sharing and cross-sector collaboration. The different roles and contributions from non-health sectors in the context of prevention of re-establishment are found in Table 3. As multisectoral collaboration coordinates efforts across sectors, strong leadership and effective management are needed. Countries and regions should develop context-specific indicators to monitor the effectiveness of multisectoral actions within national malaria strategies.

Community engagement is equally critical for prevention of re-establishment. Communities should be involved in every step, from planning to implementation and evaluation, to ensure that programmes are effective, sustainable and equitable. Communities are often the first to notice changes in receptivity, risk of importation, gaps in implementation and clusters of febrile illnesses. Their involvement provides real-time feedback, enabling managers to adapt responses quickly. Ideally, communities should be supported to take ownership of activities that mitigate risk, such as identifying and removing larval habitats, raising awareness among travellers and encouraging at-risk populations to seek health care.

Community engagement takes different forms depending on the context. Transition from malaria elimination to prevention of re-establishment may require CHWs to be well integrated into the formal health system, with proper training, supervision and support (see section 4.1.1.4).

For further guidance, readers are referred to *The comprehensive multisectoral action framework: malaria and sustainable development (58)* and the WHO *Multisectoral approach to the prevention and control of vector-borne diseases: a conceptual framework (59)*.

Table 3. Roles of non-health departments and sectors in prevention of re-establishment

Non-health departments (sectors)	Relevance to prevention of re-establishment	Contribution		
		Monitor change in receptivity	Monitor change in risk of importation	Implementation
Meteorological service	Weather forecast data concerning temperature, precipitation and extreme events	✓	N/A	N/A
Medical association	Alerting physicians about malaria risk Early referral of suspected cases and early detection of cases Engaging with private sectors	N/A	✓	✓
Agriculture	Promoting safe irrigation and agricultural methods Maintaining irrigation systems Ensuring proper usage of insecticides Planning land use, including projects that may create breeding sites Deploying migrant workers from endemic countries for agricultural activities	✓	✓	✓
Forestry	Deforestation and reforestation	✓	N/A	N/A
Immigration	Information on migrants arriving from endemic countries Collaboration on health education and case detection	N/A	✓	✓
Water resource management	Removing unwanted water bodies to eliminate potential breeding sites	✓	N/A	✓
Housing and urban–rural development	Urban planning, housing	✓	N/A	✓
Customs	Information on arrivals from endemic countries	N/A	✓	✓
Border security	Information on legal and illegal immigrants, refugees	N/A	✓	✓
Tourism	Information on people who travel to or from endemic countries Collaboration on health education and personal protection	N/A	✓	✓
Labour	Information on migrant workers, temporary workers; supporting or executing the deployment of chemoprophylaxis	N/A	✓	✓
Economic developments	Construction projects	✓	✓	✓

Non-health departments (sectors)	Relevance to prevention of re-establishment	Contribution		
		Monitor change in receptivity	Monitor change in risk of importation	Implementation
Education	Training and re-training Information on arriving student groups	N/A	✓	✓
Academic	Training and re-training, research and operational research	N/A	N/A	✓
Military services	Sharing information on malaria patients among United Nations peacekeepers	N/A	✓	✓
Communities	Intelligence on community population movements and environment, the change in receptivity and risk of importation; participating in implementation; alerting authorities or health professionals on illness clusters; evaluating implementation	✓	✓	✓
Transportation, airport, seaport	Health education and personal protection for populations at risk Supporting the rapid deployment of commodities When appropriate, implementing screening procedures for special populations or groups at risk	N/A	✓	✓
Migrant associations	Intelligence on the arrival or return of migrants Education on care seeking	N/A	✓	✓

5.4 Financing

Political commitment needs to translate into the allocation of both financial and human resources for malaria activities. While some countries have successfully eliminated malaria with support from external sources such as the Global Fund to Fight AIDS, Tuberculosis and Malaria, relying solely on such aid is not sustainable, and external funding is expected to be withdrawn. Countries must proactively design and implement transition plans with a focus on securing long-term adequate funding from national and local governments through health sector and multisectoral planning and financing approaches. For example, in Algeria, the implementation of vector control is funded by municipal governments, while in Georgia, entomological surveillance is funded by the Ministry of Agriculture. In some places, it may be an option to seek innovative financing mechanisms, for example, through public–private partnerships and social impact bonds. Suriname established funding through a public–private partnership to support its COVID-19 response. This fund is now being transitioned to support activities for the prevention of malaria re-establishment.

When malaria activities are combined with those targeting other vector-borne diseases, it is essential to regularly assess the burden of each vector-borne disease, as this may impact the allocation of resources (e.g. human resources) to malaria activities, for example during outbreaks of diseases such as dengue. In addition, periodic assessments of health system capacity to determine the optimal allocation of funding across various thematic areas, such as surveillance and outbreak response, will enable the system to adapt to changing risk patterns and ensure dynamic financial planning in response to emerging challenges such as climate change and rapid demographic shifts. While priority should be placed on securing funding for malaria activities in areas with high malariogenic potential, resources should also be available to maintain a comprehensive and robust health system nationwide to ensure early detection and timely response to malaria cases. Financing for malaria should include funding for staff training, monitoring and supervision.

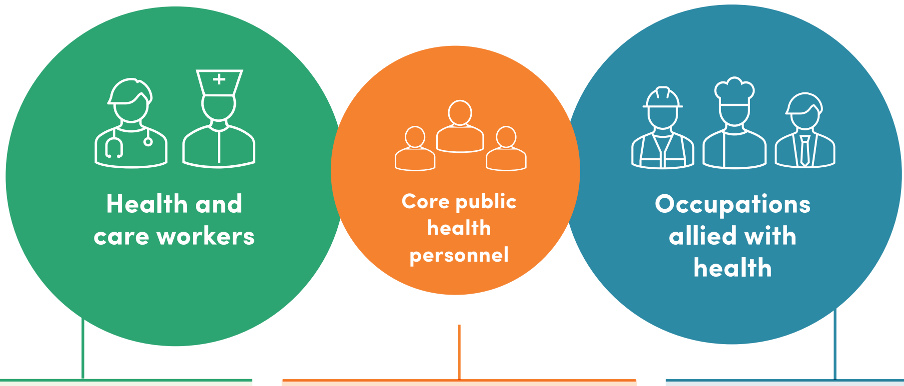
5.5 Workforce capacity for prevention of re-establishment

In most malaria-free countries, it is essential to maintain a high-level technical nucleus or core team for malaria, at least at the national level. This team should include experienced staff, such as epidemiologists and entomologists, who can oversee the quality of implementation, even if they work on multiple diseases. Maintaining experienced operational teams for surveillance, prevention and control interventions is also essential, particularly in high-risk areas. Collaboration with national research institutions can expand the programme's scope and expertise, as is done in Algeria and Belize. The functions of the core team are summarized in Fig. 6.

The competency standards for health workers involved in prevention of re-establishment, such as clinicians, laboratory technicians, entomologists, epidemiologists and vector control personnel, are similar to those required during the elimination stage. The transition from elimination to prevention of re-establishment offers an opportunity to optimize education programmes, training curricula and workforce strategies, thereby strengthening national workforce capacity. Malaria education should be integrated into medical school curricula and general practitioners' training programmes in both the public and private sectors. Physicians' refresher education should include malaria case management training. Travel medicine should be included in the PHC physicians' training curriculum (section ↗ 4.3.4). And health workers in areas with high malariogenic potential should be trained to recognize potential outbreaks.

Many countries facing the challenges of vector-borne diseases lack capacity in entomology. Developing education programmes in partnership with academic institutions can help to build this expertise. Enhancing the coordination capacity of the core team is also crucial, given the importance of collaboration with clinical services (health care workers) and non-health sectors (personnel from other allied sectors) (Fig. 6). Joint training modules and collaboration with other health programmes can enhance sustainability and reduce costs.

Fig. 6. **Public health workforce for malaria and the functions of the national malaria core team**



Health and care workers

- General health practitioners
- Specialists in infectious diseases
- Community health workers
- Lab technicians
- Nurses

Core public health personnel

- Programme manager/coordinator
- Epidemiologist
- Entomologist
- Coordinator of QA programme
- Data analyst

Occupations allied with health

Personnel from departments or sectors that contribute to PoR as in Table 3

Functions of the core team for malaria

- Develop and update national strategies and technical guidance for malaria activities.
- Oversee the implementation of activities to prevent re-establishment, including quality-assured diagnosis, case management, disease and entomological surveillance, monitoring receptivity and risk of importation, and responding to the risk.
- Identify and inform the need for multisectoral collaboration; facilitate and follow up with the implementation.
- Coordinate national training.
- Provide technical support to subnational levels on implementation.
- Convene technical advisory groups as needed.
- Convene annual reviews.
- Coordinate prompt outbreak response.

Continuous competency assessments and refresher courses are essential to maintaining workforce readiness and adapting to evolving challenges. Countries may consider licensing as an approach to upholding the competency standards of the health care workforce. For example, in Azerbaijan, malaria-related knowledge has been systematically integrated into medical re-licensing exams, ensuring that health care providers remain competent in malaria diagnosis. Similarly, Singapore's vector control law requires licensing for vector control personnel (refer to section 4.3.1).

It is recommended that countries perform a benchmarking exercise to assess the existing functions and service delivery for prevention of re-establishment, using the results from previous malaria programme reviews, certification and subnational verification. The findings can then be used for policy-making and planning *(60)*.

5.6 Procurement

Procuring small quantities of antimalarial commodities could be inefficient and expensive. Some countries, such as Malaysia, have addressed the challenge of procuring small quantities of drugs by bundling multiple orphan drugs, including antimalarial medicines, with larger quantities of other commonly needed drugs into a single procurement from one selected supplier. Inter-country or regional arrangements for procuring malaria medicines and commodities can be a viable option. It is important to maintain a stock of diagnostic tests, antimalarial drugs and insecticides. The tests and drugs may go unused; however, such an investment is necessary to maintain malaria-free status and protect public health. Countries can seek help from WHO if the challenges to procure small quantities of drugs cannot be managed.

5.7 Advisory committee on the prevention of re-establishment

Many countries established national committees or technical advisory bodies to advise on malaria elimination *(13)*. These bodies can continue to play similar roles in preventing re-establishment by providing strategic advice, oversight or technical review. In addition, such committees or groups can advocate for sustained financial and human resources and support intersectoral collaboration depending on the needs. For example, Sri Lanka established a technical advisory group to guide malaria elimination efforts, identify implementation challenges and support preparation for certification. Post-elimination, this group has continued to advise on issues related to the prevention of re-establishment. A case review subcommittee was formed under the technical advisory group to conduct monthly case review and assess the reliability of case classification *(61)*. Similarly, China has maintained a technical group to regularly review case classification and malaria-associated deaths in order to identify systemic weakness.

To ensure the effectiveness of the advisory group, countries should clearly define their functions – whether for strategic guidance, technical review or advocacy – and align the deliverables accordingly. Dedicated secretariat support should be provided by the Ministry of Health or its designated entity. Most critically, formal processes should be established to integrate the group's outputs into policy or programmatic actions, with structured feedback on implementation.

5.8 Monitoring and evaluation

As with elimination and control programmes, monitoring and evaluation is essential for assessing the effectiveness of a prevention of re-establishment programme. Since surveillance and response form the cornerstone of prevention of re-establishment, the indicators for surveillance quality used during elimination should be maintained. As clinical alertness to malaria is expected to wane, case management indicators become important and may need to be refined to identify systemic weaknesses and to promote early detection efforts. Indicators should be adapted to local contexts. For example, countries or areas might use different metrics to monitor receptivity and risk of importation and the indicators should align with such metrics. If routine vector control is implemented, specific indicators to track intervention coverage and effectiveness must be established. In countries or regions with a high number of imported cases, it may be necessary to develop indicators related to travellers' health. Indicators for outbreak preparedness might be applied to high-risk strata.

Suggested core indicators are provided in Annex 4. Countries and areas are encouraged to identify locally relevant indicators to monitor and evaluate the system to prevent re-establishment. Regular reviews of the selected indicators will help to detect gaps, optimize interventions and ensure that the goals of the programme for preventing re-establishment are achieved.

5.9 Innovation and research

Contextualizing the concepts and principles for prevention of re-establishment to sustain malaria-free status requires local evidence and knowledge, as well as new tools and methodologies. Adapting interventions and response to the risk of re-establishment at subnational levels requires implementation research. Therefore, research and operational research are integral parts of the plan for prevention of re-establishment. Research should prioritize resolving challenges to programme implementation, guide the decisions on interventions and inform the optimal use of resources. Collaboration with academic institutions, private-sector innovators and local communities, supported by necessary financial resources, is recommended. Annex 5 provides a list of key topics for research, innovation, and knowledge management for preventing malaria re-establishment, relevant to academics, policy-makers, programme managers, and implementers. These topics link to the malaria elimination/eradication research agenda *(62)*.

6 Developing a plan for prevention of re-establishment

The purpose of a prevention of re-establishment plan is to ensure the delivery of high-quality malaria curative and preventive services, prevent severe clinical consequences of malaria cases, prevent and detect local malaria transmission, and, exceptionally, contain outbreaks. The prevention of re-establishment plan is a continuation of the national elimination strategic plan. It should follow the principle of multisectoral planning, financing and management, in alignment with the national agenda on strengthening the PHC approach and EPHFs.

It is necessary to update the national plan for prevention of re-establishment regularly, for example, every three years. This will enable countries to reassess the level of receptivity, risk of importation and risk of re-establishment, update the risk stratification and adjust interventions and responses, as needed. Given regional variations in receptivity and the risk of importation, subnational prevention plans are necessary and may require more frequent updates in response to dynamic risks.

Although an operational plan for prevention of re-establishment typically covers a few years, long-term planning in health and development should consider the trends of risk of re-establishment and be designed to mitigate receptivity, risk of importation and risk of re-establishment. Planning and financing should be flexible and adaptable due to the dynamic nature of the risk of re-establishment and the challenges that may arise during integration. The prevention of re-establishment plan should focus on: maintaining a high-quality surveillance system for early detection and treatment of malaria cases; monitoring changes in receptivity and importation risk to tailor responses to local contexts; detecting and responding to outbreaks; and preventing malaria importation. The suggested components of a prevention of re-establishment plan are found in ↗ Annex 6.

Countries should perform an annual review of the implementation of the prevention of re-establishment plan, and document and disseminate the results, as was done during malaria control and elimination.

Different pathways might be followed to develop a prevention of re-establishment plan for malaria, depending on the governance structures, the available public resources, the decision-makers, and whether integration is envisioned or under way (section 5.1). Fig. 7 illustrates several common steps that may be relevant, although not all steps may be necessary depending on the context. Step 1 is applied at the national level, while Steps 2–5 are applied at both the national and subnational levels. Approach for risk stratification may be selected (Step 2) depending on the available data, resources and analytical capacity. For Step 3, the most important activity to tailor is the surveillance itself. Countries should consult the previous sections regarding decision-making and may use the following guiding questions for discussions during the tailoring process: Where should RDTs be kept and where should microscopy be maintained? Where will referrals be used to refer patients for diagnosis? Where will volunteers/CHWs be maintained? Where should the capacity for active case detection be maintained?

Fig. 7. Steps to develop a plan for prevention of re-establishment

STEP 1 Plan and prepare

- **Governments form a steering committee** and designate a focal institute or central unit to coordinate and oversee the development of the plan.
- **Identify key stakeholders** starting with those who participated in and contributed to elimination and refer to global best practice.
- **Form working groups** as necessary.
- **Seek additional external support**, particularly if integration is envisioned.

STEP 2 Convene stakeholders and perform malaria situational analysis

- **Consult current health and development policies**, such as those on PHC, EPHFs, public health workforce capacity, and plans for urbanization and environmental management.
- **Define the functions and services for prevention of re-establishment** based on global guidance and best practices.
- **Conduct a strength, weakness, opportunities and threats (SWOT) analysis of current strategies for prevention of re-establishment** using available data and assessment results. Identify missing or weak functions and services.
- **Assemble epidemiological, entomological and other data**, and perform an analysis of the level of receptivity and risk of importation.
- **Select the key indicators** to estimate receptivity and risk of importation. Analyse the distribution and trends of key indicators and implement risk stratification.

STEP 3 Optimize strategies and tailor interventions according to malariogenic potential

- **Develop strategies or policies to address missing or weak function.**
- Based on risk stratification and established criteria, **define activities for monitoring receptivity and risk of importation**, mitigating risk in each stratum, and engaging other sectors and communities in coordinated monitoring and response efforts. **Identify interventions with sustained impact.**
- **Project impacts under different scenarios and cost differences** to support efficient and equitable resource use while managing the risk. Consider phasing out unnecessary routine activities in low-risk areas (e.g. ITNs, IRS) and optimizing malaria testing networks. Make a comparison of investments on long-term impact interventions versus routine interventions maintained over time.

STEP 4 Develop an implementation plan or work plan

- **List activities** with timelines, responsible parties and budgets.
- **Prioritize maintaining capacity** and optimizing surveillance system.
- **Update outbreak preparedness and response plans.**
- **Select indicators and develop a monitoring and evaluation framework** for the prevention of re-establishment plan.
- **Develop plans for workforce capacity-building**, aligning with the national roadmap.

STEP 5 Mobilize resources and optimize

- **Assess financial and human resources.**
- **Cost activities** and develop a resource mobilization plan.
- **Perform cost–benefit analyses** to optimize the plan.

References[1]

1. World malaria report 2024: addressing inequity in the global malaria response. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/379751).
2. Epidemiological information on the status of malaria eradication. Wkly Epidemiol Rec. 1962;37(41):498–502 (https://iris.who.int/handle/10665/213397).
3. Epidemiological information on the status of malaria eradication. Wkly Epidemiol Rec. 1963;38(24):302–3 (https://iris.who.int/handle/10665/213782).
4. Declaration of Alma-Alta. Copenhagen: WHO Regional Office for Europe; 1978 (https://iris.who.int/handle/10665/347879).
5. Defining essential public health functions and services to strengthen national workforce capacity. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/376579).
6. Global technical strategy for malaria 2016–2030, 2021 update. Geneva: World Health Organization; 2021 (https://iris.who.int/handle/10665/342995).
7. Faust C, Dobson AP. Primate malarias: diversity, distribution and insights for zoonotic Plasmodium. One Health. 2015;1:66–75 (https://doi.org/10.1016/j.onehlt.2015.10.001).
8. World malaria report 2022. Geneva: World Health Organization; 2022 (https://iris.who.int/handle/10665/365169).
9. Malaria [website]. World Health Organization; 2024 (https://www.who.int/news-room/fact-sheets/detail/malaria).
10. Collins WE, Jeffrey GM. *Plasmodium malariae*: parasite and disease. Clin Microbiol Rev. 2007;20(4):579–92 (https://doi.org/10.1128/CMR.00027-07).
11. Fuehrer H-P, Campino S, Sutherland CJ. *Plasmodium brasilianum* and *Plasmodium ovale* spp.: genomic insights into distribution, dispersal and host transitions. Malar J. 2022;21(1):138 (https://doi.org/10.1186/s12936-022-04151-4).
12. Moyes CL, Henry AJ, Golding N, Huang Z, Singh B, Baird JK et al. Defining the geographical range of the *Plasmodium knowlesi* reservoir. PLoS Negl Trop Dis. 2014;8(3):e2780 (https://doi.org/10.1371/journal.pntd.0002780).
13. A framework for malaria elimination. Geneva: World Health Organization; 2017 (https://iris.who.int/handle/10665/254761).
14. Preparing for certification of malaria elimination, second edition. Geneva: World Health Organization; 2022 (https://iris.who.int/handle/10665/364535).
15. Zhou ZJ. Study of malaria control and prevention in China. Beijing: People's Hygine Publishing House; 1991.

[1] All references were accessed on 7 April 2025.

16. Molina-Cruz A, Canepa GE, Kamath N, Pavlovic NV, Mu J, Ramphul UN et al. *Plasmodium* evasion of mosquito immunity and global malaria transmission: the lock-and-key theory. Proc Natl Acad Sci USA. 2015;112(49):15178–83 (https://doi.org/10.1073/pnas.1520426112).

17. Molina-Cruz A, Raytselis N, Withers R, Dwivedi A, Crompton PD, Traore B et al. A genotyping assay to determine geographic origin and transmission potential of *Plasmodium falciparum* malaria cases. Commun Biol. 2021;4:1145 (https://doi.org/10.1038/s42003-021-02667-0).

18. Smith DL, Cohen JM, Chiyaka C, Johnston G, Gething PW, Gosling R et al. A sticky situation: the unexpected stability of malaria elimination. Philos Trans R Soc Lond B Biol Sci. 2013;368(1623):20120145 (https://doi.org/10.1098/rstb.2012.0145).

19. Li X, Snow RW, Lindblade K, Noor AM, Steketee R, Rabinovich R et al. Border malaria: defining the problem to address the challenge of malaria elimination. Malar J. 2023;22(1):239 (https://doi.org/10.1186/s12936-023-04675-3).

20. Meeting report of the WHO Evidence Review Group on the assessment of malariogenic potential to inform elimination strategies and plans to prevent re-establishment of malaria, 2–4 October 2018, Geneva, Switzerland. Geneva: World Health Organization; 2019 (https://www.who.int/publications/m/item/WHO-CDS-GMP-MPAC-2019.05).

21. Routledge I, Chevez JER, Cucunuba ZM, Gomez Rodriguez M, Guinovart C, Gustafson KB et al. Estimating spatiotemporally varying malaria reproduction numbers in a near elimination setting. Nat Commun. 2018;9(1):2476 (https://doi.org/10.1038/s41467-018-04577-y).

22. Tailoring of malaria strategies and interventions sub-nationally: a reference manual. Geneva: World Health Organization; 2025 (in press).

23. Lee YCA, Tang CS, Ang LW, Han HK, James L, Goh KT. Epidemiological characteristics of imported and locally-acquired malaria in Singapore. Ann Acad Med Singap. 2009;38(10):840–9 (https://doi.org/10.47102/annals-acadmedsg.V38N10p840).

24. Tatarsky A, Aboobakar S, Cohen JM, Gopee N, Bheecarry A, Moonasar D et al. Preventing the reintroduction of malaria in Mauritius: a programmatic and financial assessment. PLoS One. 2011;6(9):e23832 (https://doi.org/10.1371/journal.pone.0023832).

25. World Health Organization Global Malaria Programme, University of California San Francisco. Moving towards sustainable elimination in Cape Verde. Geneva: World Health Organization; 2012 (https://iris.who.int/handle/10665/75849).

26. Zhang HW, Su YP, Zhou GC, Liu Y, Cui J, Wang ZQ. Re-emerging malaria in Yongcheng city of HeNan Province. Chin J Vector Bio Control. 2007;18:42–4 (in Chinese).

27. Webster-Kerr K, Figueroa JP, Weir PL, Lewis-Bell K, Baker E, Horner-Bryce J et al. Success in controlling a major outbreak of malaria because of *Plasmodium falciparum* in Jamaica. Trop Med Int Health. 2011 Mar;16(3):298–306 (https://doi.org/10.1111/j.1365-3156.2010.02700.x).

28. Davidyants VA, Kondrashin AV, Vanyan AV, Morozova LF, Turbabina NA, Stepanova EV et al. Role of malaria partners in malaria elimination in Armenia. Malar J. 2019;18(1):178 (https://doi.org/10.1186/s12936-019-2814-y).

29. Danis K, Lenglet A, Tseroni M, Baka A, Tsiodras S, Bonovas S. Malaria in Greece: historical and current reflections on a re-emerging vector borne disease. Travel Med Infect Dis. 2013;11(1):8–14 (https://doi.org/10.1016/j.tmaid.2013.01.001).

30. Mironova VA, Shartova NV, Beljaev AE, Varentsov MI, Korennoy FI, Grishchenko MY. Re-introduction of vivax malaria in a temperate area (Moscow region, Russia): a geographic investigation. Malar J. 2020;19(1):116 (https://doi.org/10.1186/s12936-020-03187-8).

31. Malaria surveillance, monitoring and evaluation: a reference manual. Geneva: World Health Organization; 2018 (https://iris.who.int/handle/10665/272284).

32. Rios-Zertuche D, Carter KH, Panhorst Harris K, Thom M, Zuniga-Brenes MP, Bernal-Lara P et al. Performance of passive case detection for malaria surveillance: results from nine countries in Mesoamerica and the Dominican Republic. Malar J. 2021;20(1):208 (https://doi.org/10.1186/s12936-021-03645-x).

33. Azizi H, Majdzadeh R, Ahmadi A, Raeisi A, Nazemipour M, Mansournia MA et al. Development and validation of an online tool for assessment of health care providers' management of suspected malaria in an area, where transmission has been interrupted. Malar J. 2022;21(1):305 (https://doi.org/10.1186/s12936-022-04308-1).

34. Tseroni M, Georgitsou M, Baka A, Pinaka O, Pervanidou D, Tsironi M et al. The importance of an active case detection (ACD) programme for malaria among migrants from malaria endemic countries: the Greek experience in a receptive and vulnerable area. Int J Environ Res Public Health. 2020;17(11):4080 (https://doi.org/10.3390/ijerph17114080).

35. Killeen GF, Fillinger U, Kiche I, Gouagna LC, Knols BG. Eradication of *Anopheles gambiae* from Brazil: lessons for malaria control in Africa? Lancet Infect Dis. 2022;2(10):618–27 (https://doi.org/10.1016/s1473-3099(02)00397-3).

36. WHO initiative to stop the spread of *Anopheles stephensi* in Africa. Geneva: World Health Organization; 2022 (https://iris.who.int/handle/10665/363318).

37. Vector surveillance and control at ports, airports, and ground crossings. Geneva: World Health Organization; 2016 (https://iris.who.int/handle/10665/204660).

38. World Health Organization, UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases. Global vector control response 2017–2030. Geneva: World Health Organization; 2017 (https://iris.who.int/handle/10665/259002).

39. Gunasekera WMK, Premaratne R, Fernando D, Munaz M, Piyasena MGY, Perera D et al. A comparative analysis of the outcome of malaria case surveillance strategies in Sri Lanka in the prevention of re-establishment phase. Malar J. 2021;20(1):80 (https://doi.org/10.1186/s12936-021-03621-5).

40. Malaria surveillance assessment toolkit: implementation reference guide. Geneva: World Health Organization; 2022 (https://iris.who.int/handle/10665/361178).

41. Seringe E, Thellier M, Fontanet A, Legros F, Bouchard O, Ancelle T et al. Severe imported *Plasmodium falciparum* malaria, France, 1996–2003. Emerg Infect Dis. 2011;17(5):807–13 (https://doi.org/10.3201/eid1705.101527).

42. Lai S, Wardrop NA, Huang Z, Bosco C, Sun J, Bird T et al. *Plasmodium falciparum* malaria importation from Africa to China and its mortality: an analysis of driving factors. Sci Rep. 2016;6:39524 (https://doi.org/10.1038/srep39524).

43. WHO Global Logistics Center report. Geneva: World Health Organization; 2023 (https://who-global-logistic-center-report.webflow.io/).

44. Malaria microscopy quality assurance manual, version 2. Geneva: World Health Organization; 2016 (https://iris.who.int/handle/10665/204266).

45. WHO guidelines for malaria – 30 November 2024. Geneva: World Health Organization; 2024 (https://app.magicapp.org/#/guideline/LwRMXj).

46. Malaria threats map [online database]. World Health Organization; 2025 (https://apps.who.int/malaria/maps/threats/).

47. Global framework for the response to malaria in urban areas. Geneva: World Health Organization; 2022 (https://iris.who.int/handle/10665/363899).

48. Ward C, Motus N, Mosca D. A global report on population mobility and malaria: moving towards elimination with migration in mind. Geneva: International Organization for Migration; 2013 (https://migrationhealthresearch.iom.int/global-report-population-mobility-and-malaria-moving-towards-elimination-migration-mind).

49. Population mobility and malaria. New Delhi: WHO Regional Office for South-East Asia; 2017 (https://iris.who.int/handle/10665/255816).

50. Meeting report of the Evidence Review Group on border malaria, 10–11 May 2018, Geneva, Switzerland. Geneva: World Health Organization; 2018 (https://www.who.int/publications/m/item/WHO-CDS-GMP-MPAC-2018.13).

51. Lüthi B, Schlagenhauf P. Risk factors associated with malaria deaths in travellers: a literature review. Travel Med Infect Dis. 2015;13(1):48–60 (https://doi.org/10.1016/j.tmaid.2014.04.014).

52. Linares-Rufo M, Bermudez-Marval H, Garcia-Bertolin C, Santos-Galilea J, Balsa-Vazquez J, Perez-Tanoira R et al. Perspectives of primary care physicians in Spain on malaria: a cross-sectional survey and retrospective review of cases. Malar J. 2024;23(1):7 (https://doi.org/10.1186/s12936-023-04826-6).

53. Sharahili AA, Al-Eanzi F, Ghzwany AA, Alazmi AM, Alhwsawi EA. Knowledge, attitude, and practice of travel medicine among primary health care physicians in the Cluster-1, Riyadh City, Saudi Arabia: a cross-sectional study. J Family Med Prim Care. 2021;10(7):2587–93 (https://doi.org/10.4103/jfmpc.jfmpc_2354_20).

54. International travel and health: module 3: malaria. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/379612).

55. Universal health coverage [website]. World Health Organization (https://www.who.int/health-topics/universal-health-coverage).

56. Primary health care [website]. World Health Organization (https://www.who.int/health-topics/primary-health-care).

57. The 17 goals [website]. United Nations (https://sdgs.un.org/goals).

58. The comprehensive multisectoral action framework: malaria and sustainable development. New York: United Nations Development Programme; 2022 (https://www.undp.org/publications/comprehensive-multisectoral-action-framework-malaria-and-sustainable-development).

59. Multisectoral approach to the prevention and control of vector-borne diseases: a conceptual framework. Geneva: World Health Organization; 2020 (https://iris.who.int/handle/10665/331861).

60. National workforce capacity for essential public health functions: operational handbook for country-led contextualization and implementation. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/376576).

61. Datta R, Mendis K, Wikremasinghe R, Premaratne R, Fernando D, Parry J et al. Role of a dedicated support group in retaining malaria-free status of Sri Lanka. J Vector Borne Dis. 2019;56(1):66–9 (https://doi.org/10.4103/0972-9062.257778).

62. Rabinovich RN, Drakeley C, Djimde AA, Hall BF, Hay SI, Hemingway J et al. malERA: an updated research agenda for malaria elimination and eradication. PLoS Med. 2017 Nov 30;14(11):e1002456 (https://doi.org/10.1371/journal.pmed.1002456).

Annexes

Annex 1. Development process and evidence review

Annex 2. Case study: strategies and intervention packages for border malaria

Annex 3. WHO-recommended antimalarial drugs for prophylaxis in travellers

Annex 4. Core indicators for prevention of re-establishment

Annex 5. Innovation and research

Annex 6. Key components of a plan for prevention of re-establishment

Annex 1.Development process and evidence review

The main activities and their objectives in the process of developing this guidance were as follows:

- January 2023: Launch of the technical consultation on prevention of re-establishment during the fourth global forum for malaria-eliminating countries in Cape Town, South Africa; experiences and challenges for prevention of re-establishment were discussed in thematic areas with selected malaria-eliminating countries; practices, experiences and lessons learned with respect to prevention of re-establishment from China and El Salvador were reviewed and discussed.
- Formation of a working group on integration
- February 2023: Virtual meetings on prevention of re-establishment, reviewing the practices, experiences and challenges with respect to prevention of re-establishment in seven malaria-free countries: Georgia, Greece, Mauritius, Paraguay, Sri Lanka, Tajikistan, Uzbekistan.
- March 2023: Technical consultation on prevention of re-establishment: evidence review and discussed the first draft
- November 2023: Fifth meeting of the Technical Advisory Group on Malaria Elimination and Certification in Cairo, Egypt: reviewing and discussing the second draft by thematic group
- October 2024: Review of an advance draft by the Malaria Policy Advisory Group
- Country visits to selected malaria-free countries
- March 2025: Review of the near-final draft by the Technical Advisory Group on Malaria Elimination and Certification

The evidence reviewed and key contributing institutions are:

- Literature review on prevention of re-establishment (Barcelona Institute for Global Health)
- Commissioned literature review on refractoriness/susceptibility (French National Research Institute for Sustainable Development, updating the version prepared by Professor White)
- Scoping review on strengthening health systems for prevention of re-establishment (University of Essex)
- Synthesis of countries' practices and experiences with prevention of re-establishment (Barcelona Institute for Global Health)

- Commissioned case studies for prevention of re-establishment in Greece, Paraguay and Tajikistan (Barcelona Institute for Global Health and Professor Kurdova)
- Review and analysis of selected outbreaks post-malaria elimination (WHO Global Malaria Programme)
- Analysis of case and entomological data in recently certified countries to identify factors contributing to the "stability" of elimination (WHO Global Malaria Programme)
- Outcomes of the evidence reviews on border malaria *(1)* and on malariogenic potential *(2)* were considered.
- Case studies and country examples were mostly derived from published peer-reviewed journal articles or grey literature, WHO staff experiences and information shared by informants.

References

1. Meeting report of the Evidence Review Group on border malaria, 10–11 May 2018, Geneva, Switzerland. Geneva: World Health Organization; 2018 (https://www.who.int/publications/m/item/WHO-CDS-GMP-MPAC-2018.13).
2. Meeting report of the WHO Evidence Review Group on the assessment of malariogenic potential to inform elimination strategies and plans to prevent re-establishment of malaria, 2–4 October 2018, Geneva, Switzerland. Geneva: World Health Organization; 2019 (https://www.who.int/publications/m/item/WHO-CDS-GMP-MPAC-2019.05).

Annex 2. Case study: strategies and intervention packages for border malaria

Yunnan, a province in south-west China, shares a 4060 km border with Lao People's Democratic Republic, Myanmar and Viet Nam. The province has 25 border counties, which are defined as border areas in China. These areas are characterized by a tropical/subtropical climate and mountainous terrain (76.4–6740 m in altitude). Historically, malaria was highly endemic in the area, with transmission lasting over 10 months and eight *Anopheles* species identified as vectors. About 70% of the border population are rural farmers, while 30% are service workers and traders in towns.

China's health system ensures that each village has a village doctor, each township (~15 000 residents) has a hospital, and each county (~350 000 residents) has designated malaria treatment facilities. County Centers for Disease Control and Prevention oversee surveillance and response.

Yunnan shares malaria ecology and vectors with five countries in the Greater Mekong subregion. Its porous border lacks natural barriers and has many informal crossings. Ethnic groups (13 total) live on both sides, with strong cross-border ties for trade, family, education and health care. While Lao People's Democratic Republic and Viet Nam are nearing elimination, Myanmar's border areas, characterized by high malaria prevalence and civil unrest, pose significant importation risks.

Yunnan employs the "1–3–7" strategy for malaria surveillance and response and has developed the "3 + 1" strategy (Table A2.1) to address border challenges to sustain malaria elimination in border areas. These strategies focus on maintaining a high-quality surveillance system, ensuring that frontline health workers are well trained and prioritizing robust domestic systems, while supporting neighbouring countries where feasible.

Implementation is funded by the government at all levels, with additional resources allocated to border areas. Frontline health workers receive ample training, monitoring and supervision. Multisectoral collaboration, coordinated by county governments and chaired by vice governors, ensures unified and effective responses.

Table A2.1. **The "3+1" strategy for border malaria in Yunnan province, China *(1–5)***

	Target areas	Context	Goal	Interventions
Strategy 1	Border villages	Transmission focus is shared with neighbouring countries; border villages are within the flying range of mosquitoes.	Prevent spillover of malaria	• Passive case detection and proactive case detection • Entomological surveillance • Routine vector control using ITNs • Additional preventive measures such as IRS or chemoprevention depending on entomological and case data • Health education • 1–3–7 • Place RDTs in remote villages
Strategy 2	Border townships	Local population is closely related to those on the other side of the border. They frequently walk across the border and some of them, such as undocumented migrant workers or visitors of relatives and friends, are at high risk of carrying malaria infections.	Prevent introduced cases	• Passive case detection and proactive case detection • Enhanced surveillance (community engagement): village leaders or village health workers closely monitor the migrants and refer clinically suspected malaria cases to the township hospital for diagnosis and treatment • Health education • 1–3–7 • Place RDTs in remote villages
Strategy 3	Border counties	Majority areas are receptive. Risk of importation is significant. Referral system is stronger.	Prevent introduced cases	• Maintain high-quality passive case detection • Ensure referral is effective (private clinics and hospitals, pharmacies are expected to refer clinically suspected malaria cases to designated hospitals for diagnosis and treatment) • Travellers' health: information, education and communication, chemoprophylaxis • 1–3–7 (place RDTs in remote villages)
+ 1	Border areas in neighbouring countries	Malaria remains transmitted.	Reduce prevalence of malaria	Cross-border collaboration: • Support the border regions in neighbouring countries in capacity-building to control and eliminate malaria. • Provide insecticides and antimalarial drugs as required. • Provide other technical assistance. Information-sharing: cross-border meetings

References

1. Xu J-W, Lin Z-R, Zhou YW, Lee R, Shen H-M, Sun X-D et al. Intensive surveillance, rapid response and border collaboration for malaria elimination: China Yunnan's "3+1"strategy. Malar J. 2021;20:396 (https://doi.org/10.1186/s12936-021-03931-8).
2. Liu H, Zhou Y-W, Deng Y, Lin Z-R, Zhang C-L, Chen Q-Y et al. Historical review of malaria control and elimination in the border areas of China: a case study of Yunnan Province. Adv Parasitol. 2022;116:33–67 (https://doi.org/10.1016/bs.apar.2021.12.001).
3. Liu H, Zhou Y, Deng Y, Lin Z, Zhang C, Chen Q et al. Malaria from hyperendemicity to elimination along international borders in Yunnan, China during 2003–2020: a case study. Infect Dis Poverty. 2022;11:51 (https://doi.org/10.1186/s40249-022-00972-2).
4. Li X-H, Zhou H-N, Xu J-W, Lin Z-R, Sun XD, Li J-Y et al. Seven decades towards malaria elimination in Yunnan, China. Malar J. 2021 Mar 12;20(1):147 (https://doi.org/10.1186/s12936-021-03672-8).
5. Wei C, Lin Z, Yang Z, Zhou H, Zhou X, Yang R. Malaria elimination strategy and joint prevention and control of malaria across China-Myanmar border areas: an overview. Zhongguo Xue Xi Chong Bing Fang Zhi Za Zhi. 2025;37(1):19-23 (https://doi.org/10.16250/j.32.1915.2024281).

Annex 3. WHO-recommended antimalarial drugs for prophylaxis in travellers

(extracted from WHO International travel and health: module 3: malaria, 2024 update *(1)*).[1]

Generic name	Dosing regimen	Duration of prophylaxis	Use in special group	Main contraindications*
Atovaquone–proguanil combination tablet	One dose daily 11–20 kg: 62.5 mg atovaquone plus 25 mg proguanil (one paediatric tablet) daily 21–30 kg: two paediatric tablets daily 31–40 kg: three paediatric tablets daily > 40 kg: one adult tablet (250 mg atovaquone plus 100 mg proguanil) daily	Start one day before departure and continue for seven days after return.	No data, not recommended for pregnant or breastfeeding women Not recommended < 11 kg (< 5 kg in Belgium, Canada, France and the United States of America) because of limited data	Hypersensitivity to atovaquone and/or proguanil; severe renal insufficiency (creatinine clearance < 30 mL/min)
Chloroquine	5 mg base/kg weekly in one dose, or 10 mg base/kg weekly divided into six daily doses. Adult dose: 300 mg chloroquine base weekly in one dose, or 600 mg chloroquine base weekly divided into six daily doses of 100 mg base (with one drug-free day per week)	Start one week before departure and continue for four weeks after return. If daily doses, start one day before departure.	Safe for pregnant and breastfeeding women and for children	Hypersensitivity to chloroquine; history of epilepsy; psoriasis
Doxycycline	1.5 mg salt/kg daily Adult dose: one tablet of 100 mg daily	Start one day before departure and continue for four weeks after return.	Contraindicated for pregnant and breastfeeding women Contraindicated under 8 years of age	Hypersensitivity to tetracycline; liver dysfunction

[1] If the recommended drugs are not registered in the country, the other options include artemisinin-based combination therapies and perennial malaria chemoprevention.

Generic name	Dosing regimen	Duration of prophylaxis	Use in special group	Main contraindications*
Mefloquine	5 mg/kg weekly Adult dose: one tablet of 250 mg weekly	Start at least one week (preferably 2–3 weeks) before departure and continue for four weeks after return.	Safe for pregnant and breastfeeding women Not recommended under 5 kg because of lack of data	Hypersensitivity to mefloquine; psychiatric (including depression) or convulsive disorders; history of severe neuropsychiatric disease; concomitant halofantrine treatment; treatment with mefloquine in previous four weeks

Reference

1. International travel and health: module 3: malaria. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/379612).

Annex 4. Core indicators for prevention of re-establishment

Components		Indicators †	Data source	Remarks
Surveillance	1	Proportion of suspected cases tested for malaria	Surveillance data (or surveys)	Refer to sections ↗ 4.1.1 and ↗ 4.1.1.1 for monitoring methods related to this indicator or its proxy, as well as the use of the suspected case definition in clinical practice.
	2	Proportion of confirmed cases notified within a stipulated time frame (e.g. 1 day)	Surveillance data	All core variables in notification forms should be complete
	3	Proportion of confirmed cases investigated within a stipulated time frame (e.g. 3 days)	Surveillance data	All core variables in case investigation forms should be complete
	4	Proportion of confirmed cases responded to within a stipulated time frame (e.g. 7 days)	Surveillance data	As a response to a detected case, vector control or reactive case detection might be needed, as defined by national guidance
	5	Proportion of cases classified as indigenous/ introduced/imported/ induced/relapsing/ recrudescent out of all confirmed cases	Surveillance data	
	6	Proportion of cases classified with a high certainty	Operations records	As assessed by the independent case review group or its equivalent
	7	Vector occurrence (geographical distribution of malaria vectors)	Entomological surveillance data	
	8	Vector abundance (or density) (total number of adult *Anopheles* female vector mosquitoes collected per sampling method per unit time)	Entomological surveillance data	This indicator is used to assess impact of vector control interventions (if implemented), and/or to assess receptivity.
	9	Status of resistance of a vector species to an insecticide	Insecticide resistance monitoring	

Components		Indicators †	Data source	Remarks
	10	Larval habitat positivity (proportion of aquatic habitats sampled found to harbour immature *Anopheles* mosquitoes)	Entomological surveillance data	This indicator is used to measure efficacy when LSM is implemented and to assess receptivity
	11	Receptivity	Operations records; community engagement and multisectoral information-sharing	Indicators 7, 8, 10, 18 and 19 are relevant for receptivity assessment. Countries might use other information/indicators (Table 1) to assess receptivity depending on local contexts
	12	Risk of importation	Malaria case database; community engagement and multisectoral information-sharing	In addition to monitoring the number of imported cases, countries are recommended to monitor the risk of importation (Table 1).
Case management	13	Proportion of laboratories included in quality assurance/quality control programme	Operations records	
	14	Time from blood samples taken to diagnosis	Information extracted from case investigation forms	These indicators are used to monitor delay in diagnosis. Countries should define national targets , e.g. targets for indicators 14–16 should be immediate, 1 day, 1 day respectively.
	15	Time from onset of malaria symptoms to first contact with a health care provider		
	16	Time from the first contact with a health care provider to diagnosis		
	17	Proportion of malaria cases treated according to the national guidelines		This indicator should include the treatments for both uncomplicated malaria cases and severe cases.
Vector control	18	Proportion of population at risk receiving ITNs or IRS	Operations records	Indicator is relevant if IRS or ITNs are implemented. Countries should determine the at-risk population.
	19	Percentage of potential larval habitats in risk areas that are managed through environmental management or treated with larvicides or insect growth regulators	Operations records	If LSM is implemented
Prevention	20	Percentage of people who know recommended preventive measures for malaria	Surveys	Surveys should target populations at risk of malaria, such as travelers who are traveling to or arriving from endemic countries.

Components		Indicators †	Data source	Remarks
Programme indicators				
National structure	21	Existence of a national core team for malaria that oversees and coordinates the implementation of the programme for prevention of re-establishment		Functions of the core team are described in Fig. 6.
Plan for prevention of re-establishment	22	National prevention of re-establishment plan is regularly updated, costed and approved.		The plan can be integrated with health plans.
	23	Subnational prevention of re-establishment plan is established, updated annually, costed and approved.		
Workforce capacity	24	Educational and training plan is prepared annually, and resources are available for implementation.		Plan can be part of the plan for workforce capacity-building.
Outbreak preparedness and response	25	Plan for outbreak preparedness and response is developed and tested.		
	26	Simulation exercises are conducted annually in high-risk areas, and a report is prepared.		
Risk stratification	27	Risk stratification considers risk of importation and receptivity and is updated		Refer to ↗ 3.4 for the frequency of risk stratification at national and subnational levels.
Programme management	28	An annual report on the implementation of activities for prevention of re-establishment is prepared and shared with all parties concerned.		
Multisectoral collaboration	29	Malaria is included in a multisectoral collaboration mechanism at the national level, as well as at the subnational level where a risk of importation and/or re-establishment is significant.		
	30	Context-specific indicators are determined to monitor the actions from non-health ministries and sectors for prevention of re-establishment (Table 3).		For example, multisectoral meetings are convened regularly or as needed to address the malaria problem.
Cross-border collaboration	31	Cross-border collaboration activities are defined and implemented particularly when a shared transmission focus (zone) is formed with neighbouring countries/regions.		
Travellers' health	32	A comprehensive programme aimed at reducing the risk of malaria among travellers is established.		This indicator should be monitored at national level as well as in areas where importation is high.
Monitoring and evaluation	33	An annual plan for monitoring and supervision is defined; activities are undertaken, and report is available.		

Components	Indicators †		Data source	Remarks
Impact indicators				
	34	Number of indigenous cases		The target is zero for these indicators. Countries should investigate and define the factors that are associated to malaria deaths and local transmission, if they occurred.
	35	Number of introduced cases		
	36	Number of malaria deaths		

† The target of indicators that measure a percentage or a proportion should be 100%

Annex 5. Innovation and research

1. Basic and translational research
   - Development of methods that allow the assessment of infectivity of imported *Plasmodium* species to indigenous vectors.
   - Development of new tools for preventing infections: drugs for chemoprevention for high-risk populations, such as travellers, and vaccines.
   - Development of tools to permanently reduce vectorial capacity.
2. Management of the risk
   - Development of new models or frameworks to quantify the risk of malaria re-establishment.
   - Risk mapping and update: Develop user-friendly tools and platforms, or explore the existing ones (such as national malaria data repositories) to integrate data of diverse sources (e.g. epidemiological, entomological, environmental) for mapping receptivity, importation risk and malariogenic potential; these can ideally be used and easily updated by field workers.
   - Approaches: Compare different methods for estimating receptivity and importation risk, and generate evidence to guide the selection of methods.
   - Environmental management: Systematically document and synthesize experiences with environmental management (e.g. draining breeding sites, improving water storage) to reduce receptivity.
3. Innovations in health and information systems and surveillance
   - Design systems to track whether all suspected malaria cases are tested (refer to section 4.1.1.1); use artificial intelligence-driven analytics or other advanced technologies for automatic detection of clusters of imported cases (clustered in time and space) and for sending automatic alerts to relevant health professionals and managers.
4. Implementation research
   - Adaptation and use of subnational tailoring approach to define interventions mix for prevention of re-establishment.
   - Develop modelling approaches to guide the scale back of vector control and reactive case detection based on scenarios.
   - Improving adherence to chemoprophylaxis: Develop methods to enhance adherence to preventive measures among high-risk groups, such as travellers and migrants.

5. Multisectoral and cross-border collaboration:

- Case studies of multisectoral approaches: Document best practices for integrating efforts across sectors (e.g. health, environment, agriculture) to address malaria challenges, such as border malaria.
- Document experiences and best practices for cross-border collaboration to prevent re-establishment and manage shared transmission zones.

6. Integration of malaria services into health systems:

- Case studies of service integration: Document experiences and best practices for integrating malaria services into PHC systems.
- Document best practices, challenges and lessons learned with respect to integrating malaria services into the general health service.

Readers may refer to the updated research agenda for malaria elimination and eradication *(1)*.

Reference

1. Rabinovich RN, Drakeley C, Djimde AA, Hall BF, Hay SI, Hemingway J et al. malERA: an updated research agenda for malaria elimination and eradication. PLoS Med. 2017 Nov 30;14(11):e1002456 (https://doi.org/10.1371/journal.pmed.1002456).

Annex 6. Key components of a plan for prevention of re-establishment

1. Objective

2. Risk assessment and stratification:
Assess receptivity, importation risk and risk of re-establishment, including long-term trends; stratify the country according to the level of risk and tailor strategies and interventions in each stratum.

3. Surveillance and response:
Include case detection and notification; epidemiological investigation and response; entomological surveillance and targeted vector control (if implemented).

4. Case management: diagnosis and treatment

5. Prevention of malaria in travellers

6. Outbreak detection, preparedness and response

7. Intersectoral cooperation

8. Inter-country cooperation

9. Workforce capacity-building

10. Research and operational research on malaria

11. Monitoring and evaluation

12. Budget

Annexes

- **List of ministries/departments/sectors that participate in prevention of malaria re-establishment and their roles and responsibilities**
- **Implementation plan, which should specify executing parties and the sources of funding for each activity**
- **Monitoring and evaluation plan**
- **Plan to strengthen capacity of workforce for prevention of re-establishment**
- **Outbreak preparedness and response plan**

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