Malaria

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Key facts

- Malaria is a life-threatening disease caused by parasites that are transmitted to people through the bites of infected mosquitoes.
- In 2010, malaria caused an estimated 660 000 deaths (with an uncertainty range of 610 000 to 971 000), mostly among African children.
- Malaria is preventable and curable.
- Increased malaria prevention and control measures are dramatically reducing the malaria burden in many places.
- Non-immune travellers from malaria-free areas are very vulnerable to the disease when they get infected.

According to the latest estimates, there were about 219 million cases of malaria in 2010 (with an uncertainty range of 154 million to 289 million) and an estimated 660 000 deaths (with an uncertainty range of 610 000 to 971 000). Malaria mortality rates have fallen by more than 25% globally since 2000, and by 33% in the WHO African Region. Most deaths occur among children living in Africa where a child dies every minute from malaria. Country-level burden estimates available for 2010 show that an estimated 80% of malaria deaths occur in just 14 countries and about 80% of cases occur in 17 countries. Together, the Democratic Republic of the Congo and Nigeria account for over 40% of the estimated total of malaria deaths globally.

Malaria is caused by *Plasmodium* parasites. The parasites are spread to people through the bites of infected *Anopheles* mosquitoes, called "malaria vectors", which bite mainly between dusk and dawn.

There are four parasite species that cause malaria in humans:

- *Plasmodium falciparum*
- *Plasmodium vivax*
- *Plasmodium malariae*
- *Plasmodium ovale.*

Plasmodium falciparum and *Plasmodium vivax* are the most common. *Plasmodium falciparum* is the most deadly.

In recent years, some human cases of malaria have also occurred with *Plasmodium knowlesi* – a species that causes malaria among monkeys and occurs in certain forested areas of South-East Asia.

Transmission

Malaria is transmitted exclusively through the bites of *Anopheles* mosquitoes. The intensity of transmission depends on factors related to the parasite, the vector, the human host, and the environment.

About 20 different *Anopheles* species are locally important around the world. All of the important vector species bite at night. *Anopheles* mosquitoes breed in water and each species has its own breeding preference; for example some prefer shallow collections of fresh water, such as puddles, rice fields, and hoof prints. Transmission is more intense in places where the mosquito lifespan is longer (so that the parasite has time to complete its development inside the mosquito) and where it prefers to bite humans rather than other animals. For example, the long lifespan and strong human-biting habit of the African vector species is the main reason why more than 90% of the world's malaria deaths are in Africa.

Transmission also depends on climatic conditions that may affect the number and survival of mosquitoes, such as rainfall patterns, temperature and humidity. In many places, transmission is seasonal, with the peak during and just after the rainy season. Malaria epidemics can occur when climate and other conditions suddenly favour transmission in areas where people have little or no immunity to malaria. They can also occur when people with low immunity move into areas with intense malaria transmission, for instance to find work, or as refugees.

Human immunity is another important factor, especially among adults in areas of moderate or intense transmission conditions. Partial immunity is developed over years of exposure, and while it never provides complete protection, it does reduce the risk that malaria infection will cause severe disease. For this reason, most malaria deaths in Africa occur in young children, whereas in areas with less transmission and low immunity, all age groups are at risk.

Symptoms

Malaria is an acute febrile illness. In a non-immune individual, symptoms appear seven days or more (usually 10–15 days) after the infective mosquito bite. The first symptoms – fever, headache, chills and vomiting – may be mild and difficult to recognize as malaria. If not treated within 24 hours, *P. falciparum* malaria can progress to severe illness often leading to death. Children with severe malaria frequently develop one or more of the following symptoms: severe anaemia, respiratory distress in relation to metabolic acidosis, or cerebral malaria. In adults, multi-organ involvement is also frequent. In malaria endemic areas, persons may develop partial immunity, allowing asymptomatic infections to occur.

For both *P. vivax* and *P. ovale*, clinical relapses may occur weeks to months after the first infection, even if the patient has left the malarious area. These new episodes arise from dormant liver forms

known as hypnozoites (absent in *P. falciparum* and *P. malariae*); special treatment – targeted at these liver stages – is required for a complete cure.

Who is at risk?

Approximately half of the world's population is at risk of malaria. Most malaria cases and deaths occur in sub-Saharan Africa. However, Asia, Latin America, and to a lesser extent the Middle East and parts of Europe are also affected. In 2011, 99 countries and territories had ongoing malaria transmission.

Specific population risk groups include:

- **young children** in stable transmission areas who have not yet developed protective immunity against the most severe forms of the disease;
- **non-immune pregnant women** as malaria causes high rates of miscarriage and can lead to maternal death;
- **semi-immune pregnant women** in areas of high transmission. Malaria can result in miscarriage and low birth weight, especially during first and second pregnancies;
- **semi-immune HIV-infected pregnant women** in stable transmission areas, during all pregnancies. Women with malaria infection of the placenta also have a higher risk of passing HIV infection to their newborns;
- **people with HIV/AIDS**;
- **international travellers from non-endemic areas** because they lack immunity;

- **immigrants from endemic areas and their children** living in non-endemic areas and returning to their home countries to visit friends and relatives are similarly at risk because of waning or absent immunity.

Diagnosis and treatment

Early diagnosis and treatment of malaria reduces disease and prevents deaths. It also contributes to reducing malaria transmission.

The best available treatment, particularly for *P. falciparum* malaria, is artemisinin-based combination therapy (ACT).

WHO recommends that all cases of suspected malaria be confirmed using parasite-based diagnostic testing (either microscopy or rapid diagnostic test) before administering treatment. Results of parasitological confirmation can be available in 15 minutes or less. Treatment solely on the basis of symptoms should only be considered when a parasitological diagnosis is not possible. More detailed recommendations are available in the *Guidelines for the treatment of malaria (second edition).*

Antimalarial drug resistance

Resistance to antimalarial medicines is a recurring problem. Resistance of *P. falciparum* to previous generations of medicines, such as chloroquine and sulfadoxine-pyrimethamine (SP), became widespread in the 1970s and 1980s, undermining malaria control efforts and reversing gains in child survival.

In recent years, parasite resistance to artemisinins has been detected in four countries of the Greater Mekong subregion: Cambodia, Myanmar, Thailand and Viet Nam. While there are likely many factors that contribute to the emergence and spread of resistance, the use of oral artemisinins alone, as monotherapy, is thought to be an important driver. When treated with an oral artemisinin-based monotherapy, patients may discontinue treatment prematurely following the rapid disappearance of malaria symptoms. This results in incomplete treatment, and such patients still have persistent parasites in their blood. Without a second drug given as part of a combination (as is provided with an ACT), these resistant parasites survive and can be passed on to a mosquito and then another person.

If resistance to artemisinins develops and spreads to other large geographical areas, the public health consequences could be dire, as no alternative antimalarial medicines will be available for at least five years.

WHO recommends the routine monitoring of antimalarial drug resistance, and supports countries to strengthen their efforts in this important area of work.

More comprehensive recommendations are available in the WHO *Global Plan for Artemisinin Resistance Containment (GPARC),* which was released in 2011.

Prevention

Vector control is the main way to reduce malaria transmission at the community level. It is the only intervention that can reduce malaria transmission from very high levels to close to zero.

For individuals, personal protection against mosquito bites represents the first line of defence for malaria prevention.

Two forms of vector control are effective in a wide range of circumstances.

Insecticide-treated mosquito nets (ITNs)

Long-lasting insecticidal nets (LLINs) are the preferred form of ITNs for public health distribution programmes. WHO recommends coverage for all at-risk persons; and in most settings. The most cost effective way to achieve this is through provision of free LLINs, so that everyone sleeps under a LLIN every night.

Indoor spraying with residual insecticides

Indoor residual spraying (IRS) with insecticides is a powerful way to rapidly reduce malaria transmission. Its full potential is realized when at least 80% of houses in targeted areas are sprayed. Indoor spraying is effective for 3–6 months, depending on the insecticide used and the type of surface on which it is sprayed. DDT can be effective for 9–12 months in some cases. Longer-lasting forms of existing IRS insecticides, as well as new classes of insecticides for use in IRS programmes, are under development.

Antimalarial medicines can also be used to prevent malaria. For travellers, malaria can be prevented through chemoprophylaxis, which suppresses the blood stage of malaria infections, thereby preventing malaria disease. In addition, WHO recommends intermittent preventive treatment with sulfadoxine-pyrimethamine for pregnant women living in high transmission areas, at each scheduled antenatal visit after the first trimester. Similarly, for infants living in high-transmission

areas of Africa, 3 doses of intermittent preventive treatment with sulfadoxine-pyrimethamine is recommended delivered alongside routine vaccinations. In 2012, WHO recommended Seasonal Malaria Chemoprevention as an additional malaria prevention strategy for areas of the Sahel sub-Region of Africa. The strategy involves the administration of monthly courses of amodiaquine plus sulfadoxine-pyrimethamine to all children under 5 years of age during the high transmission season.

Insecticide resistance

Much of the success to date in controlling malaria is due to vector control. Vector control is highly dependent on the use of pyrethroids, which are the only class of insecticides currently recommended for ITNs or LLINs. In recent years, mosquito resistance to pyrethroids has emerged in many countries. In some areas, resistance to all four classes of insecticides used for public health has been detected. Fortunately, this resistance has only rarely been associated with decreased efficacy, and LLINs and IRS remain highly effective tools in almost all settings.

However, countries in sub-Saharan Africa and India are of significant concern. These countries are characterized by high levels of malaria transmission and widespread reports of insecticide resistance. The development of new, alternative insecticides is a high priority and several promising products are in the pipeline.. Development of new insecticides for use on bed nets is a particular priority.

Detection of insecticide resistance should be an essential component of all national malaria control efforts to ensure that the most effective vector control methods are being used. The choice of insecticide for IRS should always be informed by recent, local data on the susceptibility target vectors.

In order to ensure a timely and coordinated global response to the threat of insecticide resistance, WHO has worked with a wide range of stakeholders to develop the Global Plan for Insecticide Resistance Management in malaria vectors (GPIRM), which was released in May 2012. The GPIRM puts forward a five-pillar strategy calling on the global malaria community to:

- plan and implement insecticide resistance management strategies in malaria-endemic countries;
- ensure proper and timely entomological and resistance monitoring, and effective data management;
- develop new and innovative vector control tools;
- fill gaps in knowledge on mechanisms of insecticide resistance and the impact of current insecticide resistance management approaches; and
- ensure that enabling mechanisms (advocacy as well as human and financial resources) are in place.

Surveillance

Tracking progress is a major challenge in malaria control. Malaria surveillance systems detect only around 10% of the estimated global number of cases. Stronger malaria surveillance systems are urgently needed to enable a timely and effective malaria response in endemic regions, to prevent outbreaks and resurgences, to track progress, and to hold governments and the global malaria community accountable. In April 2012, the WHO Director-General launched new global surveillance manuals for malaria control and elimination, and urged endemic countries to strengthen their surveillance systems for malaria. This was embeddedpart of in a larger call to scale up diagnostic testing, treatment and surveillance for malaria, known as WHO's T3: Test. Treat. Track initiative.

Elimination

Malaria elimination is defined as interrupting local mosquito-borne malaria transmission in a defined geographical area, i.e. zero incidence of locally contracted cases. Malaria eradication is defined as the permanent reduction to zero of the worldwide incidence of malaria infection caused by a specific agent; i.e. applies to a particular malaria parasite species.

Many countries – especially in temperate and sub-tropical zones – have been successful in eliminating malaria. The global malaria eradication campaign, launched by WHO in 1955, was successful in eliminating the disease in some countries, but ultimately failed to achieve its overall goal, thus being abandoned less than two decades later in favour of the less ambitious goal of malaria control. In recent years, however, interest in malaria eradication as a long-term goal has re-emerged.

Large-scale use of WHO-recommended strategies, currently available tools, strong national commitments, and coordinated efforts with partners, will enable more countries – particularly those where malaria transmission is low and unstable – to progress towards malaria elimination. In recent years, 4 countries have been certified by the WHO Director-General as having eliminated malaria: United Arab Emirates (2007), Morocco (2010), Turkmenistan (2010), and Armenia (2011).

Vaccines against malaria

There are currently no licensed vaccines against malaria or any other human parasite. One research vaccine against P. falciparum, known as RTS,S/AS01, is most advanced. This vaccine is currently being evaluated in a large clinical trial in 7 countries in Africa. A WHO recommendation for use will depend on the final results from the large clinical trial. These final results are expected in late 2014, and a recommendation as to whether or not this vaccine should be added to existing malaria control tools is expected in 2015.

WHO response

The WHO Global Malaria Programme (GMP) is responsible for charting the course for malaria control and elimination through:

- setting, communicating and promoting the adoption of evidence-based norms, standards, policies, technical strategies, and guidelines;
- keeping independent score of global progress;
- developing approaches for capacity building, systems strengthening, and surveillance;
- identifying threats to malaria control and elimination as well as new areas for action.

GMP serves as the secretariat for the Malaria Policy Advisory Committee (MPAC), a group of 15 global malaria experts appointed following an open nomination process. The MPAC, which meets twice yearly, provides independent advice to WHO to develop policy recommendations for the control and elimination of malaria. The mandate of MPAC is to provide strategic advice and technical input, and extends to all aspects of malaria control and elimination, as part of a transparent, responsive and credible policy setting process.

WHO is also a co-founder and host of the Roll Back Malaria partnership, which is the global framework to implement coordinated action against malaria. The partnership mobilizes for action and resources and forges consensus among partners. It is comprised of over 500 partners, including

malaria endemic countries, development partners, the private sector, nongovernmental and community-based organizations, foundations, and research and academic institutions.