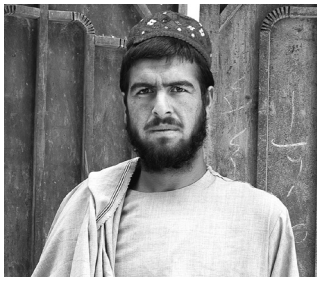
World Health Organization

GLOBAL TECHNICAL STRATEGY FOR MALARIA 2016–2030








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The definitive version of the strategy can be found in the official records of the Sixty-eighth World Health Assembly (document WHA68/2015/REC/1).

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FOREWORD

The World Health Organization's *Global Technical Strategy for Malaria 2016-2030* has been developed with the aim of helping countries reduce the human suffering caused by the world's deadliest mosquito-borne disease.

Adopted by the World Health Assembly in May 2015, the strategy provides comprehensive technical guidance to countries and development partners for the next 15 years, emphasizing the importance of scaling up malaria responses and moving towards elimination. It also highlights the urgent need to increase investments across all interventions – including preventive measures, diagnostic testing, treatment and disease surveillance – as well as in harnessing innovation and expanding research.

By adopting this strategy, WHO Member States have endorsed the bold vision of a world free of malaria, and set the ambitious new target of reducing the global malaria burden by 90% by 2030. They also agreed to strengthen health systems, address emerging multi-drug and insecticide resistance, and intensify national, cross-border and regional efforts to scale up malaria responses to protect everyone at risk.

By taking forward this strategy, countries will make a major contribution to implementing the post-2015 sustainable development framework. A major scale-up of malaria responses will not only help countries reach the health-related targets for 2030, but will contribute to poverty reduction and other development goals.

In the next 18 months, we will develop and roll out implementation plans in all WHO regions and support countries in updating their national malaria plans. We stand ready to expand our reach and increase our support to all countries irrespective of where they are along the elimination continuum.

Recent progress on malaria has shown us that, with adequate investments and the right mix of strategies, we can indeed make remarkable strides against this complicated enemy. We will need strong political commitment to see this through, and expanded financing.

We should act with resolve, and remain focused on our shared goal: to create a world in which no one dies of malaria. I remain confident that if we act with urgency and determination, we can beat this disease once and for all.





DR MARGARET CHAN

DIRECTOR-GENERAL

WORLD HEALTH ORGANIZATION

BACKGROUND

Malaria is caused by parasites of the Plasmodium family and transmitted by female *Anopheles* mosquitoes. There are four different human malaria species (*P. falciparum*, *P. vivax*, *P. malariae* and *P. ovale*), of which *P. falciparum* and *P. vivax* are the most prevalent and *P. falciparum* the most dangerous. *P. knowlesi* is a zoonotic plasmodium that is also known to infect humans.

Despite being preventable and treatable, malaria continues to have a devastating impact on people's health and livelihoods around the world. According to the latest available data, about 3.2 billion people were at risk of the disease in 97 countries, territories and areas in 2013, and an estimated 198 million cases occurred (range: 124 million–283 million). In the same year, the disease killed about 584 000 people (range: 367 000–755 000), mostly children aged under 5 years in sub-Saharan Africa.[1] In most countries where malaria is endemic, the disease disproportionately affects poor and disadvantaged people, who have limited access to health facilities and can barely afford the recommended treatment.

Between 2001 and 2013, a substantial expansion of malaria interventions contributed to a 47% decline in malaria mortality rates globally, averting an estimated 4.3 million deaths. In the WHO African Region, the malaria mortality rate in children under 5 years of age was reduced by 58%. During the same period, the global incidence of malaria was reduced by 30%.[1] Target 6.C of Millennium Development Goal 6, namely "Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases", has already been reached, and 55 of the 106 countries that had malaria transmission in 2000 are on track to achieve the goal of reducing malaria incidence by 75% by 2015, as set by the Health Assembly in 2005 in resolution WHA58.2 on malaria control.[2]

Despite this progress, the disease remains endemic in all six WHO regions and the burden is heaviest in the African Region, where an estimated 90% of all malaria deaths occur. Two countries – the Democratic Republic of the Congo and Nigeria – account for about 40% of estimated mortality due to malaria worldwide. Around the world, millions of people remain without access to malaria prevention and treatment, and most cases and deaths go unregistered and unreported. Given the projected growth in the size of the world's population by 2030, more people will be living in countries where malaria is a risk, putting further strains on health systems and national malaria programme budgets.

NEED FOR A POST-2015 TECHNICAL STRATEGY

In the early part of the 21st century, malaria received worldwide recognition as a priority global health issue. This renewed attention ended an era of neglect between the 1960s and the late 1990s, and reversed dramatic rises in malaria morbidity and mortality rates. In order to ensure that malaria trends remain on a downward trajectory, unremitting political commitment, substantial and predictable financing, and increased regional collaboration are necessary. A powerful and coordinated global

1 World malaria report 2014. Geneva: World Health Organization; 2014 (http://www.who.int/malaria/publications/world_malaria_report_2014/en/, accessed 10 March 2015).

2 Resolution WHA58.2 on malaria control. Fifty-eighth World Health Assembly, Geneva: World Health Organization; 2005 (see document WHA58/2005/REC/1, http://apps.who.int/gb/ebwha/pdf_files/WHA58-REC1/english/A58_2005_REC1-en.pdf, accessed 10 March 2015).

response together with continued investment in research and development will rid entire continents of the disease and eventually eradicate malaria from the world.

Although the implementation of core interventions expanded greatly between 2000 and 2014, the gains achieved are fragile and unevenly distributed. The human toll of malaria, and the global risk it still poses, remains unacceptably high. In many affected countries, social unrest, conflict and humanitarian disasters are major obstacles to progress. The recent outbreak of Ebola virus disease in West Africa, which affected countries that are highly endemic for malaria, has had a devastating impact on basic health service delivery, including the ability to control malaria. Recent outbreaks of malaria in countries that had been malaria-free, and resurgences in countries that have made important progress in reducing malaria morbidity and mortality rates in the past decade, highlight the continual threat of re-establishment and resurgence and the need for vigilance to ensure that these areas of transmission are promptly identified and rapidly contained.

Given the association between malaria transmission and climate, long-term malaria efforts will be highly sensitive to changes in the world's climate. It is expected that – without mitigation – climate change will result in an increase in the malaria burden in several regions of the world that are endemic for the disease, particularly in densely-populated tropical highlands. Increasing economic development, urbanization and deforestation are also expected to contribute to changes in transmission dynamics, while projected population growth in areas where malaria poses a high risk will increase the need to optimize coverage of interventions.

Malaria interventions are highly cost-effective and demonstrate one of the highest returns on investment in public health. In countries where the disease is endemic, efforts to reduce and eliminate malaria are increasingly viewed as high-impact strategic investments that generate significant returns for public health, help to alleviate poverty, improve equity and contribute to overall development.

The world has reached a critical juncture in the fight against malaria. There is both an opportunity and an urgent need to accelerate progress by reducing morbidity and mortality in all countries, by increasing the number of malaria-free countries, territories and areas, and by identifying approaches that aim to reduce transmission. Progress can be hastened through a major expansion of existing interventions, by making the response to malaria a higher technical, financial and political priority, and by ensuring that the development and use of new tools and solutions are maximized.

Efforts to prevent and control malaria contribute to and benefit from sustainable development. The objectives of reducing the disease burden and eliminating malaria are closely linked to several of the sustainable development goals being considered for the post-2015 period. Well-established linkages and factors include the contribution of malaria to the poverty cycle, the concentration of disease in vulnerable populations and those with poor access to health services, and its detrimental impact on education through missed school days and the cognitive effects of chronic anaemia.

The Malaria Policy Advisory Committee, established in 2011 to provide independent strategic advice to WHO on developing policy recommendations on malaria, recommended to the Director-General the development of a post-2015 global technical strategy on malaria. Member States at the Sixty-sixth World Health Assembly in 2013 expressed support for its preparation.[3] The strategy, adopted by the Sixty-eighth World Health Assembly in May 2015 in resolution WHA68.2, succeeds the previous WHO global malaria strategy, which was endorsed by the Ministerial Conference on Malaria (Amsterdam, The Netherlands, 1992) in the World Declaration on Malaria.

3 Summary records of the Sixty-sixth World Health Assembly, eleventh meeting of Committee A, section 1. Geneva: World Health Organization; 2013 (document WHA66/2013/REC/3) (http://apps.who.int/gb/ebwha/pdf_files/WHA66-REC3/EN/A66_REC3-en-A11.pdf, accessed 10 March 2015).

Adoption of the strategy by the Health Assembly provides the basis for ensuring that WHO is well equipped to support the completion of the unfinished health-related Millennium Development Goals agenda, which is one of the Organization's six leadership priorities for the period 2014–2019.[4]

Opportunities. Since 2000, eight countries have eliminated malaria and many others have reduced transmission to low levels. The knowledge gained from these efforts will be informative in designing programmes in the future. The next 15 years are likely to be strongly shaped by: technological advances; innovations in medicines, vaccines and vector control; and improved strategies for delivering commodities. Some of the new tools are expected to have significant additional impact, and, once validated, will need to be swiftly incorporated into national malaria responses.

Challenges. The fight against malaria is being prolonged, and in some places slowed down, by several interconnected challenges. The greatest of these is the lack of robust, predictable and sustained international and domestic financing. This is compounded by the difficulty in maintaining political commitment and ensuring regional collaboration at the highest levels. The second important challenge is biological: the emergence of parasite resistance to antimalarial medicines and of mosquito resistance to insecticides. This double threat has the potential to weaken seriously the effectiveness of malaria responses and to erode the gains recently achieved.

Other challenges that need to be met in order to accelerate progress are systemic and technical. They include: the inadequate performance of health systems, for instance weak management of supply chains and the unregulated private health sector in many countries, which allows the use of ineffective antimalarial medicines or vector control products; weak systems for surveillance, monitoring and evaluation, which compromise the ability to track gaps in programme coverage and changes in disease burden; the lack of adequate technical and human resource capacities to sustain and scale up efforts; the disproportionate risk of malaria among hard-to-reach populations, including high-risk occupational groups, migrants, people in humanitarian crises, and rural communities with poor access to health services; and the lack of adequate tools to diagnose and treat effectively infections due to *P. vivax* and other non-falciparum malaria parasites.

Another important challenge is that many people who are infected with malaria parasites remain asymptomatic or undiagnosed and are therefore invisible to the health system. Further, in some settings the density of parasitaemia is so low in a substantial proportion of individuals that it cannot be detected with current routine diagnostic tools. These people unwittingly contribute to the cycle of malaria transmission. If future disease control and elimination strategies are to succeed, they will need to take into account this large "infectious parasite reservoir". The expected development and availability over the next decade of new tools and approaches should help the detection and targeting of this reservoir and the clearing of plasmodia from asymptomatic carriers.

The emergence of drug and insecticide resistance is compounded by additional biological challenges, which need to be tackled by national malaria programmes. In some parts of the world, existing vector control tools cannot effectively protect against the disease given the diversity of malaria vectors and differences in their behaviours. In countries where both *P. falciparum* and *P. vivax* are present, the burden of disease due to *P. vivax* is more difficult to reduce because the parasite forms in the liver a dormant hypnozoite stage which is currently undetectable and leads to relapses, thereby contributing to disease transmission. In addition, human infection with zoonotic plasmodia such as *P. knowlesi* presents new challenges to malaria control and elimination.

4 WHO, Twelfth General Programme of Work 2014–2019, approved by the Sixty-sixth World Health Assembly in resolution WHA66.1. Geneva: World Health Organization; 2013 (http://apps.who.int/iris/bitstream/10665/112792/1/GPW_2014-2019_eng.pdf, accessed 10 March 2015).

This technical strategy provides a framework for the development of tailored programmes to accelerate progress towards malaria elimination. This framework should be the foundation of strategies for national and subnational malaria programmes. It defines a clear and ambitious path for countries in which malaria is endemic and their global partners in malaria control and elimination for the next 15 years. It emphasizes the need for universal coverage of core malaria interventions for all populations at risk, and highlights the importance of using high-quality surveillance data for decision-making in order to drive tailored responses consistent with national or subnational goals. The strategy identifies areas where innovative solutions will be essential for attaining its goals. It summarizes the estimated costs of implementing the strategy and provides an estimate of the research and development costs for innovative new tools.

STRATEGY DEVELOPMENT PROCESS

Following the support expressed by Member States at the Sixty-sixth World Health Assembly for the development of a global malaria strategy for the post-2015 period, the Secretariat held seven regional consultations.[5] Input was gathered from more than 400 experts representing national malaria programmes, health ministries, research organizations and implementing partners. The process, led by the Secretariat, was supported by both the Malaria Policy Advisory Committee and a dedicated Steering Committee for the Global Technical Strategy, consisting of leading malaria experts, scientists and representatives of countries in which malaria is endemic, who provided additional extensive inputs to the initial draft document. Following these consultations, a revised draft was prepared by the Secretariat for an online consultation which was open for comment between 11 July and 15 August 2014.

VISION, GOALS AND PRINCIPLES

The vision of WHO and the global malaria community is a world free of malaria. As part of this vision, the strategy sets ambitious yet feasible global targets for 2030 with milestones for measuring progress for 2020 and 2025. Countries will set their own national or subnational targets, which may differ from the global targets. The goals, milestones and targets are set out in Table 1.

These goals apply to all types of human malaria and have been developed after reviewing (1) the targets of national malaria programmes as stated in their national strategic plans, (2) the magnitude of decreases in the numbers of cases and deaths due to malaria between 2000 and 2012, as reported to WHO, and (3) the results of mathematical modelling of transmission of falciparum malaria in order to estimate the potential impact of applying different combinations of recommended interventions between 2016 and 2030.

Modelling suggests that, if coverage of malaria interventions remains at current levels, incidence could increase moderately as a result of a partial loss of malaria immunity among populations that have experienced marked reductions in transmission intensity. However, this rise and its consequences could be averted through a concerted effort to optimize the use of currently available tools, particularly vector control, at levels above 80% coverage of at-risk populations, which could significantly reduce

5 WHO Global Malaria Programme, Global Technical Strategy meeting reports. Geneva: World Health Organization; 2014 (http://www.who.int/malaria/areas/global_technical_strategy/meetings/en/, accessed 10 March 2015).

TABLE 1. GOALS, MILESTONES AND TARGETS FOR THE GLOBAL TECHNICAL STRATEGY FOR MALARIA 2016–2030

VISION – A WORLD FREE OF MALARIA

GOALS	MILESTONES		TARGETS
	2020	2025	2030
1. Reduce malaria mortality rates globally compared with 2015	At least 40%	At least 75%	At least 90%
2. Reduce malaria case incidence globally compared with 2015	At least 40%	At least 75%	At least 90%
3. Eliminate malaria from countries in which malaria was transmitted in 2015	At least 10 countries	At least 20 countries	At least 35 countries
4. Prevent re-establishment of malaria in all countries that are malaria-free	Re-establishment prevented	Re-establishment prevented	Re-establishment prevented

incidence of and deaths due to malaria. Given that reaching this level of coverage will be operationally difficult, further innovations in tools and approaches are needed for elimination of transmission in areas where transmission rates are high; they are also needed in areas and for population groups that are presently hard to reach with current interventions.

Five principles underlie the technical strategy for malaria. All countries can accelerate efforts towards elimination through combinations of interventions tailored to local contexts. Country ownership and leadership, with involvement and participation of communities, are essential to accelerating progress through a multisectoral approach. Improved surveillance, monitoring and evaluation, as well as stratification by malaria burden, are required to optimize the implementation of malaria interventions. Equity in access to health services, especially for the most vulnerable and hard-to-reach populations, is essential. Finally, innovation in tools and implementation approaches will enable countries to maximize their progression along the path to elimination.

PATH TO MALARIA ELIMINATION

Progression towards malaria-free status is a continuous process, and not a set of independent stages. Countries, subnational areas and communities are situated at different points on the path towards malaria elimination, and their rate of progress will differ and depend on the level of investment, biological determinants (related to the affected populations, the parasites and the vectors), environmental factors, the strength of health systems as well as social, demographic, political, and economic realities.

At all levels of endemicity, the risk of malaria varies significantly within a country or area, and the same strategy is not necessarily appropriate for all settings within a country. As intervention coverage is increased and malaria incidence is reduced, the heterogeneity in incidence and transmission rates is likely to further increase. A key approach to optimizing malaria responses within a country will be structuring programmes in response to stratification by malaria burden and based on an analysis

of past malaria incidence data, risk determinants related to the human host, parasites, vectors and the environment that together with an analysis of access to services.

The performance of national health systems and their adaptability to new opportunities are two of the key determinants of the rate of progress along the path. As malaria programmes reduce transmission to low or very low rates, they should shift the focus from preventing, detecting and treating clinical cases to preventing, detecting and treating every malaria infection. This change requires strengthened and sustained epidemiological and entomological surveillance systems, a requirement that can be satisfied only through substantial long-term financial and political commitment as well as significant structural and organizational changes in malaria programmes.

The first priority for all countries where transmission rates of malaria are high or moderate is to ensure maximal reduction of morbidity and mortality through sustained provision of universal access to quality-assured and appropriate vector control measures, diagnostics and antimalarial medicines, together with the implementation of all WHO-recommended preventive therapies that are appropriate for that epidemiological setting. These activities must be backed up by efficient disease surveillance systems, robust entomological and drug efficacy surveillance, as well as strong public health communication and behavioural change programmes.

In countries where the potential for malaria transmission is high, optimal application of all appropriate interventions will result in marked falls in morbidity and mortality rates, but these may not be sufficient to eliminate malaria. In these settings, additional tools will be needed to accelerate progress. Many new tools are already in development and could be available within the next five to 10 years (see section on Harnessing innovation and expanding research).

Once programmes have reduced transmission to very low levels, they should assess the technical, operational and financial feasibility of elimination and the programmatic capacity, including the ability of surveillance systems to track and manage every case of malaria infection, needed in order to eliminate every malaria infection. In addition to domestic considerations, available resources and preparedness, the situation in neighbouring countries and the risk of imported infections should be taken into account.

As programmes approach elimination or work to prevent re-establishment of transmission, all cases of malaria infection need to be detected and managed by general health services, both public and private, and reported as a notifiable disease to a national malaria registry. Patients diagnosed with malaria must be treated promptly with effective antimalarials in order to avoid preventable deaths and to decrease the probability of onward transmission in the community. In addition, entomological surveillance systems should be maintained so that appropriate vector control interventions can be introduced or modified as necessary.

STRATEGIC FRAMEWORK

In order to accelerate progress towards elimination, WHO urges affected countries and the global malaria community to maximize the impact of existing life-saving tools and strategies. Until new and improved tools and approaches become available, there is an urgent need to adopt and expand implementation of all WHO-recommended strategies so as to increase the effectiveness of responses and end preventable malaria deaths. The strategy is built on three pillars with two supporting elements that guide global efforts to move closer to malaria elimination. These are summarized below.

- **Pillar 1. Ensure universal access to malaria prevention, diagnosis and treatment.** The WHO-recommended package of core interventions – namely quality-assured vector control, chemoprevention, diagnostic testing and treatment – can dramatically reduce morbidity and mortality. In

areas of moderate-to-high transmission, ensuring universal access of populations at risk to interventions should be a principal objective of national malaria programmes. The metrics of success are the reductions in malaria case incidence and malaria mortality rates. WHO recommends implementing two sets of interventions in a complementary way: (1) prevention strategies based on vector control, and, in certain settings and in some population groups, administration of chemoprevention, and (2) universal diagnosis and prompt effective treatment of malaria in public and private health facilities and at community level. Structuring programmes in response to stratification of malaria by disease burden and including an analysis of past malaria incidence data, risk determinants related to the human host, parasites, vectors and the environment that together with an analysis of access to services will enable the tailoring of interventions to the local context and ensure efficient use of resources.

- **Pillar 2. Accelerate efforts towards elimination and attainment of malaria-free status.** Countries need to intensify efforts to reduce onward transmission of new infections in defined geographical areas, particularly in settings where transmission is low. In addition to core interventions, attaining this objective will entail targeting both parasites and vectors in well-defined transmission foci, guided by active case detection and case investigations as part of a malaria surveillance and response programme. In some settings, the achievement of elimination may require the use of medicines for prophylaxis, or other possible new approaches to remove the infectious reservoir once those are recommended by WHO. The development and adoption of innovative solutions will be essential to respond to the spread of insecticide resistance and residual transmission, and to target the hypnozoite reservoirs of *P. vivax*.

- **Pillar 3. Transform malaria surveillance into a core intervention.** Strengthening malaria surveillance is fundamental to programme planning and implementation and is a crucial factor for accelerating progress. All countries where malaria is endemic and those susceptible to the re-establishment of malaria should have an effective health management and information system in place for helping national malaria programmes to direct resources to the most affected populations, identify gaps in programme coverage, detect outbreaks, and assess the impact of interventions in order to guide changes in programme orientation. At very low levels of transmission, surveillance should trigger a locally-tailored response to every detected infection, the detection of gaps in programme coverage, declines in the effectiveness of tools, or the occurrence of outbreaks.

- **Supporting element 1. Harnessing innovation and expanding research.** In support of these three pillars, countries where malaria is endemic and the global malaria community should harness innovation and increasingly engage in basic, clinical and implementation research. Successful innovation in product development and service delivery will make a major contribution to accelerating progress. Basic research is essential for a better understanding of the parasites and the vectors, and to develop more effective diagnostics and medicines, improved and innovative vector control methods, and other tools such as vaccines. Implementation research will be fundamental to optimizing impact and cost–effectiveness, and facilitating rapid uptake in populations at risk.

- **Supporting element 2. Strengthening the enabling environment.** Strong political commitment, robust financing and increased multisectoral collaboration are key factors for further progress. To optimize national malaria

responses, an overall strengthening of health systems and improvement in the enabling environment are also crucial. Strong health systems, both public and private, are important for reducing both the disease burden and the potential for onward transmission of parasites, and enable the adoption and introduction of new tools and strategies within the shortest possible time frame. In turn, the expansion of malaria interventions can be used as an entry point for strengthening health systems, including maternal and child health programmes and laboratory services, and to build stronger systems for health information and for disease and entomological surveillance. Finally, the empowerment of communities, capacity building and supportive supervision for a strong health workforce and regulatory frameworks are important in ensuring achievement of the vision, goals and milestones in this strategy.

THREE PILLARS OF THE STRATEGY

PILLAR 1. ENSURE UNIVERSAL ACCESS TO MALARIA PREVENTION, DIAGNOSIS AND TREATMENT

The WHO-recommended package of core interventions to prevent infection and reduce morbidity and mortality comprises vector control, chemoprevention, diagnostic testing and treatment. These elements are detailed in the following paragraphs.

Vector control

Maximize the impact of vector control. Vector control is an essential component of malaria control and elimination. The capacity of vectors to transmit parasites and their vulnerability to vector control measures vary by mosquito species and are influenced by local environmental factors. Vector control must be implemented on the basis of local epidemiological and entomological data. At present, the two core, broadly-applicable vector control interventions are long-lasting insecticidal nets and indoor residual spraying.[6]

National malaria programmes need to ensure that all people living in areas where the risk of malaria is high are protected through the provision, use and timely replacement of long-lasting insecticidal nets or, where appropriate, the application of indoor residual spraying. A second core intervention should not be introduced as a means of compensating for deficiencies in the implementation of the first.[7] However, spraying may be added in certain situations in order to either prevent or mitigate resistance in areas where nets are routinely used – the decision being informed by local data. When those two interventions are deployed together, an insecticide with a different mode of action to that used on nets should be used for spraying. Supplementary methods may be appropriate in specific settings, for instance larval source

6 WHO recommendations for achieving universal coverage with long-lasting insecticidal nets in malaria control, September 2013 (revised March 2014). Geneva: World Health Organization; 2013 (http://www.who.int/malaria/publications/atoz/who_recommendations_universal_coverage_llins.pdf, accessed 10 March 2015); WHO. An operational manual for indoor residual spraying (IRS) for malaria transmission, control and elimination. Geneva: World Health Organization; 2013 (http://apps.who.int/iris/bitstream/10665/80126/1/9789241505123_eng.pdf, accessed 10 March 2015).

7 WHO guidance for countries on combining indoor residual spraying and long-lasting insecticidal nets. Geneva: World Health Organization; 2014 (http://www.who.int/malaria/publications/atoz/who-guidance-combining-irs_llins-mar2014.pdf, accessed 10 March 2015).

management where mosquitoes' aquatic habitats are few, fixed and findable.[8] Effective planning, application and monitoring of larval source management require specialized capacity that is currently lacking in most malaria programmes. This capacity needs to be built.

Numerous situations exist where transmission of malaria parasites continues even when universal coverage with insecticidal nets or spraying has been achieved.[9] For optimal impact of these interventions, programmes should ensure that vectors are exposed and susceptible to the insecticides used. Long-lasting insecticidal nets counter late-night and indoor-biting mosquitoes, and indoor residual spraying targets indoor-resting mosquitoes. This means that mosquitoes that bite in the early evening, or which are outdoor biting or resting, can evade the most frequently used interventions, leading to residual malaria transmission. Transmission can continue when people are away from houses or otherwise not under nets at the times when and places where malaria vectors prefer to bite. To maximize the impact of current vector control tools where they are appropriate, countries should implement such tools effectively and should not compromise on quality through poor implementation or use of substandard products.

Maintain adequate entomological surveillance and monitoring. To enable an effective vector control response, entomological surveillance and monitoring of coverage and impact of vector control interventions must be included in national surveillance systems. Vector control should be guided by local epidemiological and entomological data including insecticide resistance and vector behaviour. Countries should collect data across all settings, including those areas that are malaria-free but at risk of re-establishment of malaria.

Entomological surveillance must include periodic assessment of vector species present, their abundance and seasonality, time and place of biting, resting and host preference (vector behaviour), insecticide susceptibility status and underlying resistance mechanisms in order to predict vulnerability to interventions. Also essential is routine monitoring of coverage and impact of interventions, the physical condition of long-lasting insecticidal nets, the actual use of nets and their perceived usefulness by end users, and the residual effect of insecticides. The data generated should be used to inform decisions on the timing of spraying activities, contribute to net-replacement strategies, and guide the development and deployment of tools including behavioural change communication activities.

Manage insecticide resistance and residual transmission. Even though core vector control interventions continue to be effective in most areas, growing physiological resistance of mosquitoes to insecticides and the combination of vector and human behaviour that sustains continued transmission are major challenges that require an urgent and coordinated response. If left unchecked, insecticide resistance could lead to substantial increases in malaria incidence and mortality, with devastating public health consequences. All countries where malaria is endemic, including those where resistance has yet to be detected, are urged to develop and implement plans for monitoring and managing insecticide resistance.[10] Strategic use of current tools pre-

8 WHO interim position statement: the role of larviciding for malaria control in sub-Saharan Africa. Geneva: World Health Organization; 2012 (http://www.who.int/malaria/publications/atoz/interim_position_statement_larviciding_sub_saharan_africa.pdf, accessed 10 March 2015); WHO. Larval source management – a supplementary measure for malaria vector control: an operational manual. Geneva: World Health Organization; 2013 (http://apps.who.int/iris/bitstream/10665/85379/1/9789241505604_eng.pdf, accessed 10 March 2015).

9 WHO. Control of residual malaria parasite transmission: guidance note. Geneva: World Health Organization; 2014 (http://www.who.int/malaria/publications/atoz/technical-note-control-of-residual-malaria-parasite-transmission-sep14.pdf, accessed 10 March 2015).

10 WHO. Global plan for insecticide resistance management in malaria vectors. Geneva: World Health Organization; 2012 (http://apps.who.int/iris/bitstream/10665/44846/1/9789241564472_eng.pdf, accessed 10 March 2015); WHO. Test procedures for insecticide resistance monitoring in malaria vector mosquitoes. Geneva: World Health Organization; 2013 (http://apps.who.int/iris/

serves their efficacy. Methods of managing resistance include use of insecticides with different modes of action through either periodic changes (rotations) between rounds of indoor residual spraying or multiple combined interventions. Vector behaviour that compromises the effectiveness of core interventions must be tackled through the use of new tools. The cost of vector control products is a major barrier to the implementation of strategies to prevent and mitigate insecticide resistance and reduce residual transmission. Countries should better forecast vector control product requirements and support pooled procurement. Such steps should enhance manufacturers' confidence, help to stabilize the market, lead to price reductions and encourage innovation.

Strengthen capacity for evidence-driven vector control. For effective delivery and monitoring of vector control interventions, national malaria programmes need to invest in human resources and organizational and infrastructural development that will boost capacity to generate and analyse essential data.[11] A long-term strategic plan should be developed for building sustainable human resource capacity and establishing career structures and systems to ensure optimal delivery of vector control interventions. Such capacity underpins all activities for malaria control and elimination, and prevention of the re-establishment of the disease.

Implement malaria vector control in the context of integrated vector management. To maximize the impact of malaria vector control – including maintaining adequate entomological surveillance and monitoring, managing insecticide resistance and strengthening capacity for evidence-based vector control – national malaria programmes should apply the principles of integrated vector management. Integrated vector management is a rational decision-making process for the optimal use of resources for vector control. It seeks to improve the efficiency, cost–effectiveness, ecological soundness and sustainability of disease-vector control with the ultimate goal of preventing the transmission of vector-borne diseases. Countries should develop and implement national plans on integrated vector management as part of their broader strategy to control malaria. Because implementation of vector control involves different sectors, countries should also strengthen intersectoral coordination for maximum impact.

Chemoprevention

Expand preventive treatment to prevent disease in the most vulnerable groups. Preventive treatment strategies are key elements of the multipronged strategy to reduce disease burden and transmission, and they need to be substantially expanded to help countries to reduce their malaria burden. This intervention suppresses existing infections and prevents the consequences of parasitaemia, including disease and death. The strategies for preventive treatment vary, depending on the intensity of transmission and the level of parasite resistance to antimalarial medicines in a given region.

WHO-recommended preventive treatment against malaria presently includes intermittent preventive treatment of pregnant women, intermittent preventive treatment of infants, and seasonal chemoprevention for children aged under 5 years.[12] These

bitstream/10665/80139/1/9789241505154_eng.pdf, accessed 10 March 2015).

11 WHO guidance note on capacity building in malaria entomology and vector control. Geneva: World Health Organization; 2013 (http://www.who.int/malaria/publications/atoz/who_guidance_capacity_building_entomology.pdf, accessed 10 March 2015).

12 WHO. Updated WHO policy recommendation: intermittent preventive treatment of malaria in pregnancy using sulfadoxine-pyrimethamine (IPTp-SP), Geneva: World Health Organization; 2012 (http://www.who.int/malaria/iptp_sp_updated_policy_recommendation_en_102012.pdf, accessed 10 March 2015); WHO policy recommendation on intermittent preventive treatment during infancy with sulphadoxine-pyrimethamine (SP-IPTi) for Plasmodium falciparum malaria control in Africa. Geneva: World Health Organization; 2010 (http://www.who.int/malaria/news/WHO_policy_recommendation_IPTi_032010.pdf, accessed 10 March 2015); WHO policy recommendation: seasonal malaria chemoprevention (SMC) for Plasmodium falciparum

interventions are recommended in areas of moderate-to-high malaria transmission in sub-Saharan Africa, with seasonal malaria chemoprevention being recommended only in areas of highly seasonal transmission across the Sahel subregion. Preventive treatment strategies currently target falciparum malaria and need to be developed for other types of human malaria.

Protect all non-immune travellers and migrants. Chemoprophylaxis is the administration of subtherapeutic doses of antimalarial medicines at regular intervals sufficient to prevent malaria disease. Chemoprophylaxis should be given to individuals exposed to high malaria risk in combination with advice about measures to reduce vector bites, particularly non-immune travellers, who are more susceptible to malaria illness and death. It is also recommended for travellers within countries from malaria-free areas to areas with high malaria risk.

Diagnostic testing and treatment

Ensure universal diagnostic testing of all suspected malaria cases. All patients who are suspected to have malaria should have the diagnosis confirmed by parasite detection methods such as quality-assured microscopy or a rapid diagnostic test. Both public and private sector health services should confirm diagnosis before administering antimalarial treatment. Every confirmed case should be tracked and reported in the surveillance system in order to inform programme planning. Ensuring universal diagnostic testing will reduce the over-use of artemisinin-based combination therapies – the first-line treatment for uncomplicated malaria – and reduce the drug pressure on parasites.[13]

Expansion of diagnostic testing will provide timely and accurate surveillance data based on confirmed rather than suspected cases. Additionally, it will lead to improved identification and management of the many non-malarial febrile illnesses presumed to be malaria solely on the basis of the presence of fever. Expanding access to prompt diagnostic testing has lagged behind vector control prevention efforts, but strengthening diagnosis and treatment in all settings will help to reduce malaria morbidity and mortality. WHO recognizes that testing and radical treatment of vivax malaria safely and effectively currently requires two diagnoses: the presence of *P. vivax* parasites and glucose-6-phosphate dehydrogenase status.

Provide quality-assured treatment to all patients. Ensuring universal access to WHO-recommended antimalarial medicines is crucial in all settings in order to prevent the progression of uncomplicated malaria to severe illness and death. After diagnostic confirmation, every patient with uncomplicated *P. falciparum* malaria should be treated with quality-assured artemisinin-based combination therapy. In areas where chloroquine-susceptible *P. vivax* is present, uncomplicated non-falciparum malaria should be treated with either chloroquine or an artemisinin-based combination therapy known to be effective in the area . In addition to the artemisinin -based combination therapy or chloroquine, all non-pregnant adults and children with *P. vivax* or *P. ovale* who are not glucose-6-phosphate dehydrogenase deficient should receive a 14-day course of primaquine to prevent future relapse. Every severe case of malaria caused by *P. falciparum*, *P. vivax* or *P. knowlesi* should be treated parenterally with artesunate or artemether, followed by a full oral course of an artemisinin-based dombination therapy. Severe malaria requires urgent medical attention and WHO's detailed recommendations have been made available to countries[14]

malaria control in highly seasonal transmission areas of the Sahel sub-region in Africa. Geneva: World Health Organization; 2013 (http://www.who.int/malaria/publications/atoz/smc_policy_recommendation_en_032012.pdf, accessed 10 March 2015).

13 WHO. Universal access to malaria diagnostic testing: an operational manual, November 2011 (rev. February 2013. Geneva: World Health Organization; 2011 (http://whqlibdoc.who.int/publications/2011/9789241502092_eng.pdf, accessed 10 March 2015).

14 WHO. Guidelines for the treatment of malaria, Third edition. Geneva: World Health Organization; 2015 (http://www.who.int/malaria/publications/atoz/9789241549127/en/, accessed 10 June 2015); WHO. Management

Malaria programmes should develop detailed national treatment guidelines that take into account local antimalarial drug resistance patterns and health service capacities. Countries should select WHO-recommended artemisinin-based combination therapies with more than 95% efficacy demonstrated through therapeutic efficacy monitoring in local sites. Fixed-dose formulations (combining two different active ingredients co-formulated in one tablet) are strongly recommended as they facilitate adherence to treatment and reduce the potential misuse of individual components of co-blistered medicines. Oral artemisinin-based monotherapy should never be used for the treatment of uncomplicated malaria as this may promote the development of resistance to artemisinin.

Scale up community-based diagnostic testing and treatment. Training and deployment of community health workers and volunteers can substantially complement and extend the reach of public health services, particularly in rural and remote areas, where health infrastructures tend to be the weakest and malaria transmission the highest. The strategic use of community health workers and volunteers in malaria prevention and care not only bridges health system gaps, but ensures a continuum of care for the most disadvantaged populations. National malaria programmes should expand integrated community case management of malaria, pneumonia and diarrhoea, with a focus on children under 5 years of age.

Monitor safety and efficacy of antimalarial medicines and manage antimalarial drug resistance. Enhanced pharmacovigilance and surveillance of the efficacy of antimalarial medicines are essential in order to detect unexpected adverse events and reduced efficacy so that the most appropriate combinations can be selected for national treatment policies. Countries should monitor every two years the efficacy of first-line malaria therapies – against both falciparum and vivax malaria – using the standard WHO protocol for therapeutic efficacy studies.[15] A treatment failure rate exceeding 10% should prompt a change in the national antimalarial treatment policy. For the time being, artemisinin-based combination therapies remain highly effective, provided that the partner medicines remain efficacious. Caution is required, however, as the emergence of artemisinin resistance increases the risk of resistance to the partner medicines in the combination.

Contain antimalarial drug resistance. Protecting the efficacy of artemisinin-based combination therapies and developing new combinations should be a top priority for both countries where malaria is endemic and the global malaria community.[16] In countries and areas where artemisinin and artemisinin-based combination therapies continue to be fully effective, there is a need to promote correct medicine use with special attention to expanding diagnostic testing and quality-assured treatment and to extend all basic malaria interventions, including vector control, in order to reduce the potential emergence of resistance. Countries where artemisinin resistance is reported are urged to intensify malaria control in order to reduce the burden of the disease and delay or prevent spread of resistance. In areas of low transmission but where resistance to artemisinin is present, countries should target rapid elimination of falciparum malaria.

Eliminate falciparum malaria from the Greater Mekong subregion. *P. falciparum* resistance to artemisinin has emerged independently in multiple geographical locations in the Greater Mekong subregion in South-East Asia. The situation is worst along the Cambodia–Thailand border, where *P. falciparum* has become

of severe malaria: a practical handbook. Third edition. Geneva: World Health Organization; 2013 (http://apps.who.int/iris/bitstream/10665/79317/1/9789241548526_eng.pdf, accessed 10 March 2015).

15 WHO. Methods for surveillance of antimalarial drug efficacy. Geneva: World Health Organization; 2009 (http://whqlibdoc.who.int/publications/2009/9789241597531_eng.pdf, accessed 10 March 2015).

16 WHO, Roll Back Malaria Partnership. Global plan for artemisinin resistance containment. Geneva: World Health Organization; 2011 (http://www.who.int/malaria/publications/atoz/artemisinin_resistance_containment_2011.pdf, accessed 10 March 2015).

resistant to almost all available antimalarial medicines. The emergence of multidrug resistance could seriously threaten progress achieved in this region to date, and could lead to a rise in the disease burden in other parts of the world.[17] Elimination of *P. falciparum* malaria is the only strategy that can prevent the spread of resistance; this should be an urgent priority in the Greater Mekong subregion, while current tools are effective.

Remove all inappropriate antimalarial medicines from markets. All countries in which malaria is endemic should ensure that all inappropriate antimalarial medicines are removed from private sector markets. National regulatory authorities are urged to regulate against production, marketing authorization, export, import and use of oral artemisinin-based monotherapies. Countries should also take decisive steps, including surveillance and regulatory action as well as stringent follow-up, to remove ineffective antimalarial medicines from health facilities and pharmacies, including their provision through informal providers. These efforts will be crucial for preserving the efficacy of artemisinin-based combination therapies, and will make a substantial contribution to accelerating progress on the path to elimination.

All countries should aim to eliminate malaria. Attaining this objective will entail targeting both the vectors and parasites. Preventing contact between people and vectors will reduce onward transmission of new infections, while clearing the parasites from the large number of people with undiagnosed infections will speed declines in transmission. Over the next decade, new tools and approaches will become available which will help to target the infectious parasite reservoir in humans. The main technical recommendations summarized under this pillar are based on existing tools and approaches but the recommendations are expected to be expanded with 2–3 years.

PILLAR 2. ACCELERATE EFFORTS TOWARDS ELIMINATION AND ATTAINMENT OF MALARIA-FREE STATUS

Refocus programmes. Once the number of malaria cases has been reduced to low levels in a given country or subnational area, the malaria programmes' priorities and activities may need to be readjusted to complete the final phase of elimination. Thus, in addition to the interventions mentioned under Pillar 1, programmes should enhance surveillance to ensure that every infection is detected, implement targeted measures for attacking both parasites and vectors in order to interrupt local transmission, eliminate all parasites from humans, and manage the risk of re-establishment through imported malaria.

Enact legislation. New legislation is needed in order to support changes in programme prioritization, namely to ensure that the over-the-counter sale of antimalarial medicines is banned and that surveillance is further strengthened to include compulsory notification of all confirmed cases of infection detected in both public and private health care facilities. In addition, health ministries – with the support of relevant authorities – need to assume direct oversight of supply management for malaria medicines; build a centralized reporting system for epidemiological surveillance of malaria, for vector control data, outbreak reporting, and preparedness and response; and intensify coordination between public, private and community-based agencies and services.

Renew political commitment and deepen regional collaboration. The final phase of elimination needs strong political commitment, predictable long-term financing, and increased collaboration between neighbouring countries. In many coun-

17 WHO. Emergency response to artemisinin resistance in the Greater Mekong subregion: regional framework for action 2013–2015. Geneva: World Health Organization; 2013 (http://apps.who.int/iris/bitstream/10665/79940/1/9789241505321_eng.pdf, accessed 10 March 2013).

tries, there is an urgent need to expand efforts to support at-risk communities in low-transmission areas, especially in remote and hard-to-reach areas. Solutions should be found for protecting itinerant population groups and migrant workers within and across countries by informing them of the potential dangers of the disease, and providing access to prevention tools and treatment through accessible health clinics.

Reduce the number of undetected infections. Ensuring that malaria parasites are fully cleared from infected people through public health interventions will require new approaches that are not yet part of the WHO-recommended arsenal of tools. Strategies such as mass administration of medicines have been successfully used in the past, and are currently being explored in a range of transmission settings. Research is evaluating the potential role of administering transmission-blocking medicines in high-transmission settings in order to accelerate progress towards elimination. Other research is evaluating the impact and longer-term effect of administration of effective antimalarials to either an entire population or targeted population groups, including treatment of infected individuals screened for malaria parasites with highly sensitive tests.

Implement targeted malaria vector control. As transmission decreases to low levels in countries or subnational areas, universal coverage of populations at risk of malaria with vector control interventions should be maintained in most settings to prevent resurgences. For a given area, the defined population at risk will likely differ as programmes proceed along the path to elimination. A shift from universal coverage to targeting of vector control to specific populations or areas may be justified in circumstances where the inherent transmission potential is low, surveillance systems are strong, there is a high level of preparedness and the ability exists to respond quickly in the event of a resurgence. Targeted indoor residual spraying plays an important role in some settings as a response to outbreaks and resurgences, or to eliminate transmission foci. As transmission declines there may be an increased need for supplementary measures such as larval source management.

Prevent re-establishment of local malaria transmission. Even after the disease has been eliminated from a country or subnational area, continued importation of malaria cases means that the quality of case detection must remain high. Vigilance for possible renewed local transmission is a responsibility of the general health services as part of their normal function in communicable disease control, in collaboration with other relevant sectors (such as agriculture, environment, industry and tourism). Individuals who plan travel to areas where malaria is endemic should be provided with health information, chemoprophylaxis and advice about measures to protect against mosquito bites, aimed at reducing the importation of parasites. Visitors and migrants from endemic areas should be informed of the risks of malaria and given easy access to free-of-charge diagnostic and treatment facilities. Vector control must continue to be used to contain local outbreaks and protect areas that are known to be receptive to the resumption of transmission as well as exposed to frequent importation of malaria parasites. The patterns of vigilance that need to be applied in order to ensure the successful maintenance of the malaria-free status depend on the vulnerability and receptivity of an area. The programme for prevention of re-establishment of transmission has an unlimited duration. Thus, surveillance should be maintained in countries that no longer have transmission.

Implement transmission-blocking chemotherapy. Transmission-blocking chemotherapy is the use of effective antimalarial medicines to reduce the transmission of gametocytes, the sexual stage of plasmodia that are infectious to mosquito vectors, thereby interrupting the malaria transmission cycle. WHO recommends transmission-blocking chemotherapy to reduce malaria transmission, particularly in areas threatened by resistance of *P. falciparum* to artemisinin and as part of strategies

to eliminate *P. falciparum*.[18] This intervention is currently recommended in areas with low transmission and where treatment coverage is high. Transmission-blocking strategies are currently available for falciparum malaria but have not been developed for other malaria parasites.

Detect all infections to attain elimination and prevent re-establishment. In settings where the rate of transmission is very low, active detection and investigation of infections in addition to free malaria care and notification at health facilities are important for clearing residual foci of transmission.[19] Case investigations and detection of infections among people who share the living environment with someone diagnosed with malaria at a health facility will provide information on potential exposure to the same sources of infection in order to elucidate whether local transmission is occurring or if cases have been imported.

Use of medicines to reduce the parasite pool. Use of antimalarials is an element of the elimination strategy as they can eliminate the parasite pool in the treated population and, when used preventively, reduce both the pool of susceptible individuals and transmissibility of gametocytes. In the future, WHO will assess the potential role of medicines in killing mosquitoes before they are able to transmit malaria parasites, and their potential role in treating all infections regardless of clinical symptoms or health-seeking behaviour. In work aimed at elimination, all patients with laboratory-confirmed vivax or ovale malaria should be treated with a regimen for a radical cure to clear all remaining hypnozoites, which could later cause a relapse.

Devise *P. vivax*-specific strategies. For elimination to succeed, greater attention must be given to *P. vivax*, a parasite less well understood than *P. falciparum*. Vivax malaria presents multiple challenges and needs specific strategies. The challenges include the following:

- *P. vivax* tolerates a wider range of environmental conditions than *P. falciparum* and therefore has a wider geographical range;
- *P. vivax* can be transmitted from humans to mosquitoes before infected people develop symptoms;
- conventional vector control methods (long-lasting insecticide-treated nets and indoor residual spraying) may be less effective against *P. vivax* because, in many areas where *P. vivax* predominates, vectors bite early in the evening, obtain blood meals outdoors and rest outdoors;
- dormant hypnozoites are more difficult to detect because the parasitaemia is typically low and because the dormant hypnozoites residing in the liver cannot be detected with existing diagnostic tests;
- hypnozoites can give rise to multiple relapses and contribute to significant morbidity and onward transmission;
- *P. vivax* hypnozoites can only be eliminated through a 14-day course of primaquine, which can produce serious side effects (haemolytic anaemia) in patients who have glucose-6-phosphate dehydrogenase deficiency, and such treatment is contraindicated in vulnerable population groups such as infants and pregnant or breastfeeding women;

18 WHO. Updated WHO policy recommendation: single dose primaquine as a gametocytocide in Plasmodium falciparum malaria. Geneva: World Health Organization; 2012 (http://www.who.int/malaria/pq_updated_policy_recommendation_en_102012.pdf, accessed 10 March 2015).

19 WHO. Disease surveillance for malaria elimination: an operational manual. Geneva: World Health Organization; 2012 (http://apps.who.int/iris/bitstream/10665/44852/1/9789241503334_eng.pdf, accessed 10 march 2015); WHO. Policy brief on malaria diagnostics in low-transmission settings. Geneva: World Health Organization; 2014. (http://www.who.int/malaria/publications/atoz/policy-brief-diagnosis-low-transmission-settings/en/, accessed 10 March 2015).

- testing for glucose-6-phosphate dehydrogenase deficiency is challenging and not available in many settings;
- chloroquine-resistant vivax malaria is spreading.

Use surveillance as an intervention in elimination programmes. As malaria programmes progress towards elimination, the aim of surveillance is to detect all malaria infections, whether symptomatic or not; to investigate each individual case of infection, differentiating imported cases from those acquired locally; and to ensure that each detected case is promptly treated in order to prevent secondary infections. Although infections occur sporadically or in distinct foci, surveillance systems must cover an entire country, with particular attention to areas with ongoing or a recent history of transmission. Countries should monitor imported infections, which represent a significant proportion of all infections in the elimination phase and may pose a risk for re-establishment of transmission in areas in which it had previously been interrupted.[20]

PILLAR 3. TRANSFORM MALARIA SURVEILLANCE INTO A CORE INTERVENTION

Irrespective of where countries are on the path to elimination, surveillance of malaria should be upgraded to a core intervention in national and subnational malaria strategies. Surveillance as an intervention encompasses tracking of disease and programmatic responses and taking action in response to data received. At present, most high-burden countries are not in a position to capture essential malaria data on a continuing basis, thereby making it difficult to optimize responses, assess disease trends and respond to outbreaks. Surveillance may function most intensively as an intervention when programmes are closest to elimination, but effective surveillance is required at all points on the path to elimination. The benefits of effective surveillance and the actions needed to transform surveillance are described below.

Strong malaria surveillance enables programmes to optimize their operations, by empowering programmes:

- to advocate investment from domestic and international sources, commensurate with the malaria disease burden in a country or subnational area;
- to allocate resources to populations most in need and to interventions that are most effective, in order to achieve the greatest possible public health impact;
- to assess regularly whether plans are progressing as expected or whether adjustments in the scale or combination of interventions are required;
- to account for the impact of funding received and enable the public, their elected representatives and donors to determine if they are obtaining value for money;
- to evaluate whether programme objectives have been met and learn what has worked and not worked so that more efficient and effective programmes can be designed.

Surveillance in areas of high transmission. Data analysis and programme monitoring are based on aggregate numbers, and actions are undertaken at a population level to ensure that all populations have access to services and there are no

20 WHO. Disease surveillance for malaria elimination: an operational manual. Geneva: World Health Organization; 2012 (http://apps.who.int/iris/bitstream/10665/44852/1/9789241503334_eng.pdf, accessed 10 March 2015).

adverse disease trends.[21] Accurate and timely information on numbers of and trends in malaria-associated deaths is a key requirement for tracking the progress of malaria control. Concerted efforts should be made to ensure that all admissions for malaria to hospitals and health centres and deaths from malaria therein are confirmed by a parasitological test and reported through a national surveillance system. The representativeness of hospital data should be characterized in selected sites with well-defined catchment populations and that continuously track the cause of death.

Surveillance in areas of low transmission. In areas where rates of transmission are low or moderate, there is appreciable heterogeneity in the distribution of malaria and it becomes increasingly important to identify the population groups most susceptible to disease, and to target interventions appropriately. Malaria can be concentrated in marginalized populations, such as those living in remote or border areas, itinerant and migrant workers, and tribal populations with limited access to services. It may be necessary to take diagnostic testing and treatment services directly to populations without access to services (i.e. to undertake proactive case detection and treatment). As the immunity of populations at risk wanes as interventions take effect, it is important for programmes to be vigilant against potential outbreaks, with intensified reporting (e.g. weekly) of the incidence of infections and the monitoring of major determinants of transmission, such as meteorological data.

Surveillance in areas targeted for elimination of malaria. Malaria-specific reporting systems are increasingly needed to satisfy the additional information demands for targeting and monitoring interventions in particular risk groups and foci. As progress is made towards elimination, it becomes necessary to investigate individual cases of infection or clusters of cases in order to understand risk factors and eliminate foci of transmission. It also becomes increasingly important to ensure that surveillance systems capture data on cases detected by private sector care providers, both formal and informal. Increasing resources and capacity are required to run and maintain malaria surveillance systems that become more complex and resource-intensive in moving to the elimination phase, and additional skills, training and activities will have to be provided for the personnel involved. Strong surveillance systems need to be maintained to sustain the status of elimination once it is achieved; countries also need to monitor the risk of importation (vulnerability) and the transmission potential in risk areas (receptivity).[22]

Invest in routine information systems. Routine information systems are crucial for surveillance at all stages of malaria control and form the basis for monitoring of malaria programme activities. Sufficient investments must be made in the management and use of data from improved routine information systems in order to generate the information needed for programme planning, implementation and evaluation. Adequate financial and logistical support is needed for provision of office supplies and equipment, training and retraining of staff, supervision of health facilities, and communications. Data reporting requires management with quality controls in place and good follow up. Building the technical capacity of staff for data analysis and interpretation is the overriding need in order to enable programmes to use surveillance information most effectively.

Collect necessary data for understanding disease trends and overall programme performance. Necessary information includes data on resources available for malaria control (programme financing, staff and commodities), existing levels of service provision (access to services and intervention coverage), and trends in health services utilization. It also covers data on populations affected, including malaria

21 WHO. Disease surveillance for malaria control: an operational manual. Geneva: World Health Organization; 2012 (http://apps.who.int/iris/bitstream/10665/44851/1/9789241503341_eng.pdf, accessed 10 March 2015).

22 WHO. Disease surveillance for malaria elimination: an operational manual. Geneva: World Health Organization; 2012 (http://apps.who.int/iris/bitstream/10665/44852/1/9789241503334_eng.pdf, accessed 10 March 2015).

parasite prevalence rates and factors that are associated with a higher risk of acquiring malaria. Multiple sources of data include routine information systems (to track finances, commodity flows, service delivery, and disease trends), health facility surveys (to track implementation of services delivered by health facilities), household surveys to track programme coverage and parasite prevalence (in populations), and findings of implementation research. Entomological monitoring systems are required to update information periodically on vectors and their behaviour and susceptibility to insecticides. Therapeutic efficacy studies are essential for detecting resistance to antimalarial medicines. The weight given to different data sources will vary according to the level of malaria transmission and the maturity and capacities of a malaria programme.

Develop national strategic plans that take into account the epidemiology and heterogeneity of malaria in a country. As intervention coverage is increased and malaria incidence is reduced, the heterogeneity in incidence and transmission rates increases. A key approach to optimizing malaria responses within a country or territory will be stratification, in which a country or area is divided into smaller units where different combinations of interventions may need to be delivered. National strategic plans should take into account the readiness of health systems to expand malaria programmes and identify the resources required to achieve intended levels of coverage and impact. They should define the role of different stakeholders in the implementation of the plan and set targets for monitoring progress and ensuring accountability.

Monitor the implementation of national malaria strategic plans at regular intervals. In particular, annual reviews should be undertaken before budgets are prepared; mid-term reviews may be conducted to assess interim progress; and a final programme review should be undertaken before development of the next strategic plan. Feedback showing the status of selected key indicators should be communicated to districts and health facilities on a monthly or quarterly basis and include private health facilities. It is important that data are summarized in ways that staff in health facilities and districts can readily assess the facilities' performance. Programme monitoring and surveillance should not be confined to malaria programme managers and implementers. Other government departments, elected leaders, community members and donors have a stake in ensuring high quality malaria programmes and need to be able to scrutinize the operations they are supporting. If involved in the review process, they can help to ensure that malaria programmes are responsive to populations' needs and that malaria control and elimination are promoted as a development priority.

Ensure the surveillance system is monitored. Routine health information systems and well-functioning disease surveillance enable programmes to monitor malaria financing, intervention coverage and disease trends. It is important that performance of the surveillance system itself is also monitored through metrics such as the percentage of health facilities submitting monthly reports, the proportion of health facilities receiving quarterly feedback, and, in the advanced phase of malaria elimination, the proportion of cases and deaths investigated. Other important characteristics that should be evaluated periodically include timeliness, accuracy, representativeness and validity. Monitoring the surveillance system itself will identify weaknesses and enable actions to be taken to improve surveillance, which in turn can improve the performance of the malaria programme and accelerate progress towards malaria elimination.

SUPPORTING ELEMENTS

SUPPORTING ELEMENT 1. HARNESSING INNOVATION AND EXPANDING RESEACH

Important new tools are expected to become available within the lifetime of this strategy. These include new and more effective medicines, new combinations of medicines, improved diagnostics, new vaccines, new insecticides and other innovative vector control tools. Until new tools are available, programmes should undertake implementation research to refine approaches to applying existing interventions most effectively and efficiently in local contexts. Implementation research will need to focus in particular on population coverage and compliance in the short and long terms as well as human resource issues. These studies should be so designed as to provide results of sufficient quality to provide evidence for policy recommendations. As candidate tools and approaches become available, they will be reviewed and advised upon by WHO and national regulatory bodies. Countries should ensure the existence of a regulatory environment that facilitates rapid assessment, and appropriate uptake of validated tools is critical. Bottlenecks to the introduction of new tools must be identified through implementation research and removed early in order to facilitate immediate use once the evidence-base is available to define the appropriate conditions for their deployment. The priorities in five different areas are outlined below.

Vector control

Numerous potential tools and approaches are under development for overcoming the specific challenges of vector insecticide resistance and residual transmission. These include new insecticides, formulations or methods of application, new attractants and repellents, new bioactive agents (e.g. fungi or endo-symbionts), new mosquito life-cycle targets (e.g. sugar feeding, mating or oviposition phases), and genetically-modified mosquitoes. New strategies are also being explored to improve the delivery of interventions, such as the novel use of mobile-phone technology and digital mapping. Tools are also needed for protection of people when they are outside of homes protected by core interventions owing to occupational or other reasons.

The improvement of existing core vector control interventions is a priority area that requires further attention, given the expected continued large expenditures on these tools. Beside the integration of new active ingredients into these interventions, the development and validation of nets with improved or prolonged residual effect and physical integrity as well as usefulness are important. Countries should therefore continue to implement operational research to improve access, ownership and usage of nets and quality and uptake of indoor residual spraying, including components of behavioural change communication.

It is vital that options are urgently explored to ensure timely and affordable access to improved vector control tools, including those to mitigate insecticide resistance and residual transmission. Countries and the global community must work with industry and research institutions to identify and validate markers of insecticide resistance, assess the extent and drivers of residual transmission, and evaluate candidate tools. Clear definition of the evidence needed to validate new tools is required along with a recognized process for recommending programmatic implementation.

Quality assurance of existing and new vector control products and equipment is crucial for sustained efficacy and safety. As global and national capacity to conduct quality control assessments is currently limited, countries must invest in building sufficient expertise and necessary facilities.

Diagnostic testing and treatment

Research is required to develop tools that can more readily detect low-level parasitaemia in asymptomatic carriers and ascertain the effectiveness of different screening strategies both at higher transmission levels, in order to appropriately target interventions, and when countries enter the elimination phase. Better species-specific point-of-care rapid diagnostic tests are needed for all non-falciparum malaria parasites, and diagnostics for hypnozoites of *P. vivax* are needed.

Simple, point-of-care rapid diagnostic tests are needed to establish the glucose-6-phosphate dehydrogenase status of individuals in order to expand access to treatment of vivax malaria with 8-aminoquinoline antimalarials.

A robust pipeline of new candidate therapeutic agents is required because the long-term usefulness of any medicine or combination is threatened by the emergence and spread of resistance. The ideal combination would be a safe, effective and affordable single-dose treatment that can produce radical cure, reduce transmissibility of gametocytes, with prophylactic effect for both *P. falciparum* and *P. vivax* infections, and can be used during pregnancy and in people with glucose-6-phosphate dehydrogenase deficiency. New regimens of medicines that are safe, well-tolerated, affordable, avoid promoting resistance and demonstrate broad spectrum of activity need to be developed for treatment of confirmed clinical cases and for potential mass use against the parasite reservoir, including the sexual stages of both *P. falciparum* and *P. vivax*. New regulatory pathways will need to be created to develop novel chemoprophylactic agents as well as clear research strategies for developing antimalarial medicines for preventive treatment.

Reliable and easily applied and interpretable tests for molecular markers of drug resistance for all components of medicine combinations are urgently required. The identification and validation of molecular markers will improve our ability to monitor the emergence and spread of resistance to each medicine compound individually. In addition to molecular markers detecting resistance of *P. falciparum*, markers are also needed to detect resistance of *P. vivax*. The monitoring of molecular markers for drug resistance, once they become available, will be useful particularly in areas of low transmission where therapeutic efficacy studies are becoming increasingly difficult to perform.

Context-specific strategies are required to understand better the treatment-seeking behaviours of people in regions with continuing transmission in order to increase demand for treatment, testing and recommended therapy. Innovative methods should be devised in order to ensure that both public and private providers, and those outside the formal health system, adhere to standard guidelines for detecting, treating and recording all malaria cases.

Malaria vaccines

Malaria vaccines are expected to be an important addition to the arsenal of tools in the future. Several vaccine candidates, with different modes of action, are currently in various stages of development to prevent *P. falciparum* and *P. vivax* infections. At least one of these (RTS,S) is close to licensure and review for policy recommendation. The global health community has called for the development and licensing, by 2030, of malaria vaccines with protective efficacy of at least 75%. Malaria vaccines are currently envisaged as a complementary tool that should not replace the core package of interventions.

Surveillance

Advances in information technology and communications offer prospects of increased timeliness of reporting, better sharing of data (between information systems and different levels of a health system) and enhanced data analyses. Information technology

can be applied to optimize and improve procurement and supply management, early warning systems, and the mapping of gaps in service delivery. Moreover, adoption of new technologies should offer the chance to improve management of systems and strengthening capacities and the human resources involved.

Efforts are needed to enable better sharing of results of interventions and drug-sensitivity testing and information about advances in surveillance and research that are often generated and held by multiple institutions. All agreements for research or service delivery should include a provision for data-sharing, possibly through open-access portals.

Research is needed to identify which strategies are most effective in detecting cases, and to assess the effectiveness of response packages once cases have been detected.

Elimination

Research is required to define the range of transmission settings in which reducing transmission by targeting the parasite reservoir is an effective intervention. This research will need also to define optimum combinations of approaches and to optimize intervals between treatments and methods for monitoring the effectiveness of this intervention. The latter includes assessment of highly sensitive submicroscopic diagnostic assays for detecting both *P. falciparum* and *P. vivax* parasitaemia.

Relapses of infection with *P. vivax* contribute to a significant proportion of transmission of vivax malaria from its hypnozoites in the liver. Strategies aimed at this parasite reservoir need to be developed as part of vivax elimination strategies, including those for people not eligible for primaquine therapy.

Basic research is needed to develop new tools to prevent transmission, including vaccines that target different stages of the parasite life cycle and may be effective in preventing all infections, or by directly targeting the sexual stages and preventing infection of and from mosquitoes.

SUPPORTING ELEMENT 2. STRENGTHENING THE ENABLING ENVIRONMENT

Malaria interventions need to be embedded in, and supported through, a strong enabling environment that can ensure that efforts are expanded in an effective and sustainable manner. The main activities to contribute to this enabling environment are as follows.

Increase international and domestic financing. There is an urgent need to increase and sustain high-level political commitment and the availability of predictable and long-term financing for malaria programmes. International donors are encouraged to maintain and increase commitments to malaria goals and programmes; new financing solutions should be conceived to tap into emerging development financing and private sector resources. Countries where malaria is endemic are urged to increase the domestic resources directed to strengthening health systems and combating the disease. Robust and predictable financing is also essential to sustain recent successes: if countries were to fall back on existing levels of intervention coverage, because of lack of funding, some of the recent gains in global malaria efforts could be lost. Maintenance of robust malaria programmes and capacities is paramount at every step along the path to elimination and in preventing re-establishment of transmission.

Ensure robust health sector response. In many countries in which malaria is endemic, inadequate health system capacities are a major obstacle to further progress and acceleration. Substantial investments are needed to strengthen health systems, particularly basic health infrastructures, commodity-delivery systems, pharmaceutical

regulation, human resources, and vital registration systems in order to improve the environment in which national malaria programmes operate. Strong collaboration between malaria programmes and other health programmes – such as reproductive health, maternal and child programmes, laboratory services and regulatory authorities (for diagnostic devices, medicines and insecticides) – is essential for the successful implementation of malaria interventions.

Strengthen health workforce and malaria expert base. In most countries where malaria is endemic, there is a chronic shortage of skilled health professionals, clinical practices are outdated, surveillance systems are inadequate, and monitoring and evaluation programmes are weak. Malaria programmes operate in a complex environment, with a continuous need to adjust responses in line with outbreaks and resurgences, changing transmission patterns, and development of drug and insecticide resistance. Robust expansion of malaria interventions requires significantly expanded human resource capacities at national, district and community levels. The education, training and motivation of health workers, programme staff and malaria researchers – including adequate mentoring, supervision, and compensation – is the key to ensuring programme effectiveness. There are several new tools on the horizon, whose introduction will require new skills and even further investments in capacity building. A strengthening of the workforce should be recognized as an essential part of health systems strengthening.

Ensure the sustainability of malaria responses. To do this and to maximize the potential of malaria investments, national malaria strategic plans should be embedded in a broader health systems approach. A stronger focus on improved supply chains for quality-assured diagnostics, medicines and vector control tools, well-planned procurement, the harnessing of new technologies for data collection and management, and better regulation and oversight of the activities of private sector pharmaceutical vendors are all crucial to making systemic improvements. High-quality and efficient provision of malaria prevention and care – in both the public and private health sectors – will benefit from, and help to build, stronger health systems.

Improve government stewardship and cross-border collaboration of malaria programmes. Given the large number of stakeholders and the important role in malaria programmes of development partners, private industry, research and academia, private sector health facilities, nongovernmental organizations and community health workers, national public health programmes in countries in which malaria is endemic should improve their overall coordination of the work on malaria. Effective cross-border collaboration between national programmes must be initiated and strengthened in order to ensure optimal coverage of intervention in these areas. National programmes should ensure that all work on programme implementation and elimination is fully in line with national strategic priorities and complies with WHO recommendations, and that appropriate regulatory frameworks exist to ensure safe use of quality-assured tools by appropriately trained personnel.

Strengthen multisectoral collaboration. Collaboration with non-health sectors needs to be augmented. National malaria programmes should become an integral part of poverty-reduction strategies, national development plans and regional development cooperation strategies. The response should be elevated from a single-disease approach to a health-in-all-policies approach. The engagement of ministries of finance, education, environment, industry, transport and tourism is especially important, as is the active contribution of regulatory authorities. For vector control, integrated vector management sometimes offers the appropriate platform for efficient delivery of interventions.

Encourage private sector participation. The private health sector, including industry, health facilities and other actors, has a vital role in the development and delivery of commodities and services, for instance through the development of new tools and interventions and bringing them to market. A stronger engagement will be essential to improve the quality of interventions, including formal and informal

private sector provision of patient care and the appropriate reporting to the national surveillance systems of all malaria cases, treatment outcomes and deaths. New and improved partnerships are needed to improve the supply chain for commodities. These partnerships can also play an important role in protecting workers who are recruited for major development projects and treating those who become infected.

Empower communities and engage with nongovernmental organizations. Close collaboration with community leaders and nongovernmental implementing partners is an essential factor for success. Malaria interventions cannot succeed unless communities adopt governmental guidance on the use of prevention tools and recommended therapies. Integrated, people-centred, community services are needed, and these should be introduced in coordination with health care providers in the public and private sectors. Populations living in remote or hard-to-reach areas and with limited access to health facilities can only be supported through community-based approaches, often in partnership with nongovernmental implementing partners. Well-planned public health communication and behavioural change programmes are essential to educating affected communities about the benefits, and correct use, of malaria prevention tools.

COST OF IMPLEMENTING THE GLOBAL TECHNICAL STRATEGY

To achieve the milestones and goals set out in this strategy, malaria investments, including both international and domestic contributions, need to increase substantially above the current annual spending of US$ 2.7 billion. The annual investment will need to increase to an estimated total of US$ 6.4 billion per year by 2020 to meet the first milestone of 40% reduction in malaria incidence and mortality rates. This should then be further increased to an annual investment of an estimated US$ 7.7 billion by 2025 to meet the second milestone of a 75% reduction. To achieve the 90% reduction goal, the total annual malaria spending will need to reach an estimated US$ 8.7 billion by 2030. The cost of implementation has been estimated from the quantities of goods required for expanding interventions, multiplied by the estimated unit cost for the provider of delivering each intervention, and an analysis of surveillance and financing data available in national strategic plans and WHO's annual world malaria reports.[23] Additional funding of an average of US$ 673 million (range: US$ 524 million–822 million) will be needed annually for research and development. This estimate stems from a risk-adjusted portfolio model of malaria research and innovation needs until 2030.

MEASURING GLOBAL PROGRESS AND IMPACT

Global progress in reducing mortality and morbidity and finally eliminating malaria will be based on countries' surveillance efforts. Progress will be measured using multiple data sources, including routine information systems, household and health facility surveys and longitudinal studies. Progress should be monitored through a minimal set of 14 outcome and impact indicators (see Table 2) drawn from a larger set of

23 All world malaria reports can be downloaded from: http://www.who.int/malaria/publications/world_malaria_report/en/ (accessed 10 March 2015).

indicators recommended by WHO and routinely tracked by malaria programmes. Certain indicators are applicable only to subsets of countries, which are defined by levels of malaria endemicity (e.g. intermittent preventive treatment of malaria for pregnant women in sub-Saharan Africa) or by the position on the path to elimination (e.g. investigation of cases and foci for programmes engaged in malaria elimination activities). For other indicators, such as those for vector control, the population at risk who may benefit from the intervention may be defined differently for programmes at different points along the path to elimination. Countries should ensure that a baseline for at least these 14 indicators where appropriate is available for 2015 so that it is possible to monitor progress through the course of the strategy.

TABLE 2. INDICATORS FOR THE POST-2015 GLOBAL TECHNICAL STRATEGY FOR MALARIA 2016–2030

OUTCOME

- Proportion of population at risk who slept under an insecticide-treated net the previous night
- Proportion of population at risk protected by indoor residual spraying within the past 12 months
- Proportion of pregnant women who received at least three or more doses of intermittent preventive treatment of malaria while attending antenatal care during their previous pregnancy (sub-Saharan Africa only)
- Proportion of patients with suspected malaria who receive a parasitological test
- Proportion of patients with confirmed malaria who receive first-line antimalarial treatment according to national policy
- Proportion of expected health facility reports received at national level
- Proportion of malaria cases detected by surveillance systems
- Proportion of cases investigated (programmes engaged in elimination)
- Proportion of foci investigated (programmes engaged in elimination)

IMPACT

- Parasite prevalence: proportion of the population with evidence of infection with malaria parasites
- Malaria case incidence: number of confirmed malaria cases per 1000 persons per year
- Malaria mortality rate: number of malaria deaths per 100 000 persons per year
- Number of countries that have newly eliminated malaria since 2015
- Number of countries that were malaria-free in 2015 in which malaria was re-established

ROLE OF THE SECRETARIAT

The Secretariat will continue to provide support to Member States and work closely with organizations in the United Nations system, donors, intergovernmental organizations, institutions of research and academia and all other technical partners whose work is fundamental to a successful implementation of this strategy. The Secretariat will undertake the following activities to help to achieve global, regional and national targets for malaria control and elimination.

The Secretariat will continue to set, communicate and disseminate normative guidance, policy advice and implementation guidance to support country action. It will

ensure that its policy-setting process – which includes the Malaria Policy Advisory Committee – is responsive to the rapidly changing malaria context and that its global technical guidance is regularly updated to incorporate innovative tools and strategies that are proven effective. The Secretariat will continue to assess and pre-qualify vector control products, diagnostics and antimalarial medicines.

The Secretariat will provide guidance and technical support to Member States in reviewing and updating their national malaria strategies in line with the priority actions outlined in this strategy. It will ensure that its own capacities are strengthened at the global, regional and country level to enable it to lead a coordinated global effort to reduce the disease burden by at least 90% by 2030, and to support the implementation of all recommendations in this strategy. It will work with Member States to develop regional implementation plans, where appropriate.

The Secretariat will support countries in strengthening their national malaria surveillance systems in order to improve the quality, availability and management of malaria data, and to optimize the use of such data for decision-making and programmatic responses. It will monitor implementation of the strategy and regularly evaluate progress towards the milestones and goals set for 2020, 2025 and 2030. It will also provide support to countries for developing nationally appropriate targets and indicators to facilitate the subregional monitoring of progress.

In line with its core roles, the Secretariat will continue to monitor regional and global malaria trends, and make these data available to countries and global malaria partners. It will support efforts to monitor the efficacy of medicines and vector control interventions, and – to this end – maintain global databases for efficacy of medicines and insecticide resistance. It will regularly report to the regional and global governing bodies of the Organization, the United Nations General Assembly, and other United Nations bodies.

WHO will promote the research and knowledge generation that is required to accelerate progress towards a world free of malaria.

The strategy will be updated at regular intervals in order to ensure linkage with the latest policy recommendations and complementary technical guidance.

GLOBAL TECHNICAL STRATEGY AT A GLANCE

VISION – A WORLD FREE OF MALARIA

GOALS	MILESTONES		TARGETS
	2020	2025	2030
1. Reduce malaria mortality rates globally compared with 2015	At least 40%	At least 75%	At least 90%
2. Reduce malaria case incidence globally compared with 2015	At least 40%	At least 75%	At least 90%
3. Eliminate malaria from countries in which malaria was transmitted in 2015	At least 10 countries	At least 20 countries	At least 35 countries
4. Prevent re-establishment of malaria in all countries that are malaria-free	Re-establishment prevented	Re-establishment prevented	Re-establishment prevented

PRINCIPLES

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

STRATEGIC FRAMEWORK

– comprising three major pillars, with two supporting elements: (1) innovation and research and (2) a strong enabling environment

Maximize impact of today's life-saving tools

- **Pillar 1.** Ensure universal access to malaria prevention, diagnosis and treatment
- **Pillar 2.** Accelerate efforts towards elimination and attainment of malaria-free status
- **Pillar 3.** Transform malaria surveillance into a core intervention

Supporting element 1. Harnessing innovation and expanding research

- Basic research to foster innovation and the development of new and improved tools
- Implementation research to optimize impact and cost–effectiveness of existing tools and strategies
- Action to facilitate rapid uptake of new tools, interventions and strategies

Supporting element 2. Strengthening the enabling environment

- Strong political and financial commitments
- Multisectoral approaches, and cross-border and regional collaborations
- Stewardship of entire heath system including the private sector, with strong regulatory support
- Capacity development for both effective programme management and research



Global Technical Strategy for Malaria 2016–2030

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