

SECTION I: GLOBAL MALARIA SITUATION

I. DATA AVAILABILITY AND SOURCES

Since 2002, the WHO RBM Department has systematically compiled information on malaria burden and control in a global database. The contents of this database are available online via WHO's Global Atlas of Infectious Disease.¹ The present report is based on information from this database, as summarized below.

1. Countries with malaria

This report covers 107 malaria-endemic countries and territories, including a few that reported no malaria transmission in 2003 but which had reported malaria transmission within the time frame considered in this report (from 1990 to 2003).

Endemicity is defined as the probable presence of malaria transmission (Map 1 and Annex 5). Classifications of endemicity are not necessarily based on malaria cases and deaths reported in countries' health information system (HIS). Several countries in North Africa, the Eastern Mediterranean and Central Asia, which have recently made tremendous progress in reducing transmission and are now within reach of eliminating malaria, were considered among the malaria-endemic countries. This was done because the confirmation of a malaria-free status or the absence of transmission is often difficult, awaiting codified measures for certification and continued vigilance.

Countries that have only imported cases or occasional local transmission—introduced cases resulting from imported cases—are not included, although surveillance of malaria cases and provision of access to effective antimalarial treatment remain important in these countries as well. This report focuses on countries with endemic malaria, and thus does not include information related to the burden of malaria among travellers or on prevention and treatment for this special population.

¹ http://www.who.int/globalatlas/autologin/malaria_login.asp

2. WHO annual malaria reporting

Each year, WHO regional offices request information from country officials and the NMCPs on a variety of areas related to malaria control. These include malaria cases and deaths from national HIS reported by various categorizations, drug policies and results of drug efficacy studies. Reporting also covers malaria-related services delivered by national control programmes, such as distribution and (re-)treatment of ITNs and houses sprayed for vector control during indoor residual spraying (IRS) campaigns. In addition, countries are asked for information on funds available for malaria control activities.

The aspects reported vary between regions as a result of regional differences in capacity for monitoring, existing reporting systems, and malaria epidemiology and control measures (Table 2).

Table 2. Aspects included in annual reporting from countries and territories to WHO regional offices

| Region | Subregion | Reported malaria cases by: | | | | Malaria-related services delivered | | | Malaria financing | |
|--------------|------------------------------|--------------------------------|-----|-----|-------------------|------------------------------------|-------------------|---|-------------------|-------------------------|
| | | Laboratory confirmation status | Age | Sex | Sub-national area | ITNs distributed or sold | Nets (re-)treated | Households sprayed during IRS campaigns | Budgeted expenses | Actual funding received |
| Africa | Central | – | ✓ | – | – | ✓ | ✓ | ✓ | ✓ | ✓ |
| | East | – | ✓ | – | – | ✓ | ✓ | ✓ | ✓ | ✓ |
| | North | ✓ | – | – | ✓ | – | – | ✓ | ✓ | ✓ |
| | Southern | – | ✓ | – | – | ✓ | ✓ | ✓ | ✓ | ✓ |
| | West | – | ✓ | – | – | ✓ | ✓ | ✓ | ✓ | ✓ |
| Asia | Central Asia & Transcaucasia | ✓ | – | – | ✓ | – | – | – | – | – |
| | Eastern Mediterranean | ✓ | – | – | ✓ | – | – | ✓ | ✓ | ✓ |
| | South-East Asia | ✓ | ✓ | – | ✓ | ✓ | ✓ | ✓ | ✓ | – |
| | Western Pacific | ✓ | – | – | ✓ | – | ✓ | – | – | – |
| The Americas | Central America & Caribbean | ✓ | ✓ | – | ✓ | – | ✓ | ✓ | ✓ | – |
| | South America | ✓ | ✓ | – | ✓ | – | ✓ | ✓ | ✓ | – |

– = not included; ✓ = included

3. Reported cases and deaths from health information systems

In most countries, reported case rates represent only part of the actual total number of malaria cases, since many people are treated at home or in private facilities that do not report to the national HIS. Nevertheless, if HIS reporting is reasonably consistent and complete over the years, trends in reported cases might give some indication of the local trend in the malaria burden. Most countries with malaria outside Africa south of the Sahara report to WHO the number of cases recorded in their HIS during each year, with the exception of one missing report each in recent years from Belize and Haiti and occasional missing reports from Indonesia, Turkmenistan, Yemen and North African countries. Few countries in Africa south of the Sahara report malaria case rates every year (Table 3).

The definition of a reported case differs between countries and regions. In the Americas and in most countries of Asia, North Africa and Transcaucasia all reported cases are confirmed by laboratory diagnosis, usually microscopy. But in most countries in Africa south of the Sahara, cases are diagnosed and reported based on purely clinical grounds without laboratory testing (Annex 1 and Table A.21). For this reason, and because many African countries do not report any annual numbers of cases to WHO, trends in reported cases are not evaluated for Africa south of the Sahara.

Only in South-East Asia and the Western Pacific were malaria deaths reported with reasonable completeness over the years and by country. This report therefore reviews trends in reported death rates for these regions only.

Table 3. Number of malaria-endemic countries reporting malaria cases to WHO, by region and calendar year, 1990–2003

| Region | Subregion | Total no. of countries | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 ^a |
|--------------|------------------------------|------------------------|-----------|-----------|-----------|-----------|-----------|------------|-----------|-----------|------------|-----------|-----------|-----------|-----------|-------------------|
| Africa | Central | 8 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 6 | 7 | 4 | 4 | 4 | 2 | 3 |
| | East | 12 | 5 | 5 | 7 | 9 | 9 | 10 | 9 | 7 | 10 | 11 | 10 | 9 | 9 | 8 |
| | North | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 |
| | Southern | 11 | 7 | 6 | 7 | 8 | 8 | 10 | 9 | 8 | 10 | 11 | 11 | 11 | 10 | 6 |
| | West | 16 | 13 | 13 | 12 | 13 | 14 | 16 | 15 | 16 | 14 | 14 | 13 | 10 | 7 | 3 |
| Asia | Central Asia & Transcaucasia | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 6 |
| | Eastern Mediterranean | 9 | 9 | 9 | 8 | 8 | 9 | 8 | 9 | 9 | 8 | 9 | 9 | 8 | 9 | 9 |
| | South-East Asia | 10 ^b | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 10 | 8 | 10 | 10 | 10 | 9 |
| | Western Pacific | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 9 |
| The Americas | Central America & Caribbean | 10 | 10 | 10 | 10 | 10 | 10 | 9 | 10 | 9 | 10 | 10 | 10 | 10 | 9 | 9 |
| | South America | 11 | 11 | 11 | 11 | 10 | 11 | 11 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| Total | | 107 | 90 | 89 | 90 | 93 | 96 | 100 | 98 | 95 | 101 | 99 | 99 | 94 | 88 | 76 |

^a As a result of a general delay in the receipt of national reported case rates at WHO headquarters, the number of countries reporting in 2003 is not yet complete.

^b The number of countries increased from 9 to 10 with the establishment of Timor-Leste in 1999.

4. Monitoring antimalarial drug efficacy

Antimalarial drug resistance has become one of the greatest challenges in malaria control. In order to ensure the effective treatment of malaria, national drug policies must be regularly reviewed and revised as needed. These revisions are based on drug efficacy studies in sentinel sites that met a standardized WHO protocol (9); data from such studies are presented in this report. (Annex 1 gives definitions of drug efficacy; numbers of drug efficacy studies are in Section IV.)

5. Coverage of interventions through household surveys

The greatest burden of malaria and the greatest need for prevention and treatment occur in poorly accessible rural settings, where cases are often managed at home rather than in a formal health-care setting. Most people do not obtain their ITNs for protection against malaria from health facilities, and malaria patients seen in health facilities might not be representative of the people at risk of malaria in the population at large. For these reasons, household surveys are the most appropriate mechanism for monitoring the coverage of ITNs and the appropriate treatment for malaria in populations at risk.

Two major survey tools have provided the majority of population-level data for this report: Multiple Indicator Cluster Surveys (MICS) and Demographic and Health Surveys (DHS).

Multiple indicator cluster surveys

Between 1999 and 2001, MICS were conducted in 67 countries with support from UNICEF. MICS are nationally representative, with an average of around 6000 households sampled through a two-stage cluster design (10). The standard MICS questionnaire includes questions on possession and use of ITNs and use of anti-malarial drugs for the treatment of fever for children under 5 years of age. MICS also provide data on all-cause under-5 mortality. Survey results and questionnaires are available on the Internet.²

Demographic and health surveys

DHS are nationally representative household surveys that focus on reproductive and child health (11). Typically, DHS consist of interviews with 4000–12 000 women between 15 and 49 years of age living in households that are sampled in a multiple-stage cluster design. Because the questionnaires are standardized and structured, DHS results are comparable between countries and over time. Since 1998, specific questions on malaria prevention and treatment have been included in DHS, where relevant. In addition to providing information on major RBM coverage indicators, DHS are a primary source of information on all-cause under-5 mortality rates. DHS are organized by Macro International, Calverton, MD, United States of America, and are funded primarily by the United States Agency for International Development (USAID). Questionnaires and survey results are available on the Internet approximately one year after completion of field work.³

Over 50 MICS and DHS surveys contributed data on national-level ITN coverage for this report (Section IV and Annex 1). In addition, incidental national surveys conducted by health ministries were included. For countries where national surveys were lacking, high-quality cluster-sampled surveys conducted in subnational areas were considered. These included surveys conducted by the nongovernmental organizations (NGOs) NetMark (12) and Population Services International (PSI) (13).

² <http://www.childinfo.org>

³ <http://www.measuredhs.com>

6. Malaria-related commodities and service delivery

Service delivery measures are essential for interim progress evaluation between surveys of population coverage that occur only at approximately five-year intervals. In 2003, 41 of the 107 countries and territories with malaria reported on the number of nets (re-)treated with insecticide, 51 on nets sold or distributed, and 21 on the number of households sprayed. In addition, all WHO Member countries are asked to report annually on the quantities of insecticides used for vector control activities including against malaria vectors, according to guidelines published by the WHO Pesticide Evaluation Scheme (WHOPES). The latter information was comprehensively reported by WHO (14) and is summarized in this report.

7. Finances

WHO received data on national funds for malaria control from about half of the countries and territories (57 of 107) with malaria in 2003. Some of these countries also reported the different sources of the total budget. Information is not always comparable between countries because some numbers represent actually allocated funds, while others represent only budgeted funds. Interpreting available financial data is difficult given these inconsistencies, despite an overall improvement in the number of countries reporting since 2000 (Table 4).

Table 4. Number of countries reporting on funds for malaria control efforts, 1995–2003

| Region | Subregion | Total number of countries | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
|--------------|-----------------------------------|---------------------------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Africa | Central | 8 | – | – | – | – | 5 | 5 | 5 | 5 | 7 |
| | East | 12 | – | 2 | 1 | 1 | 6 | 8 | 7 | 8 | 9 |
| | North | 3 | 1 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 1 |
| | Southern | 11 | – | – | – | – | 3 | 4 | 4 | 7 | 8 |
| | West | 16 | – | – | – | – | 7 | 7 | 9 | 9 | 8 |
| Asia | Central Asia and Transcaucasia | 7 | – | – | – | – | – | – | – | – | – |
| | Eastern Mediterranean | 9 | 2 | 4 | 6 | 3 | 1 | 5 | 4 | 5 | 6 |
| | South-East Asia | 10 ^a | 3 | 5 | 5 | 6 | 7 | 7 | 6 | 7 | 9 |
| | Western Pacific | 10 | 1 | 1 | 1 | 1 | 2 | 3 | 3 | 3 | 6 |
| The Americas | Central America and the Caribbean | 10 | – | – | – | 9 | 8 | 7 | 7 | 6 | – |
| | South America | 11 | – | – | – | 9 | 8 | 8 | 8 | 8 | 3 |
| Total | | 107 | 7 | 14 | 15 | 30 | 48 | 55 | 55 | 59 | 57 |

^a The number of countries increased from 9 to 10 with the establishment of Timor-Leste in 1999.

8. Presentation of results

The data described above are assembled in country profiles and regional tabulations (Annex 1 and Annex 2). In 2004, country profiles were sent to countries for comments and updating and to provide short descriptions of progress; 24 selected profiles from countries with a high malaria burden relative to the region to which they belong are included in this report. Additional profiles from all countries that provided information by 31 December 2004 to WHO are available on the RBM web site.⁴

This report continues with a summary of the global malaria burden, followed by an overview of global control policies and strategies. Next, malaria burden and progress in control, including intervention coverage and drug efficacy data, are described separately for Africa, the Americas and Asia (including the Eastern Mediterranean and Transcaucasia) regions. These regions differ in malaria epidemiology, in the set of appropriate intervention strategies and in monitoring and evaluation systems. Therefore, the relevant indicators also differ. Regional summaries are followed by sections on global malaria control financing and global commodities and service delivery. The last section highlights gaps and limitations in the presented data and suggests ways for improving monitoring and evaluation at country, regional and global levels.

⁴ <http://rbm.who.int/>

II. MALARIA BURDEN

As of 2004, 107 countries and territories have reported areas at risk of malaria transmission (Map 1). Although this number is considerably less than in the 1950s, with 140 endemic countries or territories (15), 3.2 billion people are still at risk. Present estimates are that around 350–500 million clinical disease episodes occur annually (2). Around 60% of the cases of clinical malaria (Box 2 and Map 3) and over 80% of the deaths (1) occur in Africa south of the Sahara. Of the more than 1 million Africans who die from malaria each year (1), most are children under 5 years of age. In addition to acute disease episodes and deaths in Africa, malaria also contributes significantly to anaemia in children and pregnant women, adverse birth outcomes such as spontaneous abortion, stillbirth, premature delivery and low birth weight, and overall child mortality. The disease is estimated to be responsible for an estimated average annual reduction of 1.3% in economic growth for those countries with the highest burden (3).

The wide variation seen in the burden of malaria between different regions of the world is driven by several factors. First, there is great variation in parasite–vector–human transmission dynamics that favour or limit the transmission of malaria infection and the associated risk of disease and death. Of the four species of *Plasmodium* that infect humans—*P. falciparum*, *P. vivax*, *P. malariae* and *P. ovale*—*P. falciparum* causes most of the severe disease and deaths attributable to malaria and is most prevalent in Africa south of the Sahara and in certain areas of South-East Asia and the Western Pacific (Map 4). The second most common malaria species, *P. vivax*, is rarely fatal and commonly found in most of Asia, and in parts of the Americas, Europe and North Africa. There are over 40 species of anopheline mosquitoes that transmit human malaria (Map 2), which differ in their transmission potential. The most competent and efficient malaria vector, *Anopheles gambiae*, occurs exclusively in Africa and is also one of the most difficult to control. Climatic conditions determine the presence or absence of anopheline’s vectors. Tropical areas of the world have the best combination of adequate rainfall, temperature and humidity allowing for breeding and survival of anophelines.

The second major factor contributing to regional and local variability in malaria burden is differences in levels of socioeconomic development. Determinants include general poverty, quality of housing and access to health care and health education, as well as the existence of active malaria control programmes providing access to malaria prevention and treatment measures. The poorest nations generally have the least resources for adequate control efforts. In many poor countries, exposure to malaria of vulnerable populations is enhanced by migrations enforced by poverty and/or conflict.

As a result of differing intensities of malaria transmission, the population groups at risk of malaria also differ between world regions. The majority of deaths in tropical Africa occur in areas of stable transmission of falciparum malaria. In these areas, the two groups at highest risk are very young children, who have not yet acquired clinical immunity, and pregnant women, whose immunity to malaria is temporarily impaired. In areas of unstable or highly seasonal falciparum malaria transmission, which is common in most regions outside Africa, the lack of frequent exposure to malaria infection early in life delays the acquisition of clinical immunity, and thus older age groups remain at relatively high risk for malarial disease when

exposed (16). In fact, in some of these areas, adult groups such as forest workers in South-East Asia or migrant workers in Latin America are those most likely to be exposed to malaria and thus at highest risk for severe disease and death.

During the 20th century, human efforts to control malaria, and general socioeconomic development, including access to health care, have markedly reduced the spread of malaria. These gains are most evident in areas where transmission previously occurred only at low intensity, in the Americas, Asia, Europe and Transcaucasia. During the Global Malaria Eradication Programme between 1957 and 1972, vector control—mainly through DDT spraying combined with improved access to treatment—reduced or eliminated malaria transmission in considerable parts of these regions. In contrast, most of Africa south of the Sahara and some foci elsewhere continued to suffer malaria transmission at high intensity. In some areas malaria has resurged after interruption of eradication efforts that were not sustainable (17).

More recently, there is evidence that, compared with the 1980s, the burden of malaria increased during the 1990s in several areas in terms of proportions of population at risk, the severity of infections and the number of deaths. Malaria re-emerged in several countries in Central Asia and Transcaucasia with an increased frequency of epidemics and with the re-establishment of stable endemic transmission. In rural Africa south of the Sahara, child mortality caused by malaria is estimated to have increased by up to twofold during the 1980s and the early 1990s, while mortality resulting from other causes decreased over the same period (18, 19). Factors contributing to the increase in malaria include: (i) resistance of parasites to

BOX 2. ESTIMATED GLOBAL DISTRIBUTION OF CLINICAL MALARIA CASES

In 2004, an improved method for estimating the incidence of clinical malaria episodes for all countries was developed by the RBM MERG task force on malaria morbidity (2). These estimates will allow regular updating for tracking trends and progress of RBM objectives and the Millennium Development Goals, as well as provide data for WHO's annual analysis of the Global Burden of Disease series.

The estimates are based on populations living at different malaria endemicity levels in urban and rural parts of all countries and by age group (Fig. 1). Standardized definitions of malaria endemicity are used to classify the world's population (21) (Map 1). For each population group, a fixed rate of incidence of clinical episodes is applied. Incidence rates were estimated based on a literature review of community-based longitudinal studies. Country-specific estimates are then adjusted for the local coverage and the impact of ITN and IRS, based on data from household coverage surveys. For countries outside Africa, resulting incidence estimates are triangulated against HIS case reports to allow adjustment in the event of major inconsistencies.

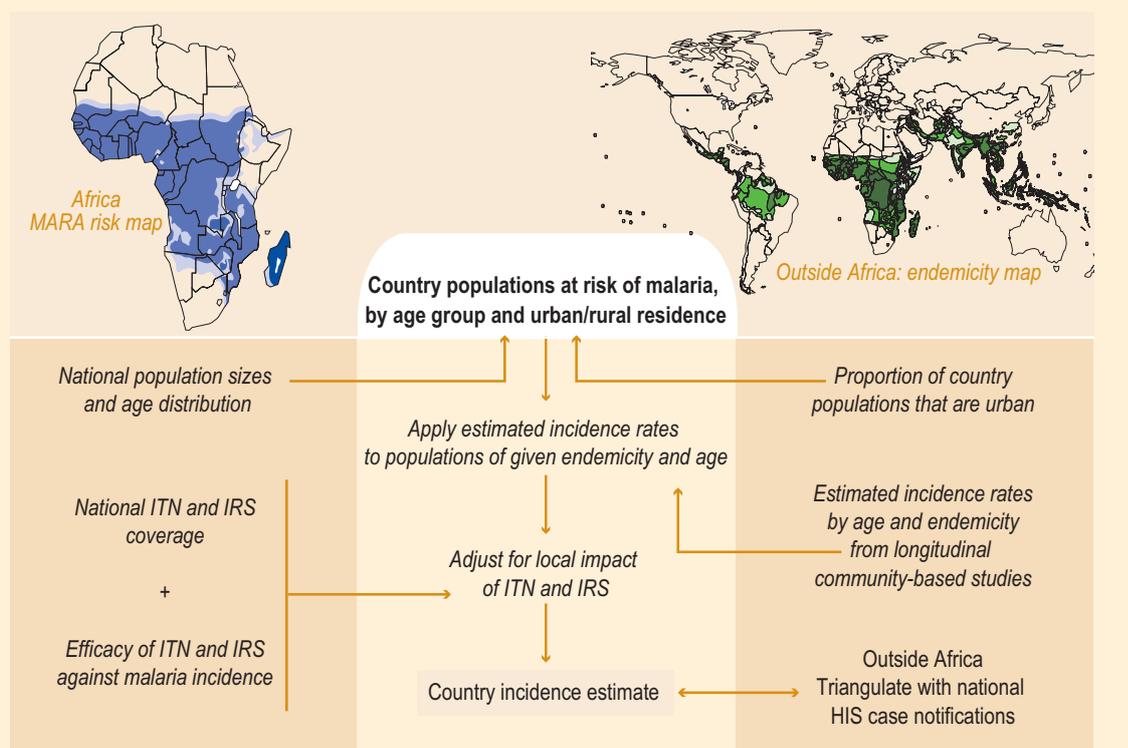
Provisional country-level estimates as of January 2005 of the rates of total clinical incidence and falciparum malaria incidence are shown in Maps 2 and 3, respectively. These are being refined based on improvements in the global endemicity map (Annex 4 and Map 1). The estimates indicate that around 59% of the world's clinical malaria cases occur in Africa, around 38% in Asia and around 3% in the Americas. For falciparum malaria specifically, the estimated regional distribution is around 74% in Africa, 25% in Asia and around 1% in the Americas.

commonly used antimalarial drugs; (ii) breakdown of control programmes; (iii) complex emergencies; (iv) collapse of local primary health services; and (v) resistance of mosquito vectors to insecticides. Within this same period, however, malaria was well-controlled in the five northernmost African countries, and elimination or a very low level of transmission was maintained in some of the islands off the coast of Africa. Throughout the past decades, malaria was generally much less intense in Central America and South America than in Africa and South-East Asia, where transmission is mostly limited to *P. vivax*—except for the Amazon basin—and a relatively low but fairly stable incidence was reported throughout the 1990s.

From the available data, it is not yet possible to determine with sufficient confidence whether the global burden of malaria has changed substantially, for better or worse, since 2000 when RBM implementation began in many countries. In some areas, fluctuations in malaria transmission from year to year potentially confound evaluations of broader trends. Therefore, conclusions typically require an analysis of epidemiological data over multiple years. For the high-burden continent of Africa, reliable data on under-5 mortality from birth history surveys and demographic surveillance will only become available after a time lag of several years (18, 20) (Annex 4).

Nevertheless, for some countries and areas throughout the world there is evidence that successful control has had an impact on malaria disease burden. These success stories are presented in the respective sections of each region.

Figure 1. Outline of method for estimating the incidence of clinical malaria at country level, under development at WHO/RBM (2)



III. MALARIA CONTROL POLICIES AND STRATEGIES

Appropriate malaria control strategies vary with local malaria endemicity. The national control policies of malarious countries (Table A.1) generally conform to the key strategies advocated by RBM for their epidemiological setting (Table 5).

Table 5. Priority malaria control strategies, by epidemiological setting

| Epidemiological setting | Control strategy |
|---|---|
| Stable endemic malaria <i>Examples:</i> large parts of East, Central and West Africa, Papua New Guinea, Solomon Islands and Vanuatu | Prevention <ul style="list-style-type: none"> – ITNs for children under 5 years of age, pregnant women and people living with HIV/AIDS – IRS, where appropriate – IPT in pregnancy Treatment <ul style="list-style-type: none"> – Early and effective case management including presumptive treatment for suspected cases and home management where appropriate |
| Unstable malaria <i>Examples:</i> parts of Southern Africa, Transcaucasia, Central Asia and the Americas; highland and desert fringe areas, some urban areas, plantations, irrigation schemes | Prevention <ul style="list-style-type: none"> – IRS – Larviciding – Environmental management – ITNs Treatment <ul style="list-style-type: none"> – Early and effective case management in suspected cases – Diagnostics to confirm cases, if possible before treatment |
| Free of malaria <i>Examples:</i> parts of Southern and North Africa, Ethiopian and Eritrean highlands and Transcaucasia | Prevention <ul style="list-style-type: none"> – For travellers going to malarious areas, chemoprophylaxis and personal protective measures against mosquitoes Treatment <ul style="list-style-type: none"> – Early and effective case management in suspected cases – Diagnostics to confirm cases, if possible before treatment |

1. Treatment policies

All 107 malarious countries and territories have a national antimalarial treatment policy, and most continually update the policy based on evidence of drug efficacy, safety, cost and availability.

Artemisinin-based combination therapies

In response to widespread resistance of *P. falciparum* to monotherapy with conventional antimalarial drugs such as chloroquine and sulfadoxine–pyrimethamine (Map 5), WHO now recommends combination therapies as the treatment policy for falciparum malaria in all countries experiencing such resistance. The preferred combinations contain a derivative of the plant *Artemisia annua*, which is presently cultivated mainly in China and Viet Nam. Artemisinin-based combination therapies (ACTs) are the most highly efficacious treatment regimens now available.

Since 2001, 42 malaria-endemic countries have adopted ACTs: 38 as first-line treatment and 14 as second-line treatment (Map 6). Of these 42 countries, 23 are in Africa, although only 9 countries were actually implementing ACT treatment policies as of 2004. An additional 14 countries are in the process of changing their malaria treatment policy.

To ensure the quality of products, an international mechanism to prequalify manufacturers of ACTs and other artemisinin-based pharmaceuticals has been established by WHO and UNICEF. Products and manufacturers that comply with internationally recommended standards are included on a list that is published as a guide to those involved in procuring ACTs. To date, two ACTs and their manufacturers—artemether–lumefantrine (Coartem®) from Novartis Pharma AG and artesunate tablets from Sanofi-Synthélabo/Guilin—have been prequalified.

Home management of malaria

In areas of high malaria transmission and poor access to facility-based health care, particularly in rural Africa, RBM advocates home management of children under 5 years of age with malaria as a strategy to achieve high coverage of prompt and effective antimalarial treatment in this highly vulnerable group (22). This involves educating mothers, training community-level providers—including shopkeepers—and supplying pre-packaged quality-assured medicines. Home management is now included in the national control strategies in 22 African countries and 2 countries in the Eastern Mediterranean.

2. Insecticide-treated nets

In areas of malaria transmission where sustained vector control is required, ITNs are the principal strategy for malaria prevention. All countries in Africa south of the Sahara, the majority of Asian malaria-endemic countries and some American countries have adopted ITNs as a key malaria control strategy (Table A.1). To promote the usage of ITNs, the NMCPs use various implementation methods including: (i) stimulating the growth of commercial markets; (ii) reducing taxes and tariffs; (iii) cost-sharing; (iv) social marketing subsidies; and (v) ITN distribution free of charge among vulnerable groups such as children under 5 years of age, pregnant women and the poorest or most marginalized populations. Services for (re-)treatment of existing untreated nets are another powerful means of increasing ITN coverage.

Recently developed techniques for the long-lasting insecticide treatment of nets provide a possible solution for the need to regularly re-treat nets. Although long-lasting insecticidal nets (LLINs) are more expensive than conventional ITNs, the cost of maintaining coverage is lower, since they remain effective for 4 to 5 years. Two brands of LLINs are now recommended by WHO (23), and they are rapidly being adopted in many countries. Whereas previously production of LLINs was centered in Asia, a producer in the United Republic of Tanzania began production of a WHO-recommended LLIN in November 2004. Technology transfer to high-malaria settings is seen as the way to bring prices down.

3. Indoor residual spraying and other methods of vector control

IRS is a highly effective method for malaria vector control that is particularly useful for achieving a rapid reduction in transmission during epidemics and other emergency situations—provided it is well timed and high coverage is achieved. In areas of intense malaria transmission, IRS could have a long-term impact similar to that of ITNs, although ITNs are generally recommended in such areas because of better sustainability.

The dwindling availability of low-risk and cost-effective insecticides is a threat to malaria vector control. This is a result of increasing vector resistance and the lack of development over the past 20 years of new insecticide compounds for public health use. In May 2004, the Stockholm Convention on Persistent Organic Pollutants became operational. While enforcing strict measures to reduce environmental damage from persistent organic pollutants, the Convention stated that DDT is still needed in some countries for disease vector control (24). WHO recommends that countries select the insecticide for IRS based on local situation analysis; DDT is one of the 12 insecticides that can be used for this purpose.

In the Americas and in Asia, vector control—mostly involving IRS—is included in the national control policies of all countries. About half of African countries also include IRS as part of their malaria control efforts.

4. Malaria control during epidemics and complex emergencies

Up to 1 billion people throughout the world live in areas at risk of epidemic or hypoendemic malaria (21). A considerable proportion of global malaria deaths occurs among populations affected by conflicts, currently affecting 18 countries in Africa alone. Population displacement, increased vulnerability as a result of malnutrition and concurrent infections, exposure to malaria vectors from poor or lack of housing, collapse of health services and supply lines, and environmental deterioration resulting in increased vector breeding all contribute to the increased malaria burden in populations affected by complex emergencies.

Timely prevention of malaria epidemics requires robust early warning systems. Effective control requires early detection through weekly disease surveillance, combined with adequately funded preparedness plans of action that ensure the availability of control tools—such as drugs, IRS and ITNs—for rapid deployment. Malaria early warning systems can predict the risk of epidemics from seasonal climate forecasts and from monitoring anomalies in rainfall and temperature based on satellite observations (25). Weekly disease surveillance allows early detection—within 2 weeks (8)—of any unusual increase in malaria cases and immediate action to be taken (26). Most countries in Africa and Asia with areas at risk of highly seasonal or epidemic malaria include epidemic preparedness in their malaria control policies. In Africa, weekly reporting of malaria cases is implemented in at least 15 of the 25 epidemic-prone countries, either under a system of integrated disease surveillance and response or in sentinel sites. At least 8 African countries are developing a malaria early warning system. However, the effective use of these weekly surveillance data for timely, targeted interventions remains an area of ongoing operational research.

For malaria control during complex emergencies, the challenge is to implement priority interventions that are scientifically optimal and operationally feasible, in both the short and the longer term. Case management with ACTs is recommended in complex emergencies, and ACTs must be made widely available in health facilities and through outreach to affected populations. Vector control measures should aim for high coverage to be fully effective; and coordination among implementing agencies is key.

5. Malaria prevention and treatment in pregnant women

To reduce the negative consequences of malaria in pregnancy, WHO recommends the use of intermittent preventive treatment (IPT) for pregnant women in all areas with stable transmission of falciparum malaria. IPT involves provision of at least 2 treatment doses of an effective antimalarial during routine antenatal clinic visits to all pregnant women in these areas (27). As an integral part of the WHO Making Pregnancy Safer strategy, IPT is included in the control policies of 26 African countries with highly endemic malaria. Several other countries in Africa are reviewing their policies in light of the WHO recommendation, or are piloting IPT in selected areas. All malaria-endemic countries in Africa have policies for treatment of malarial illness in pregnancy, and the majority of highly endemic countries recommend that pregnant women have access to ITNs.