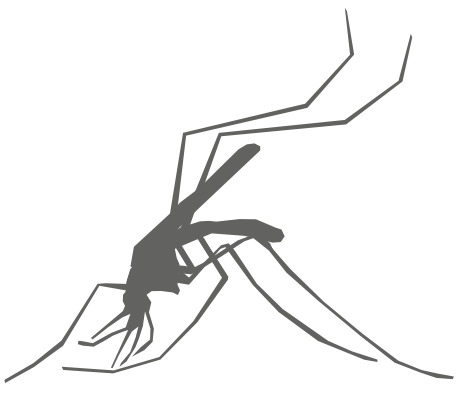
DISEASE SURVEILLANCE FOR MALARIA CONTROL

AN OPERATIONAL MANUAL



World Health Organization

ROLL BACK MALARIA PARTNERSHIP

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Contents

Foreword

Information on the number and distribution of malaria cases and deaths is critical for the design and implementation of malaria control programmes. It is needed to determine which areas or population groups are most affected by malaria, so that resources can be targeted to the populations most in need. Information on the incidence of disease in relation to past levels is needed to alert programmes about epidemics, so that control measures can be intensified. Data on changes in disease incidence and mortality are also needed in order to judge the success of a programme and to determine whether it is performing as expected or whether adjustments in the scale or blend of interventions are required.

The capacity of malaria surveillance systems to provide information on the distribution of and trends in malaria varies widely across the globe. The aim of this manual is to provide guidance to malaria-endemic countries in designing and managing surveillance systems for malaria control and elimination, so that malaria programmes can obtain more complete, and more accurate information on malaria incidence, which can be used to help plan and monitor the programme. The manual provides guidance on (i) the general principles that govern surveillance systems, including case definitions, procedures for case detection and investigation; (ii) data recording, reporting and analysis; and (iii) factors to be considered in establishing malaria surveillance systems.

Recent developments in diagnostic testing present new opportunities for malaria surveillance systems. The availability of inexpensive, quality-assured rapid diagnostic tests for malaria means that parasite-based diagnosis is now possible not only at peripheral health-care facilities but also at the community level. Thus, malaria surveillance can be based on confirmed rather than suspected cases at all levels of the health system. As malaria control measures expand and the proportion of fevers due to malaria falls rapidly, it becomes increasingly important to track confirmed malaria cases, rather than non-malarious fevers, so that resources can be targeted to areas where problems remain and progress in malaria control is accelerated.

The development of effective surveillance systems requires significant investments, both financial and human. A critical factor in the functioning and sustainability of monitoring systems is the availability of qualified, experienced personnel. Investment in data collection systems without a commensurate investment in human resources to analyse the data and use the information generated is unlikely to yield significant returns; ultimately, data should be used to influence decisions, and it is quality of the decisions rather than the quality of the data that will accelerate the control of malaria.

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Abbreviations

ITN	insecticide-treated net
LLIN	long-lasting insecticidal net
PCR	polymerase chain reaction
RDT	rapid diagnostic test
WHO	World Health Organization

Acknowledgements

In 1994, a document from the WHO Regional Office for Africa described information systems for the evaluation of malaria programmes and included indicators for inpatient (severe) malaria cases and malaria deaths.[1] The 20th report of the WHO Expert Committee on Malaria (1998) included epidemiological indicators with standardized case definitions.[2] Malaria was one of 40 diseases included in the *WHO recommended surveillance standards*, published in 1999.[3]

In 2007–2008, WHO released three documents on malaria elimination that provided guidance on surveillance.[4,5,6] Information on surveillance during the elimination phase is also available from the WHO Regional Office for Europe (in Russian). WHO published recommended indicators for monitoring malaria programmes in the *World malaria report* in 2008, 2009, 2010 and 2011.

In 2008, a document on disease surveillance and indicators for malaria control was prepared by the Global Malaria Programme at WHO. In April 2009, a WHO Global Malaria Programme Technical Advisory Group reviewed the disease surveillance guidelines and indicators for the control phase. The group recommended that WHO also prepare surveillance and indicator guidance for the elimination phase.

New versions of the manuals for disease surveillance for malaria control and elimination were produced in 2010 and revised in July 2011, before being reviewed by WHO regional offices and external partners , including members of the Roll Back Malaria (RBM) Monitoring and Evaluation Reference Group (MERG).

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[2] *Expert Committee on Malaria: twentieth report.* Geneva, World Health Organization, 1998 (WHO Technical Report Series No. 892). Available online at **http://whqlibdoc.who.int/trs/WHO_TRS_892.pdf**.

[3] Available online at **http://www.who.int/csr/resources/publications/surveillance/whocdscsrisr992.pdf**.

[4] *Guidelines on the elimination of residual foci of malaria transmission*. Cairo, WHO Regional Office for the Eastern Mediterranean, 2007 (EMRO Technical Publications Series 33). Available online at **http://www.emro.who.int/dsaf/dsa742.pdf**.

[5] *Malaria elimination: a field manual for low and moderate endemic countries*. Geneva, World Health Organization, 2007. Available online at **http://whqlibdoc.who.int/publications/2007/9789241596084_eng.pdf**.

[6] *Global malaria control and elimination: report of a technical review.* Geneva, World Health Organization, 2008. Available online at **http://whqlibdoc.who.int/publications/2008/9789241596756_eng.pdf**.

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Glossary

Active case detection: The detection by health workers of malaria infections at community and household level in population groups that are considered to be at high risk. Active case detection can be conducted as fever screening followed by parasitological examination of all febrile patients or as parasitological examination of the target population without prior fever screening.

Annual blood examination rate: The number of examinations of blood slides for malaria by microscopy per 100 population per year.

Case-based surveillance: Every case is reported and investigated immediately (and also included in the weekly reporting system).

Case definition (control programmes)

Confirmed malaria: Suspected malaria case in which malaria parasites have been demonstrated in a patient's blood by microscopy or a rapid diagnostic test.

Presumed malaria: Suspected malaria case without a diagnostic test to confirm malaria but nevertheless treated presumptively as malaria.

Suspected malaria: Patient illness suspected by a health worker to be due to malaria. The criteria usually includes fever. All patients with suspected malaria should receive a diagnostic test for malaria, by microscopy or a rapid diagnostic test.

Case definition (elimination programmes)

Autochthonous: A case acquired by local transmission, i.e. an indigenous or introduced case (also called 'locally transmitted')**.**

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

Indigenous: Any case contracted locally (i.e. within national boundaries), without strong evidence of a direct link to an imported case. These include delayed first attacks of *P. vivax* malaria due to locally acquired parasites with a long incubation period.

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

Introduced: A case contracted locally, with strong epidemiological evidence linking it directly to a known imported case (first generation from an imported case, i.e. the mosquito was infected from a case classified as imported).

Locally transmitted: A case acquired by local transmission, i.e. an indigenous or introduced case (also called 'autochthonous').

Malaria: Any case in which, regardless of the presence or absence of clinical symptoms, malaria parasites have been confirmed by quality-controlled laboratory diagnosis.

Case investigation: Collection of information to allow classification of a malaria case by origin of infection, i.e. whether it was imported, introduced, indigenous or induced. Case investigation includes administration of a standardized questionnaire to a person in whom a malaria infection is diagnosed.

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

Case notification: Compulsory reporting of detected cases of malaria by all medical units and medical practitioners, to either the health department or the malaria elimination service (as laid down by law or regulation).

Certification of malaria-free status: Granted by WHO after proof beyond reasonable doubt that the chain of local human malaria transmission by Anopheles mosquitoes has been fully interrupted in an entire country for at least 3 consecutive years.

Control charts: Figures summarizing information on key malaria indicators collected by surveillance for regular, periodic review by malaria control programme personnel.

Discharge register: List of patients who leave inpatient hospital care. Discharge registers should contain the date of admission, patient's name, residence, age, sex, diagnosis, length of stay and reason for leaving (discharged, died, transferred, absconded). This information should be abstracted from the patient file by appropriately trained staff.

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

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

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

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

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

False negative (or false positive): A negative (or positive) result in a test when the opposite is true.

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

Gametocyte: The sexual reproductive stage of the malaria parasite present in the host's red blood cells.

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

Intervention (public health): Activity undertaken to prevent or reduce the occurrence of a health condition in a population. Example of interventions for malaria control include the distribution of insecticide-treated mosquito nets, indoor residual spraying with insecticides, provision of effective antimalarial therapy for prevention or curative treatment of clinical malaria.

Line list: Information on cases recorded in rows and columns, with data for each case in columns across one row. The information may include case identification number; demographic factors (patient's name, address, age, sex); clinical factors (date of attendance, type of test, test result, treatment received); intervention factors (house sprayed, insecticide-treated net ownership, preventive therapy).

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

Malaria-free: An area in which there is no continuing local mosquito-borne malaria transmission, and the risk for acquiring malaria is limited to introduced cases.

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

Malaria prevalence: The number of malaria cases at any given time in a specified population, measured as positive laboratory test results.

Monitoring (of programmes): Periodic review of the implementation of an activity, seeking to ensure that inputs, deliveries, work schedules, targeted outputs and other required actions are proceeding according to plan.

National focus register: Centralized computerized database of all malaria foci in a country.

National malaria case register: Centralized computerized database of all malaria cases registered in a country, irrespective of where and how they were diagnosed and treated.

Outpatient register: List of patients seen in consultation in a health facility, which may include the date of the consultation, patient's age, place of residence, presenting health complaint, test performed and diagnosis.

Parasite prevalence: Proportion of the population in whom Plasmodium infection is detected at a particular time with a diagnostic test (usually microscopy or a rapid diagnostic test).

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

Population at risk: Population living in a geographical area in which locally acquired malaria cases occurred in the current and/or previous years.

Rapid diagnostic test: An antigen-based stick, cassette or card test for malaria in which a coloured line indicates that plasmodial antigens have been detected.

Rapid diagnostic test positivity rate: Proportion of positive results in rapid diagnostic tests among all the tests performed.

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

Re-establishment of transmission: Renewed presence of a constant measurable incidence of cases and mosquito-borne transmission in an area over a succession of years. An indication of the possible re-establishment of transmission would be the occurrence of three or more introduced and/or indigenous malaria infections in the same geographical focus, for 2 consecutive years for P. falciparum and for 3 consecutive years for *P. vivax*.

Relapse (clinical): Renewed manifestation of an infection after temporary latency, arising from activation of hypnozoites; therefore limited to infections with *P. vivax* and *P. ovale*.

Sensitivity (of a test): Proportion of people with malaria infection (true positives) who have a positive test result.

Slide positivity rate: Proportion of slides found positive among the slides examined.

Specificity (of a test): Proportion of people without malaria infection (true negatives) who have a negative test result.

Surveillance (control programmes): Ongoing, systematic collection, analysis and interpretation of disease-specific data for use in planning, implementing and evaluating public health practice.

Surveillance (elimination programmes): That part of the programme designed for the identification, investigation and elimination of continuing transmission, the prevention and cure of infections and final substantiation of claimed elimination.

Transmission intensity: Rate at which people in a given area are inoculated with malaria parasites by mosquitoes. This is often expressed as the 'annual entomological inoculation rate', which is the number of inoculations with malaria parasites received by one person in 1 year.

Transmission season: Period of the year during which mosquito-borne transmission of malaria infection usually takes place.

Vector control: Measures of any kind against malaria-transmitting mosquitoes intended to limit their ability to transmit the disease.

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

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

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

Vulnerability: Either proximity to a malarious area or frequent influx of infected individuals or groups and/or infective anophelines.

1. Surveillance in different phases of malaria control

1.1 Introduction

A malaria surveillance system consists of the tools, procedures, people and structures that generate information on malaria cases and deaths, which can be used for planning, monitoring and evaluating malaria control programmes. An effective malaria surveillance system enables programme managers to:

- identify the areas or population groups most affected by malaria;
- identify trends in cases and deaths that require additional intervention, e.g. epidemics; and
- assess the impact of control measures.

With this information, programmes can direct resources to the populations most in need and respond to unusual trends, such as outbreaks of cases or the absence of a decrease in the number of cases despite widespread implementation of interventions. As a result, progress in malaria control can be accelerated and wastage of resources avoided.

The design of malaria surveillance systems depends on two factors: (i) the level of malaria transmission and (ii) the resources available to conduct surveillance. In the initial phase of control, there are often so many malaria cases that it is not possible to examine and react to each confirmed case individually: rather, analysis is based on aggregate numbers, and action is taken at a population level. As transmission is progressively reduced, it becomes increasingly possible, and necessary, to track and respond to individual cases. Table 1 illustrates the way in which malaria surveillance is undertaken in different transmission settings and phases of control.

Table 1 Malaria surveillance in different transmission settings and phases of control

	Control phase		**Elimination phase**
Transmission:	**High & moderate**	**Low**	**Very low**
Parasite prevalence (2-9 yrs):	>10%	<10%	
Incidence:	Cases and deaths common and concentrated in <5 yrs	Cases and deaths less common and are distributed according to degree of exposure	Cases sporadic
	Limited temporal variation	Variable within and between years Risk of epidemics	Imported cases are high proportion of total
	Limited geographical variation	Geographical heterogeneity Concentrated in marginal populations	Focal distribution
Fevers:	Proportion of fevers due to malaria relatively large	Proportion of fevers due to malaria small	Proportion of fevers due to malaria very small
Health facility attendance:	High proportion due to malaria	Low proportion due to malaria	
Vectors:	Efficient	Controlled efficient/ inefficient	Controlled efficient/ inefficient
Aims of program:	Mortality & case reduction	Case reduction	Eliminate transmission

Table 1 Malaria surveillance in different transmission settings and phases of control			
Surveillance system:			
Resources:	Low expenditures per head Low quality and poor accesibility of services	Widespread availability of diagnostics and treatment	Resources to investigate each case
Data recording:	Aggregate numbers	Aggregate numbers Lists of inpatients and deaths → lists of all cases	Case details
Investigation:	Inpatient cases	Inpatient cases → all cases	Individual cases

The term 'high transmission' has usually been used to indicate hyper- and holoendemic malaria (parasite prevalence in children aged 2–9 years > 50%), 'moderate transmission' to indicate mesoendemic malaria (10–50% parasite prevalence) and 'low transmission' to indicate hypoendemic malaria (parasite prevalence < 10%)[1,2]. The threshold of 10% is used to characterize low transmission in this manual for consistency and to provide a general guide to the types of malaria surveillance possible at different levels of malaria endemicity. The thresholds are not, however, fixed, and surveillance strategies for low-transmission settings might sometimes be more appropriately undertaken when parasite prevalence is < 5% rather than < 10%.

1.2 Control phase: high- and moderate-transmission settings

High- and moderate-transmission settings are generally characterized by: (i) a concentration of malaria cases and deaths in children under 5 years of age, with pregnant women also susceptible to the effects of malaria; (ii) a high proportion of cases due to *Plasmodium falciparum*; (iii) suspected malaria comprising a high percentage (typically > 20%) of outpatient attendances, hospital inpatients and recorded deaths; (iv) a high proportion of fevers due to malaria, (although generally < 30%); (v) high parasite prevalence rates in children (> 10%); (vi) efficient anopheline vectors; and (vii) a high frequency of malaria-related deaths.

High- and moderate-transmission settings are often found in low-income countries, which have low expenditures per person on health care services. This results in weak health systems that are not easily accessed by the population, lower staff to patient ratios, frequent interruptions of medical supplies and limited use of parasitological diagnosis. In such settings, the primary emphasis of malaria programmes has often been on reducing mortality (by prevention and appropriate management of severe cases) and the secondary emphasis on case reduction. The features of surveillance in high-transmission settings are shown in Box 1.1.

[1] *Terminology of malaria and of malaria eradication. Report of a drafting committee.* Geneva, World Health Organization, 1963.

[2] Hay SI, Smith DL, Snow RW. Measuring malaria endemicity from intense to interrupted transmission. *Lancet Infectious Diseases*, 2008, 8:369–378.

BOX 1.1.

Features of malaria surveillance systems in the control phase: high- and moderate-transmission settings

Registers of individual cases are maintained at health facilities, which allow recording of diagnostic tests performed and test results. Given the high frequency of malaria cases and the limited resources for maintaining an extensive recording and reporting system, malaria surveillance systems rely on the reporting and use of aggregate data by district and higher administrative levels. Malaria surveillance is frequently integrated into a broader system of health information or communicable disease surveillance.

At the health facility level, case-based surveillance of malaria inpatient cases and deaths is undertaken with the aim of responding to cases of severe disease and attaining a target of zero malaria deaths. Cases are graphed monthly to assess the extent to which control measures are reducing the incidence of malaria.

At district and national levels, cases and deaths are summarized monthly on five control charts, in order to assess the efficacy of malaria control interventions and identify trends that require an urgent response. The control charts cover: (i) malaria incidence and mortality rates; (ii) proportional malaria incidence and mortality rates; (iii) general patient attendance rates; (iv) diagnostic activity (annual blood examination rate); and (v) quality of diagnosis and health facility reporting. Analysis is also undertaken by health facility catchment area and by district in order to set priorities for malaria control activities.

1.3 Control phase: low-transmission settings

Low-transmission settings are characterized by (i) a lower incidence of confirmed malaria cases; (ii) a more uniform spread of cases by age or more concentrated in population groups with higher exposure; (iii) lower malaria mortality rates; (iv) a parasite prevalence in children aged 2–9 years < 10%; (v) generally more seasonal malaria, with a higher risk of epidemics;[1] (vi) a small proportion of fevers attributable to malaria, especially in the low-transmission season; (vii) malaria distribution more focal within districts; and (viii) imported cases comprising a significant proportion of all cases. In some temperate and subtropical areas, *P. vivax* may occur in higher proportions, particularly as *P. falciparum* disappears more quickly than *P. vivax* in response to control measures.

Health systems in low-transmission settings are usually stronger than in high-transmission settings, and there may be widespread availability of parasitological diagnosis and appropriate treatment. Malaria may, however, be concentrated in marginalized populations, such as those living in remote border areas, migrant workers and tribal populations, and innovative ways may have to be found to reach these groups. The features of malaria surveillance in low-transmission settings are shown in Box 1.2.

[1] The two types of setting with low transmission are (i) locations in transition from high or moderate transmission to low transmission and (ii) locations that have had low transmission for many years because of environmental factors or less efficient vectors. Epidemics may be more likely in areas in which malaria control has been successful and in which efficient anopheline vectors remain.

BOX 1.2.

Features of malaria surveillance systems in the control phase: low transmission settings

Registers of individual malaria cases are maintained at health facilities, with records of the diagnostic tests performed and the results. As well as aggregate data being reported to district and higher administrative levels, line lists of inpatients and inpatient deaths are forwarded to district level, and, when case loads and district capacity permit (for example, < 150 patients per district per month), lists of all confirmed cases are submitted monthly.

At health facility level, case-based surveillance of malaria cases and deaths is undertaken, with the aim of identifying population groups with the highest malaria incidence and probable sources of infection. Cases are graphed daily or weekly to identify trends that require attention and are mapped by village to identify clusters of cases.

At the district level, malaria cases and deaths are summarized weekly or monthly on the same five control charts used in high-transmission settings, in order to assess the impact of malaria control interventions and identify trends that require urgent response. The control charts cover: (i) malaria incidence and mortality rates; (ii) proportional malaria incidence and mortality rates; (iii) general patient attendance rates; (iv) diagnostic activity (annual blood examination rate); and (v) quality of diagnosis and health facility reporting. Analysis is undertaken by health facility catchment area and by village in order to set priorities for activities. A register of severe cases and deaths is maintained and investigations undertaken to identify and address programme weaknesses.

At national level, cases and deaths are summarized monthly on the five control charts in order to assess the impact of malaria control interventions. Analysis is undertaken by district in order to set priorities for activities.

1.4 Elimination phase

In the elimination phase, cases occur sporadically or in distinct foci. Imported cases may comprise a significant proportion of all cases and may pose a risk for re-establishment of transmission in areas in which it had previously been interrupted. Countries have resources to investigate each case to ascertain whether it is imported or locally acquired and undertake appropriate control measures. Box 1.3 shows the features of surveillance in elimination settings.

BOX 1.3.

Features of malaria surveillance systems in the elimination phase

Case-based surveillance is performed. Each confirmed case is immediately notified to district, provincial and central levels. A full investigation of each case is undertaken to determine whether it was imported, acquired locally by mosquito-borne transmission (introduced, indigenous, relapsed) or induced. The national reference laboratory reconfirms all positive test results and a sample of negative test results and organizes laboratory participation in a national quality assurance network.

Each new focus of transmission is investigated, including an entomological investigation, to ascertain risk factors and devise the optimal strategies for control. The focus is classified, and its status is updated continuously.

The malaria programme monitors the extent of surveillance, mainly by tracking blood examination rates by village and by month in high-risk foci and comparing the number of diagnostic tests done with the number expected.

Programme managers at district level keep: (i) malaria case investigation forms, patient records, focus investigation forms and a register of foci with changes in status; (ii) maps showing the distribution of cases by household, vector breeding places, possible sites of transmission and geographical features, such as hills, rivers and roads; and (iii) data on integrated vector control interventions.

Full documentation of programme activities and surveillance results is kept securely at national level in preparation for certification of malaria elimination.

There are no strict rules about when countries change their approach to surveillance. This depends on the level of malaria transmission and the capacity of the control programme to perform specific surveillance activities. Some countries in relatively high-transmission settings may adopt certain approaches used in low-transmission settings, and their control programmes would be expected to progress more rapidly as a result of better targeting of interventions. Many low-transmission countries may wish to adopt certain approaches used in the elimination phase. Different approaches may be used in different settings within a country, particularly when transmission intensity varies geographically.

This manual describes the general principles that govern surveillance systems in the control phase (in high-, moderate- and low-transmission settings), including case definitions, procedures for case detection and indicators for programme management. It also outlines recommended practices for recording, reporting and analysing data and presents factors to be considered when establishing surveillance systems in the control phase. The companion manual, entitled *Disease surveillance for malaria elimination*, covers similar topics in settings in which the programme is oriented towards eventual malaria elimination.

2. Concepts of malaria surveillance in the control phase

2.1 Introduction

The objective of malaria control is to reduce the incidence of and mortality from malaria as rapidly and economically as possible. Surveillance systems can help programme managers to do this, by providing information on the populations in which the incidence of malaria is highest (and therefore to whom resources should be targeted) and on changes in incidence over time that require attention.

The main source of information for malaria surveillance in the control phase is reports of confirmed malaria cases, malaria inpatients and malaria deaths obtained from all or selected public sector health facilities. These may be complemented by data from household surveys on the prevalence of parasitaemia and intervention coverage.

In high- and moderate-transmission areas, monthly counts of malaria cases, inpatients and deaths can be used to determine trends over time and the geographical distribution of malaria. At health facility level, data on individual patients are used to investigate the circumstances surrounding each admitted case and death, so as to identify programme weaknesses and potential improvements. As transmission is reduced and the risk of epidemics increases, more frequent analysis of cases is undertaken at health facility level to allow early detection of potential outbreaks. Moreover, as the numbers of severe cases and deaths diminish, health facilities can report details of each malaria inpatient and death to district level so that a district register of severe cases can be assembled and action taken to address persistent problems.

In low-transmission areas when there is appreciable heterogeneity in the distribution of malaria, it becomes increasingly important to identify the population groups most susceptible to infection and to target resources appropriately. When the case incidence is reduced sufficiently, health facilities can begin to report details of individual malaria cases to district level. These reports can be used to construct a case register that provides more detailed information on the principal locations and population groups affected by malaria.

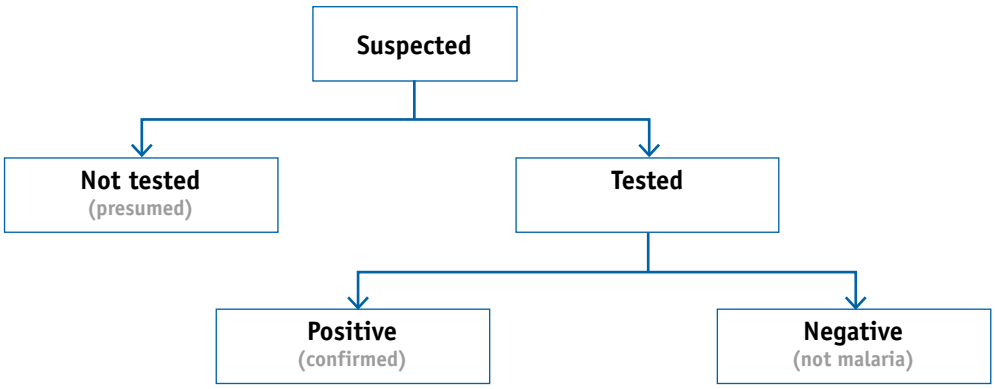
In the initial phases of building an effective malaria surveillance system, attention will focus on ensuring good-quality data. This involves making sure that all people with suspected malaria receive a diagnostic test, that cases are correctly classified according to the test result, that there is a quality management system for both microscopy and rapid diagnostic tests (RDTs), and that registration and reporting from health facilities are complete and consistent. The quality of surveillance systems must be monitored continuously by maintaining an up-to-date list of operational health facilities, keeping track of which facilities have submitted the required reports, following up on missing reports, reviewing the data submitted and following up on incomplete or erroneous data as well as providing positive feedback to health facilities that submit timely, complete, accurate data. Data from surveillance must also be interpreted carefully to identify any weaknesses in systems.

2.2 Case definition

Malaria cases

Although WHO now recommends that all suspected cases of malaria be confirmed with a diagnostic test before treatment (the different types of diagnostic test are described in Annex 1), this is not yet the practice in all settings, either because access to diagnostic testing is not yet available or because of stock-outs of RDTs or the materials necessary to prepare and examine blood films by microscopy. Thus, it is necessary to distinguish between suspected malaria cases, presumed cases and confirmed cases. The relations among these categories are shown diagrammatically in Figure 1.

FIGURE 1.



Suspected malaria case: In a suspected case, a patient is suspected by a health worker of having malaria. The criteria for suspected malaria usually include fever or a history of fever, but the precise criteria vary according to local circumstances and are established by the national malaria control programme.[1] All suspected cases of malaria are tested by either microscopy or an RDT.

Presumed (not tested) malaria case: In a suspected malaria case, the patient did not receive a diagnostic test for malaria but was nevertheless treated for malaria. Such cases have also been referred to as 'probable' cases;[2] however, in most settings, the chance that a suspected case will be confirmed is < 50%, and therefore use of the term 'probable' is inappropriate. Such cases are also sometimes referred as 'unconfirmed' cases. In this guide, the term used is 'presumed malaria case'.

Confirmed malaria case: A suspected case of malaria in which malaria parasites have been demonstrated, generally by microscopy or a RDT, becomes a confirmed case. The definition implies that the patient displayed symptoms of malaria, and the presence of parasites was confirmed. In some suspected cases with a positive test, particularly in populations that have acquired immunity to malaria, febrile illness may be due to other causes. Nevertheless, a diagnosis of confirmed malaria is still given. If a concurrent disease is suspected, it should be further investigated and treated.

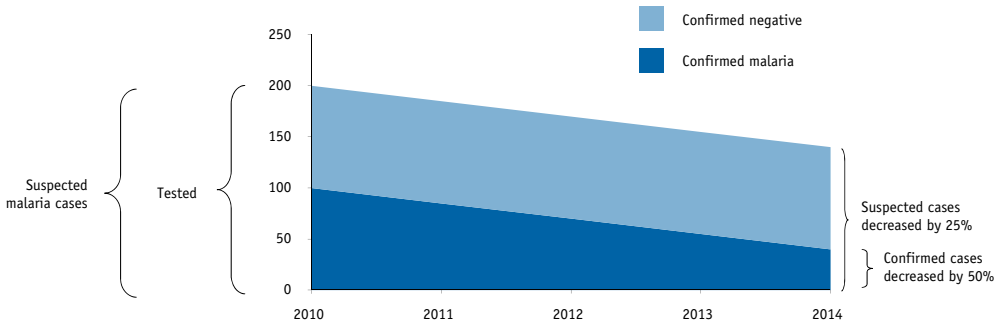
Not malaria (confirmed not to be malaria): Patients with suspected malaria for whom a diagnostic test was negative would usually be given a diagnosis other than malaria. It is possible that some patients who test negative by microscopy or RDT have very low levels of parasitaemia that are detectable only by more sensitive techniques, such as polymerase chain reaction (PCR)[3] testing. Microscopy or RDT might have to be repeated if no other source of fever is identified and the symptoms continue. Such low levels of parasitaemia are generally considered not to be clinically significant in most settings, and diagnostic testing with microscopy or RDT should allow adequate tracking of malaria trends.

[1] *Universal access to malaria diagnostic testing; an operational manual*. Geneva, World Health Organization, 2011.
[2] *WHO expert committee on malaria: twentieth report*. Geneva, World Health Organization, 1998.
[3] Polymerase chain reaction is a highly sensitive test for detecting very small amounts of genetic material from parasites.

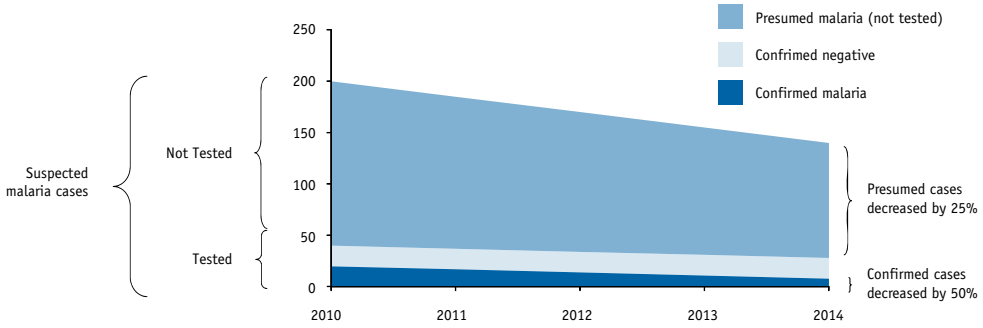
As a high proportion of suspected and presumed cases (generally > 70%[1]) are not malarious fevers, these counts do not provide good measures for malaria surveillance (see Box 2.1). Malaria surveillance should therefore be based on confirmed cases. It is also important to report the different categories (suspected, presumed and confirmed) separately; it is not helpful to add these numbers (e.g. to report presumed plus confirmed cases), as the final values are not comparable over time when the incidence of malaria in the community changes.

BOX 2.1.

Advantage of focusing on confirmed cases of malaria



The example above shows trends in malaria in a district in which 100% of suspected cases were tested for malaria. It can be seen that non-malarial fevers comprised 50% of all suspected malaria cases in 2010. Between 2010 and 2014, it is projected that the number of confirmed malaria cases will drop by 50%, while that of non-malarial fevers will remain constant. The number of suspected cases will drop by only 25%, and most will not be due to malaria. Thus, surveillance of confirmed malaria cases is far more sensitive to programme change than surveillance of suspected cases.



The example above shows trends in malaria for a district with the same trends in malaria as above but in which testing is done on only 20% of suspected cases of malaria. Although the numbers of confirmed cases detected will be smaller, the trend is similar to that above: between 2010 and 2014, the number of confirmed malaria cases is predicted to drop by 50%; however, the number of presumed or untested cases will drop by only 25% and, if tested, most would not be malaria in 2014. Similarly, the number of presumed plus confirmed cases will drop by only 25%. Thus, surveillance of confirmed malaria cases is more sensitive to programme change than surveillance of presumed cases.

[1] D'Acremont V, Lengeler C, Genton B. Reduction in the proportion of fevers associated with *Plasmodium falciparum* parasitaemia in Africa: a systematic review. *Malaria Journal*, 2010, 9:240.

Severe malaria cases and deaths

Malaria cases can be categorized as uncomplicated or severe. The clinical features of severe malaria are listed in Annex 2. In general, people with uncomplicated malaria are treated as outpatients, while those with severe malaria are managed as inpatients.[1] For surveillance purposes during the control phase, therefore, outpatient and inpatient malaria cases are considered proxies for uncomplicated and severe malaria, respectively.[2]

The numbers of inpatient malaria cases and deaths should be taken from the register of discharges in which malaria is the primary diagnosis. If a discharge register is not kept, inpatient cases may be recorded from ward books, although the diagnosis at the time of admission should not be used for surveillance, as this may be presumed rather than confirmed malaria. Inpatients with a primary discharge diagnosis of malaria should have had a positive test for malaria during hospitalization. If parasite-based testing is not available, the discharge diagnosis on clinical grounds and response to treatment are used to assign the discharge diagnosis. The predictive value of a discharge diagnosis on clinical grounds for severe malaria is considered to be higher than for uncomplicated malaria and can be used for surveillance purposes if testing is not available. Diagnostic testing should be introduced for inpatients as a priority, to enhance not only malaria surveillance but also treatment outcomes.

The numbers of inpatients and deaths at all hospitals and health centres with beds should be reported.

2.3 Case detection

Cases can be detected passively or actively.

Passive case detection

Passive case detection is the regular or periodic collection of data from case reports or registers in health care facilities at which patients seek care at their discretion. Passive case detection can also include mobile health services at defined posts, additional fixed health posts in high-transmission or problem areas and treatment in community-based programmes at which patients seek care at their discretion.

Active case detection

Active case detection involves searching for malaria cases and diagnostic testing at the community or household level by health workers on regular or occasional visits. Testing may be confined to patients with fever, or everyone may be tested (mass screening). Active case detection can be done to fill gaps in passive case detection systems (e.g. to detect cases in populations with limited access to services, such as migrant populations). This is sometimes known as 'proactive' case detection, in which a population is examined even though there may be no evidence of confirmed cases. Active case detection may also be undertaken in response to a confirmed case or cluster of cases, in which a defined population potentially linked to a confirmed case is identified, and symptomatic cases are tested (possibly with a RDT then by blood slide for confirmation) as well as asymptomatic cases (by blood slides only). This is sometimes known as 'reactive' case detection.

[1] Some countries with low transmission and in the elimination phase might admit uncomplicated malaria cases to ensure full adherence to treatment.

[2] The use of inpatient malaria cases as a proxy for severe malaria in Africa is described in *Information systems for the evaluation of malaria programmes. A practical guide*. Brazzaville, WHO Regional Office for Africa, 1994 (AFRO/CTD/94.3).

In general, malaria surveillance in the control phase relies on passive case detection, particularly monthly or weekly reports of confirmed malaria cases submitted by public health facilities. These may be supplemented by reports from private health facilities run by religious organizations, mining companies or other organizations that have an agreement to report to the ministry of health. Reports of cases tested and treated by community health workers should also be included in the surveillance system, when such programmes exist.

Monthly reports from health facilities should distinguish between cases detected passively, actively and in the community; otherwise, trends in the number of cases could be affected by the extent of active case detection undertaken each month or irregular reporting from community health workers.

As malaria incidence decreases and becomes increasingly focused in marginalized populations, active case detection and community health workers are likely to have more important roles in identifying cases.

2.4 Surveillance indicators

In the initial phase of malaria control in high-transmission settings, there are so many malaria cases that it is not possible to examine and react to each case individually; rather, much analysis is based on aggregate counts of cases and deaths, and action is taken at a population level, e.g. deciding which populations would benefit from additional measures, such as indoor residual spraying.[1] The counts might, however, have to be adjusted to take into account population size, diagnostic activity or other factors, thus transforming numbers into 'indicators', so that they provide more meaningful information (see Box 2.2). Ten indicators are particularly useful for malaria surveillance in the control phase (see Annex 3 for full definitions):

1. Number of confirmed malaria cases per 1000 population per month or per year

This indicator can be calculated by month and by year. The number of malaria cases fluctuates with the transmission season; it can be useful in assessing the success of preventive programmes and demand for treatment in the public sector. The variable is, however, sensitive to changes in reporting rates, diagnostic practice and use of health facilities. Care should be taken to ensure that reporting has been consistent over time, by examining trends in health facility reporting rates, annual blood examination rates and total outpatient attendance. If these indicators have changed, it may be more informative to examine trends in test positivity rates (slide or RDT) or confine the analysis to a subset of health facilities that have reported consistently over time.

[1] An exception would be the investigation of severe cases and deaths, which would initially be undertaken at health facility level with support from districts.

BOX 2.2.

Adjusting for population size: calculating incidence rates

Absolute numbers of malaria cases, inpatients and deaths can be used to examine trends over time and can help to identify places in which the problem of malaria is greatest. Absolute numbers are less useful for assessing which populations are at the highest risk for acquiring malaria, as most geographical units have different population sizes. For example, it is difficult to decide whether 100 cases in a population of 3400 represents a higher risk for acquiring malaria than 270 cases in a population of 8500. In order to make comparisons between populations easily, the number of cases is usually expressed for a standard population of 1000 or 10 000, by dividing the number of cases by the population size and multiplying by the standard size of population desired.

Population A: 100 cases per 3400 population x 1000 = 29.4 cases per 1000 population

Population B: 270 cases per 8500 population x 1000 = 31.8 cases per 1000 population

Adjustment to a standard population can also be used to take into account the growth of populations over time, which may be significant when examining trends in cases over an extended period such as 10 years.

The denominator is generally the *population at risk* for malaria. This is defined as the population in areas in which there is ongoing transmission of malaria. People travelling to such areas may acquire malaria, but these are not normally included in the population at risk. For international comparisons and other situations in which information on the overall risk to populations is desired (including those not exposed to malaria), the *total population* of a country may be used as the denominator. If cases are broken down by age, sex or occupational group, the size of these groups should be used as the denominator.

Programme managers may also be interested in knowing the size of other populations (e.g. those living in areas where vectors are circulating or target populations for interventions), but these are generally not used for calculating incidence rates.

Estimates of population size published by the relevant government department should be used (e.g. the statistical office, planning bureau or census office). These are usually based on projections from censuses undertaken at intervals of approximately 10 years. Population growth rates between censuses are used to project population sizes after the latest census. Thus, as the time for the next census approaches, the population projections may deviate considerably from the actual population sizes, particularly at local level. When new census results are released, the projected populations calculated for previous years must be updated to take into account the latest—and more accurate—counts.

2. Number of inpatient malaria cases per 10 000 population per month or per year and

3. Number of inpatient malaria deaths per 100 000 population per month or per year

These two variables are indicators of severe malaria and deaths and are therefore also important for judging the success of malaria programmes. In order to monitor trends, it is often more informative to examine the number of inpatient cases, owing to the comparative rarity of deaths. For instance, a district with a population of 100 000 and a crude birth rate of 35 per 1000 population, a rate of mortality of children under 5 years of 100 per 1000 births and 25% of deaths due to malaria may expect fewer than 9 malaria deaths per year. If 20% of the deaths occur in health facilities, a district will expect to record fewer than 20 malaria deaths per year (or two per month), although they may be clustered according to seasons with the highest transmission. In contrast, with a case fatality rate of 2%, the same district could see 100 inpatient malaria cases per month.

The numbers of inpatient malaria cases are known to fluctuate by malaria transmission season and are sensitive to changes due to malaria control activities, decreasing rapidly when high coverage with interventions has been achieved.[1] The rapidity of changes in the numbers of malaria inpatients and deaths might also be influenced by the initial level of transmission, with more gradual change in areas with the highest transmission intensity and higher parasite prevalence in children.

Inpatient cases should be confirmed by parasitological diagnosis. In situations where parasitological testing is not common, an inpatient diagnosis of malaria is nevertheless considered to be more specific than an outpatient diagnosis, and, despite the possibility of overdiagnosis, trends in inpatient malaria cases are likely to reflect real changes.

As for malaria cases, care should be taken to ensure that reporting of inpatient cases has been consistent over time. It is therefore important to examine trends in health facility reporting rates, as well as total numbers of inpatients and deaths. If there have been changes in these indicators, it may be more informative to examine trends in the proportions of inpatients and deaths due to malaria or to confine the analysis to the subset of health facilities that have reported consistently over time.

Trends in the numbers of inpatient malaria cases and deaths should align with the total number of confirmed malaria cases, and any differences should be investigated. These may be due to: reporting issues (e.g. some health facilities may not report inpatient data), differences in diagnostic practice over time or real changes (e.g. a decrease in the proportion of cases becoming severe because of improved access to more timely, effective treatment).

4. Malaria test positivity rate (RDT and/or slide positivity rate)

This indicator can provide information on trends in malaria. In some settings, slide positivity rates have decreased from 30–60% to < 10% in response to control measures implemented in the previous 2–3 years. Test positivity rates can vary by season, and the peak test positivity rate seen during a year might be quite different from the annual average.

Both slide and RDT positivity rates are less sensitive to changes in reporting rates, diagnostic practices and health facility utilization rates than trends in confirmed cases or incidence rates (because data that are changing are excluded from both the numerator and denominator). For this reason, they may be more helpful in identifying areas in which malaria transmission is most intense than malaria incidence rates (which are particularly affected by the accessibility and use of health facilities as well as reporting rates). They are not, however, immune to distortion. For example, test positivity rates can increase if parasitological diagnosis has been extended to

[1] *World malaria report 2011*, Geneva, World Helath Organization, 2011.

populations living in more intense transmission areas where testing was not available previously. Attention should also be paid to the quality of diagnostic testing and potential changes over time; in some health facilities, poor-quality microscopy can lead to considerable overdiagnosis of malaria.[1] Therefore, possible errors and confounding factors should be taken into account when interpreting trends.

5. Percentage of cases due to P. falciparum

In areas in which more than one species of *Plasmodium* is present, it is useful to monitor the percentage of cases due to *P. falciparum*, as this can provide information on the extent of malaria control, the likelihood of observing severe cases and the extent to which the programme should be adjusted to address *P. vivax* or other species. In areas where control measures are intensified, the proportion of cases due to *P. falciparum* may decrease; *P. vivax* appears to be respond less quickly to control measures because it can tolerate a wider range of environmental conditions and because the dormant liver stage (hypnozoite) enables infections to persist in the absence of mosquito transmission. *P. ovale* and *P. malariae* may also become more frequent, but these are rare in most settings.

6. Percentage of inpatients with a discharge diagnosis of malaria, and

7. Percentage of inpatient deaths due to malaria

These indicators may also be examined to assess trends in malaria. Like test positivity rates, they are less sensitive to changes in reporting rates and health facility use rates. A disadvantage of these indicators is that changes in attendance for conditions other than malaria can affect the percentage of inpatients with a discharge diagnosis of malaria and deaths due to malaria, e.g. non-malaria inpatient cases and deaths in children < 5 years old could decline if child survival and immunization activities have rapidly achieved high coverage (e.g. introduction of vaccination for *Haemophilus influenza*e type B, pneumococcus and rotavirus). Furthermore, changes in the percentages of case and deaths due to malaria (as well as slide positivity rates) will not reflect percentage changes in malaria cases or incidence, as the number of malaria cases is part of the denominator.

8. Annual blood examination rate

This indicator provides information on overall diagnostic activity and can be useful in interpreting trends in malaria cases. While some past guidance suggested that the annual blood examination rate should be in the region of 10% in order to provide reliable trends, the empirical evidence for such a target is not strong. In high-transmission settings, the rate is likely to greatly exceed 10%;[2] e.g. in the Solomon Islands, the rate is 60%, just as a result of passive case detection.

9. Percentage of suspected malaria cases receiving a diagnostic test

Programmes should ensure that the percentage of suspected cases receiving a diagnostic test is 100% by monitoring the indicator continually, finding out why some health facilities achieve < 100% (e.g. because of RDT stock-outs or lack of training) and taking appropriate action. During the period that diagnostic testing is being expanded, it may be difficult to obtain an accurate picture of trends. It is likely that the number of confirmed cases will increase while the number of presumed cases decreases (the number of suspected cases may decrease if guidance on who should be tested is more restricted). Slide and RDT positivity rates might provide some

[1] Kahama-Maro J et al. Low quality of routine microscopy for malaria at different levels of the health system in Dar es Salaam. *Malaria Journal*, 2011, 10:332.

[2] In a population of 10 000, it is expected that about 20%, or 2000, will be under 5 years of age. Each child may have four episodes of fever per year, of which 40%, or 3200, can be expected to be seen at a public health facility. If all receive a diagnostic test, the annual blood examination rate will be 32% for child fevers alone.

information on disease trends but could be influenced by a change in the composition of the population being tested as testing is made more widely available. (It will not be possible to use the percentage of all attendances due to malaria as an indicator, as the indicator is also affected by the change in diagnostic practice.) Alternatively, it may be possible to explore trends in inpatient cases and deaths for anaemia and blood transfusions in children < 5 years, as these are less likely to be affected by a change in the rate of testing.[1] In such situations, it may be preferable to focus the analysis, at least temporarily, on health facilities in which diagnostic practice has not changed much (e.g. health facilities that have always used microscopy), until reliable time series are built up elsewhere.

10. Completeness of reporting

Programmes should ensure that all health facilities report in a timely manner (usually within 2 weeks of a month's end). Completeness of reporting is usually assessed by the number of monthly reports received from health facilities in relation to the number expected (the number of health facilities multiplied by the number of months considered). This indicator gives equal weight to all health facilities and so may not reflect the completeness of case reporting; missing reports from district hospitals are likely to represent a larger number of missing cases than missing reports from remote rural health facilities. In either case, the action required is the same: to follow up missing reports and make arrangements that will facilitate future reporting. Additionally, completeness of reporting does not take into account the extent to which patients attending health facilities fail to be registered (e.g. because of a large patient load). Special studies are needed to assess the extent of this type of problem.

As well as these 10 indicators, it can be useful to examine trends in total outpatient attendance and total numbers of inpatients and deaths to obtain information on overall health facility use, which may be influenced by changes in user fees, opening of roads or political instability; these can strongly affect observed trends in malaria.

2.5 Limitations of surveillance data

Cases reported to malaria surveillance systems represent an incomplete sample of all patients with fever or malaria. In most malaria-endemic countries, less than half of all fever cases attend public health facilities (from which the majority of malaria surveillance reports are derived). The data reported may also be incomplete because not all febrile patients receive a diagnostic test or because health facilities do not register all patients or submit monthly reports. These factors can make comparison of incidence rates among areas difficult (see Box 2.3).

Not only do health facility surveillance reports represent only a fraction of all fever and malaria cases occurring in the community, but they may also represent a biased sample, in that health facility attendees may live closer to the facilities and have better access to medicines and a range of government services and economic opportunities. Therefore, it is possible that trends observed in health facilities are not representative of broader trends in the community. The extent to which bias occurs is influenced by the overall accessibility of services: bias is more likely to occur when only a small percentage of patients with fever or malaria are treated in the health system. Bias is also influenced by the extent to which interventions that affect malaria incidence are correlated with the presence of health facilities. As implementation of some interventions, such as wide-scale distribution of insecticide-treated nets (ITNs) or indoor residual spraying, is not linked to health facilities, reductions in the number of cases are just as likely to occur in populations that are distant from health facilities as those who live close by.

[1] In low-transmission areas, the probability that malaria is the underlying cause of inpatient anaemia in children may be low and hence may not be relevant in monitoring malaria.

BOX 2.3.

Influence of health facility attendance, diagnostic testing and reporting rates on reported malaria incidence rates

While incidence rates derived from surveillance of malaria cases take into account the size of the population, they may not always reflect the true incidence of malaria in the population because:

- The proportion of suspected cases that attend public health facilities (from which most data are derived) may differ by area and over time.
- The proportion of people attending public health facilities who receive a diagnostic test may differ by area and over time.
- Health facility reporting rates may differ by area.

The example below shows two districts, one urban and one rural, with different rates of malaria in the community. The incidence in the urban district is half that in the rural district, but a larger proportion of patients seek care in public health facilities, a larger proportion receive a diagnostic test and a larger proportion of health facilities submit monthly reports. As a consequence of all these factors, the reported incidence of malaria is higher in the urban district (14 per 1000) than in the rural one (12 per 1000).

		Urban district	Rural district
A	True number of cases per 1,000 population	50	100
B	% cases attending public health facilities	60%	40%
	Cases potentially detected per 1,000 (A * B)	30	40
C	% attenders receiving a diagnostic test	60%	50%
	Cases detected per 1,000 (A * B * C)	18	20
D	% health facilities reporting	80%	60%
	Cases detected per 1,000 (A * B * C * D)	14	12
Percentage of all cases detected		29%	12%

Thus, it is sometimes observed that areas with better access to and better health facilities have a higher incidence of malaria than areas with limited access. It is therefore useful to look at other indicators (overall health facility use rates, percentage of cases receiving a diagnostic test, completeness of health facility reporting) to help interpret data. It may also be useful to examine other indicators, such as diagnostic test positivity rates.

If the facility use rates and reporting rates are known, incidence rates derived from malaria cases seen in health facilities can be adjusted for these factors, to provide a more representative estimate of incidence (see *World malaria report 2008*. Geneva, World Health Organization, 2008, Annex 1).

The likelihood of bias can be explored by examining the results of nationally representative household surveys, such as demographic and health surveys, 'multiple indicator cluster surveys' or malaria indicator surveys. These can indicate the extent to which people with fever use public health facilities, private providers or stay at home. Household surveys from around the world suggest that about 40% of people with fever typically seek treatment in public health facilities although the proportion varies between countries and within countries. Not all cases of fever recorded in household surveys will be malaria, however, and it is possible that people with non-malarious fever are less likely to seek treatment in health facilities. Household surveys can also provide information on the extent to which interventions such as ITN distribution are implemented equitably (by wealth quintile or urban or rural area).

Malaria programmes should also estimate the proportion of all deaths that occur in health facilities, by comparing the number of deaths recorded in health facilities with the total number of deaths expected to occur in a country or area (see Box 2.4). This will give some indication of the completeness of death reporting. Even so, the proportionate breakdown of deaths by cause observed in health facilities may not be representative of all deaths that occur in the community.

BOX 2.4.

Calculating the percentage of deaths that occur in health facilities

The number of deaths occurring in a country is calculated by multiplying the total population by the rate at which people die (the crude death rate). Similarly, to calculate the number of deaths occurring in any age group, the population size of each age group is multiplied by the rate at which people in that age group die (age-specific death rate). Population sizes by age group are usually available from statistics bureaux in countries. Age-specific death rates may be available from the same source or can be derived from life tables produced by WHO. Sample calculations for Zambia in 2010 are shown below. These indicate that approximately 20% of deaths occurred in health facilities overall, with slightly higher rates for people over 5 years of age.

	Population[a]	Age specfic death rates[b]	Expected number of deaths	No. of deaths in health facilities[c]	% of deaths occurring in facilities
	A	B	A*B	C	C/(A*B)
0-4	2,412,000	0.03086	74,434	14,370	19%
5+	8,972,000	0.00876	78,595	18,990	24%
Total	**11,384,000**	**0.01344**	**153,029**	**33,360**	**22%**

[a] From *United Nations population prospects 2010*. http://esa.un.org/unpd/wpp/unpp/panel_indicators.htm.
[b] WHO life table. http://www.who.int/healthinfo/statistics/mortality_life_tables/en/index.html.
[c] From Ministry of Health, Zambia.

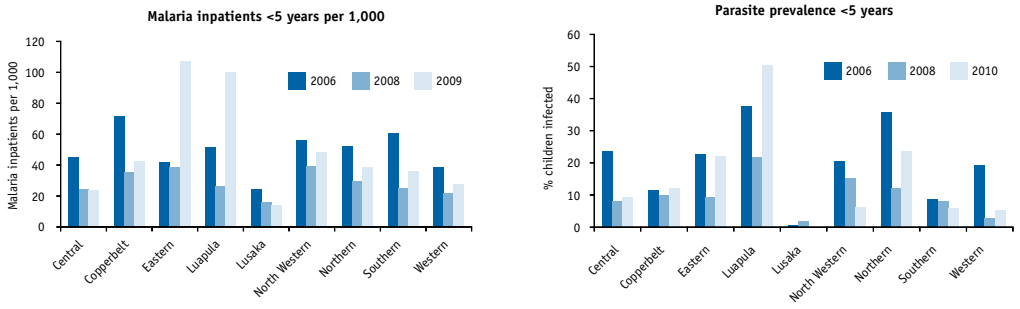
When possible, the results from surveillance systems should be compared with other sources of data to verify interpretations or explore why differences occur. It is of particular interest to examine geographical variation or trends over time in parasite prevalence and the prevalence of anaemia in children under 5. These indicators are measured in an increasing number of household surveys in high- and moderate-transmission settings (see Box 2.5). Nationally representative parasite prevalence surveys are generally less useful when nationwide parasitaemia has declined to < 5%, as measurement errors, seasonality and geographical heterogeneity can make the results difficult to interpret.[1] In these settings, the requirement for large sample sizes and the high associated costs often preclude implementation of such surveys.

[1] Hay SI, Smith DL, Snow RW. Measuring malaria endemicity from intense to interrupted transmission. *Lancet Infectious Diseases*, 2008, 8:369–378.

BOX 2.5.

Comparing surveillance data with household surveys

Zambia reported downward trends in malaria inpatient cases among children under 5 years of age between 2004 and 2008 but in 2009 there were small increases in 5 of 9 provinces and large increases in Eastern and Luapula provinces. Household surveys undertaken in 2006, 2008 and 2010 showed similar increases in parasite prevalence in Eastern and Luapula provinces. An increase in parasite prevalence was also noted in Northern Province. Apart from different measures being used, differences may also be due to the latest parasite prevalence survey being conducted in 2010 whereas the latest year for which surveillance data were available when the analysis was conducted was 2009.



While surveillance data are subject to incomplete reporting and bias, this source of information has the advantage of continuous collection from every district in a country; for most districts, such data are the only readily available source of information on malaria that can be used by programme managers. When surveillance systems are working well, they show consistent seasonal variation in the numbers of cases, coinciding with the pattern of malaria transmission. They also show reductions in morbidity and mortality in response to interventions and can alert managers to unexpected increases. Thus, although results should be interpreted with care, they are a critical source of information for programme management and should not be ignored. Continued efforts to improve reporting systems and use of these data will help to improve the quality of malaria surveillance and the operation of malaria control programmes.

2.6 Using surveillance data

Objectives of surveillance systems

Malaria surveillance systems have two principle objectives, to provide programme managers with information to identify geographical locations and population groups in which the incidence of malaria cases and deaths are greatest and to track changes in the incidence of malaria cases and deaths over time.

Identify geographical locations and population groups in which the incidence of malaria cases and deaths are greatest. Information on where malaria incidence is greatest helps programmes to direct resources to populations in greatest need, e.g. to make sure that sufficient ITNs are available to populations living in high-transmission areas or that laboratory facilities are upgraded in areas with the most suspected cases. Both the absolute numbers of malaria cases and deaths and

the rate per 1000 population are relevant in deciding where resources should be preferentially allocated. On the one hand, it is important to tackle the problem in populations where the risk is greatest; interventions can help to reduce morbidity and mortality in these populations markedly. On the other hand, it is important to ensure that programmes confront the bulk of the problem, as judged by absolute numbers. In high- and moderate-transmission settings, there is generally less geographical heterogeneity than in low-transmission settings; consequently, there may be much less scope to target resources differentially by area, and malaria control interventions may be implemented evenly across a district. As control measures are introduced, however, any heterogeneity in incidence may become more pronounced, reflecting variation in implementing control measures (e.g. gaps in distribution of ITNs, lack of ITN use, insecticide resistance) as opposed to environmental factors.

Follow changes in the incidence of malaria cases and deaths over time. Information on changes in malaria incidence over time can help programme managers to assess whether their interventions have been successful in reducing cases and deaths and can help to detect outbreaks that may require special responses. Programme managers in high-transmission areas will be particularly interested to observe whether the numbers of cases and deaths are being reduced or whether problems are being experienced in some locations and, as a consequence, the programme should be modified. Areas with high malaria transmission are generally not prone to epidemics, although there may still be marked seasonality in the occurrence of malaria and changes from year to year in the intensity of transmission owing to climatic factors. Managers should be aware of and be prepared for such fluctuations.

Change in emphasis as malaria programmes progress

In the initial phase of malaria control, attention is usually focused on strengthening surveillance systems, in particular ensuring improvement in two indicators, namely: the percentage of suspected cases that receive a diagnostic test and completeness of reporting. It may not be possible to undertake all the analyses on malaria morbidity and mortality desired; e.g. it may be difficult to examine trends for an entire district, and attention might have to be confined to health facilities that report consistently, until reliable data are obtained from all facilities. Nevertheless, it is important to try to improve data quality and to review data whenever possible in order to identify problems in implementation and, when possible, accelerate progress in malaria control.

As malaria control programmes are scaled up and transmission declines, the epidemiology of malaria is likely to change in the following ways:

- The numbers of severe and hospitalized cases and deaths decrease markedly.
- The number of uncomplicated confirmed cases decreases.
- Malaria transmission becomes more focal.
- The age distribution of cases, severe cases and deaths shifts to older children and adults.
- Populations become less immune, the risk for epidemics increases, and these may be responsible for significant fatalities in such populations.
- Imported cases may represent an important fraction of the overall incidence.

Improved health infrastructure and changing epidemiology demand a change in the approach to surveillance. As malaria becomes more focal and concentrated in particular population groups, more attention and analysis of indicators by health facility or population groups is needed to target resources more precisely. Malaria may be concentrated in marginalized populations, such as those living in remote border areas, migrant workers and tribal populations, and programmes should find innovative ways to reach these groups.

In low-transmission settings, data must also be reviewed more frequently at health facility level in order to detect outbreaks as soon as possible. Epidemics may be more likely in areas in which malaria has been controlled successfully but in which efficient vectors remain than in areas that have had low levels of transmission due to environmental factors or inefficient vectors. Managers should be alert to malaria outbreaks and be ready to intensify control measures in some locations in order to prevent or contain outbreaks.

Case investigation and reporting of individual cases

In the initial phase of control, it is recommended that each severe malaria case and death be investigated at health facility level, with the support of district staff, to identify and address programme weaknesses (such as poor coverage with ITNs, delays in seeking treatment and stock-outs of antimalarial medicines). As transmission is reduced and the number of severe cases decreases, the opportunities for intensifying investigation of severe cases and deaths increase. It becomes possible to establish a district-wide register of all severe cases, with the aim of investigating and eliminating future cases and addressing programme weaknesses.

As transmission decreases further, malaria programmes at the district level can begin to establish registers of all confirmed malaria cases reported in the district. The registers can contain information on the background characteristics of each case (e.g. location, age, sex, occupational group). Analysis of such registers can help to identify which population groups are most affected, in order better to target interventions and further accelerate malaria control.

Heterogeneity in programme implementation

Malaria control may progress more rapidly in some parts of a country than in others, and the strategy for surveillance may therefore vary; e.g. some districts may rely exclusively on reporting aggregate cases, while others may supplement this with reporting the details of individual cases. Indeed, some parts of a country might be pursuing elimination and therefore have to identify the origin of each case in order to intensify control measures in specific localities to ensure that transmission is halted at the earliest possibly opportunity. Countries with a preponderance of low-transmission areas may wish to examine the manual on *Disease surveillance for malaria elimination* to see if some strategies can be adapted for use in the control phase.

3. Data recording, reporting, analysis and use

3.1 Recording

Communities and health posts

A register should be kept by community health workers and health posts that records, for each attendance, the date of attendance, patient's name, village of residence, sex, age, whether it is a new attendance or repeat visit for the same episode of illness and the malaria test result, diagnosis and treatment given (Annex 4). Such information will allow community health workers or staff at health posts to identify the epidemiological characteristics of malaria in their area (such as the age and sex breakdown of cases and the locations in which most cases originate). In low-transmission settings, travel history and work location may help identify sources of infection. The register should indicate any cases that are subsequently referred.

Health centres and hospitals

Outpatients. A register should be kept at health facility level for each outpatient attendance, which records the date of attendance, patient's name, residence, sex, age, whether it is a new attendance or repeat visit for the same episode of illness, initial diagnosis, type of malaria test, test result, final diagnosis and treatment given (Annex 4). This information will enable staff at the health facility to identify the epidemiological characteristics of malaria in their area (such as the age and sex breakdown of cases and the locations in which most cases originate). In low-transmission settings, travel history and work location may help identify sources of infection. The register should include cases that are subsequently admitted; attempts should also be made to include inpatients who bypass the outpatient department, so that a complete record is kept of all cases attending the health facility. As outpatient registers are used for all outpatients, and not just people with malaria, the existing registers may have to be modified to allow for collection of this information, by the addition of columns or changing column headings. Additional information, beyond that routinely collected in outpatient registers, will be needed for malaria case investigation and reporting of individual cases to district level (see Box 3.2).

Practices for registration of cases vary widely by country. In settings where malaria cases comprise a high proportion of all outpatients, a separate malaria register will not be kept. Ideally, the diagnosis recorded in the outpatient register would be the final diagnosis after administration of a parasitological test (microscopy or RDT); however, in some large health facilities, the outpatient register may list the health condition initially suspected by a health worker in an outpatient department (suspected malaria), while malaria tests are undertaken in a laboratory and the results are recorded in a separate laboratory register (confirmed malaria). The treatment given is sometimes recorded in a hospital pharmacy register (or not at all if patients have to purchase drugs from pharmacies outside a hospital). In such cases, a monthly report may include aggregate numbers for the initial diagnosis (suspected malaria) as well as test results (number tested, number of confirmed cases) and malaria treatment given. While individual patient results are not tracked, there should be correspondence between the number of suspected cases, the

number of confirmed cases and the number of treatments given. In low-transmission settings, a dedicated malaria notification register may be used to record individual case details. Malaria case investigators should collect pages from the register weekly, a first duplicate form being for electronic data entry, a second duplicate for case investigation and the original staying in the health facility.

Tally sheets can also be kept in health facilities to help in calculating the relevant statistics, during the day, at the end of the day or, in less busy clinics, at the end of the week (Annex 5). The tally sheets should be consistent with the requirements of reporting to district level. Daily totals of malaria cases should be recorded in a book, keeping track of daily attendances for all major causes (the categories being be the same as those on the monthly reporting form used in a country). At the end of the week, the daily totals should be tallied to provide a weekly total, and at the end of the month the weekly totals should be tallied to provide monthly totals (Annex 6). Such tally sheets and daily records should be kept for all conditions reported monthly, not just malaria.

Inpatients. Practices for registration of inpatients vary by country. Health facilities may maintain admission, ward and discharge registers. The most important one for malaria surveillance systems is the discharge register, which contains the final diagnosis.[1] Discharge registers should contain the date of admission, the patient's name, residence, age, sex, diagnosis, length of stay and reason for leaving (discharged, died, transferred, absconded) (Annex 7). This information should be abstracted from the patient's file by appropriately trained staff. If a separate discharge register is not compiled, staff may abstract this information on malaria discharges specifically. In smaller health facilities, abstraction may be done by the officer in charge, while in larger facilities this may be undertaken by a medical records clerk, consulting with attending physicians if necessary. In health facilities that undertake disease coding, malaria diagnoses should follow the practices outlined in the relevant version of the *International Classification of Diseases* and identify the species of parasite (see Box 3.1). Note that discharge registers are used for all inpatients and not just those with malaria; additional information will be needed for malaria case investigation and reporting of individual cases to district level.

[1] In disease outbreaks, admission registers may be used to provide more timely information.

BOX 3.1.

Malaria classification in the *International Classification of Diseases* (ICD), revisions 9 and 10

ICD10 codes

B50 *Plasmodium falciparum* malaria

B51 *Plasmodium vivax* malaria

B52 *Plasmodium malariae* malaria

B53 Other specified malaria

B54 Unspecified malaria

ICD9 codes

084 Malaria

084.0 *Falciparum* malaria [malignant tertian]

084.1 *Vivax* malaria [benign tertian]

084.2 Quartan malaria

084.3 *Ovale* malaria

084.4 Other malaria

084.5 Mixed malaria

084.6 Malaria, unspecified

084.7 Induced malaria

084.8 Blackwater fever

084.9 Other pernicious complications of malaria

District level

Teams at district or intermediate level should maintain the following information:

- monthly reports of the number of suspected malaria cases, number of malaria tests performed and number of confirmed cases, with total outpatient attendances, inpatients and deaths. In low-transmission settings, weekly reports may be kept.
- a register of malaria programme health structures and staff (health facilities by type and personnel by specialty: nurse assistants, nurses, clinicians, laboratory technicians, parasitologists, epidemiologists and their professional qualifications). The register should be updated annually and include a list of all health facilities and laboratories undertaking malaria testing.
- maps showing the distribution of confirmed cases, inpatients and deaths by health facility catchment area, village or administrative boundary, to be updated annually; and
- all reports and analyses produced by district staff during the past 5 years and submitted to higher levels. Feedback and other information from higher levels should be collated.

National level

Databases held at national level should have the same structure as those at district level. When possible, information should be recorded by health facility (rather than aggregated by district) to allow a greater range of analyses, although this may be challenging in countries with large numbers of health facilities.

3.2 Reporting

Reports from health posts and community health workers to health facilities

If a health facility supervises health posts or community-based providers, the following data should be reported monthly to the supervising health facility (Annex 8):

- number of suspected malaria cases seen,
- number of suspected malaria cases tested with an RDT,
- number of confirmed malaria cases < 5 years of age (positive RDTs),
- number of confirmed malaria cases aged > 5 years (positive RDTs),
- number of confirmed cases treated with antimalarial medicine,
- number of presumed malaria cases (not tested) treated with antimalarial medicine, and
- number of cases referred to a higher-level facility.

The summed values for these indicators, the number of community health workers expected to report and the actual number reporting can be written on the health facility reporting form. The data should be kept separate and not added to health centre attendances in order to avoid affecting trends over time by fluctuations in reporting from lower-level facilities (e.g. a sudden outbreak of cases may be assumed if several late reports are received from health posts).

Reports from health facilities to the district level

High-transmission settings: Each month, health facilities in high-transmission settings should report to the district level the numbers of:

- suspected malaria cases,
- cases tested by microscopy,
- cases tested by RDT,
- cases confirmed by microscopy (< 5 and > 5 years of age),
- cases confirmed by RDT (< 5 and > 5 years of age),
- confirmed cases treated with antimalarial medicine,
- presumed malaria cases (not tested) treated with antimalarial medicine,
- inpatient cases of malaria (< 5 and > 5 years of age), and
- deaths from malaria (< 5 and > 5 years of age).

Annex 9 gives examples of data elements to be included on report forms. In areas where testing of all suspected cases is standard practice, it might be assumed that it is unnecessary to report suspected cases, as all suspected cases will be tested. Testing might, however, not always be possible, because laboratory staff are off duty or there is a stock-out of RDTs; hence, it recommended to maintain the capacity to report total suspected cases. The numbers of suspected and tested cases should include patients admitted for malaria (i.e. the numbers of discharges, deaths, transfers and absconders). Patients tested with both an RDT and microscopy should be counted only once, either for RDT or microscopy. In areas with a mix of species, a species breakdown should be reported for confirmed cases (number of *P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale*, *P. knowlesi*, and mixed infections).

It is useful to obtain information on the total numbers of new outpatient attendances (< 5 and > 5 years of age), inpatients (< 5 and > 5 years of age) and deaths (< 5 and > 5 years of age). This information should be readily available, as in high transmission areas it is expected that malaria variables would be contained in an integrated health information system.

The number of reports submitted by health facilities to districts and other levels should be kept to a minimum, although there may some advantage in sending duplicate forms to both district and central level simultaneously to speed up the flow of information.

Low-transmission settings: The same three outpatient data elements (suspected, tested, confirmed) and the same two inpatient data elements (cases, deaths) for at least two age groups (< 5 and > 5 years of age) should be reported, with total numbers of outpatients, inpatients and deaths (< 5 and > 5 years of age) (see Annex 9).

As the frequency of severe cases and deaths decreases, line lists of inpatient malaria cases and inpatient deaths can be reported to district level (Annex 10), with the intention of intensifying analysis and response; these represent severe outcomes that should not occur and should be a high priority for elimination.

Health facilities can move to monthly reporting to the district of line lists of all confirmed malaria cases (Annex 11), when the average number of confirmed malaria cases at health facilities is 5–10 per month or fewer (in districts with 20 health facilities, data entry of 100–200 records per month would be required; in a country with 1000 health facilities reporting 5–10 cases per month, the number of cases would be 5000–10 000 per month or 60 000–120 000 per year). Health facilities and districts would continue to report aggregate data on the numbers of suspected, tested and confirmed cases in order to calculate the full range of indicators outlined above.

Core variables for line listing of confirmed cases should include both demographic and clinical factors (date of attendance, patient's name, village or suburb of residence, sex, age, type of test, test result) and intervention factors (ITN ownership and use in past 14 days, house sprayed, treatment received) (see Annex 11). Optional variables could include: date of onset of symptoms, date of first contact with the health system, presence of gametocytes on microscopy slides (*P. falciparum* only), occupation, other intervention factors, travel outside the country, travel outside the district to endemic areas within the country and other data that are locally or nationally important. Even basic information on individual cases, such as village of residence, is, however, helpful; programmes should avoid being overly ambitious in collecting additional case information so as to ensure complete, accurate reporting.

3.3 Data analysis

Health facility level

Data should be reviewed at least monthly in order to answer the questions below. In hospitals in which staff have little involvement in preventive programmes, staff from the district malaria programme team may assist in this analayis.

How can severe case and deaths be prevented? In order to undertake initiatives that will have the greatest impact on malaria morbidity and mortality, health facility staff should focus on malaria inpatients and malaria-related deaths and investigate, at the individual level, why they acquired malaria and how it developed into severe disease (see Box 3.2). Investigation of cases shortly after admission to wards may enable health facility staff to recognize gaps in the provision of preventive measures (ITNs or indoor residual spraying), the use of preventive measures, delays in seeking treatment or poor access to diagnostic testing and treatment. The gaps identified can be addressed by making better use of health facility resources or liaising with people at community level or other government services.

BOX 3.2.

Investigation of inpatient cases and deaths

Data on each inpatient case of confirmed malaria (a proxy for severe malaria) or malaria death should be used to investigate possible programme weaknesses in the prevention or treatment of malaria.

1. Examine the age, pregnancy status, village and month of illness to characterize the epidemiology of the admitted cases and deaths. It is important to assess whether cases arise in particular villages, to plan a more focused response, or are scattered throughout the health facility catchment area, suggesting that a more generalized response is necessary.
2. Examine the preventive measures used:
   - Did the household of the patient own a long-lasting insecticidal net (LLIN)? Yes, no
   - Are more than two people using each LLIN? Yes, no
   - Were LLINs hanging during the 2 weeks before hospitalization? Never, some nights, all nights
   - Did the patient sleep under an LLIN in the 2 weeks before symptoms of malaria developed? Never, some nights, all nights
   - If he or she did, how old was the LLIN? < 1, 1–3, > 3 years
   - If he or she did, what was the condition of the net? Holes < 100 cm^2 (good), holes > 100 cm^2 (too torn) or holes that can be repaired (not too torn, serviceable).

If few patients report owning an LLIN (e.g. < 25%), LLIN ownership is a major problem in the health facility catchment area. If a high proportion of patients report owning an LLIN but many report not using them, LLIN usage is major problem in the health facility catchment area. If a high proportion of patients used an LLIN (e.g. > 50%[1]), the efficacy of the LLIN may be in doubt (e.g. they may have holes, the insecticide may have deteriorated or mosquitoes may be developing resistance to the insecticide). Further entomological investigation may be required.

3. Examine the treatment received.
   - Was treatment received? Yes, no.
   - Was treatment received promptly after onset of symptoms? < 24 h, 1–3 days, > 3 days.
   - If treatment was received, were the medicine and dosage appropriate? Yes, no.
   - What were the reasons for delay in receiving treatment? Not aware of treatment, distance to facility, stock-outs, cost of medicine.

In order to answer these questions, it is necessary to record: the date of onset of symptoms; date of first contact with the health system; diagnostic test administered, if any; test result; type of antimalarial medicine received; date of first dose of antimalarial medicine; and date of admission.

In most situations, treatment with artemisinin-based combination therapy is highly effective and should prevent uncomplicated malarial infection from proceeding to severe malaria. If a high proportion of severe malaria cases have not received this therapy, it may be necessary to determine ways of improving access to and compliance with treatment. If, however, a significant proportion of cases (e.g. > 25%) report taking a full 3-day course of artemisinin-based combination therapy, the possibility of low efficacy of the medicines (e.g. fake or substandard medicines or drug resistance) should be considered.

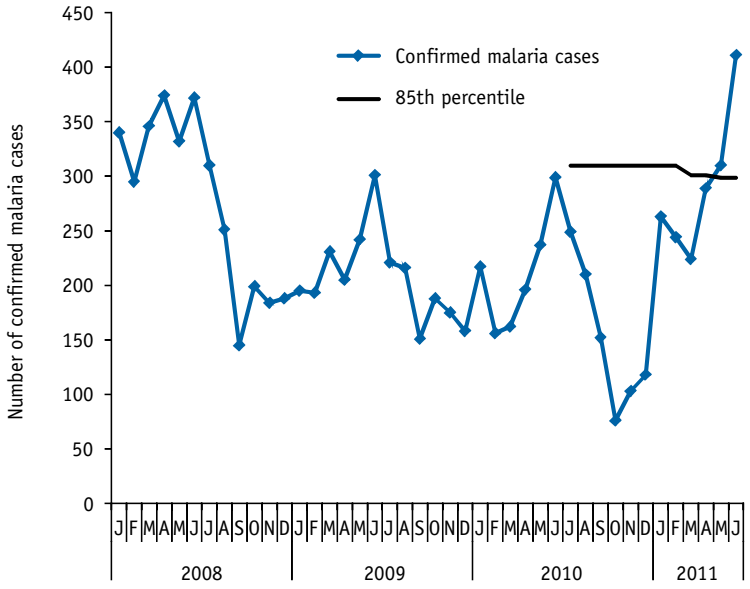
[1] As the efficacy of ITNs is not 100%, isolated cases of malaria may be expected in users of LLINs.

Are there unusual changes in the numbers of cases? The number of confirmed malaria cases should be plotted monthly to identify any variation over time. This assessment can be made more easily if the previous 2 or 3 years of data are plotted on the same chart. The latest month's value for confirmed cases can be compared with an '85th percentile' threshold value to determine whether it is unusually low or high (see Box 3.3). The 85th percentile threshold is derived by examining the previous 3 years of monthly case numbers and calculating the fifth highest number of cases that occurred in the past 3 years.[1] If the latest month's value exceeds the 85th percentile, district level staff should be notified, and an investigation should be undertaken to determine whether further action is necessary. If the number of cases remains stable despite an increase in malaria control interventions, such as recent distribution of ITNs, an investigation may also be merited to assess whether the ITNs have reached the target populations, are being used and are effective against the local anopheline vector population.

BOX 3.3.

Calculating an 85th percentile threshold to assess whether the numbers of cases are higher than usual

The monthly number of confirmed malaria cases in the current year should be plotted on a graph with the previous 2 or 3 years of data to determine whether or not there are variations in the numbers of cases. The latest month's value for confirmed cases can be compared with an 85th percentile threshold value to determine whether it is unusually low or high. The laest 2 months' values in the example exceed the 85th percentile and therefore look unusually high.



[1] In 3 years there are 36 months. The 85th percentile is the fifth highest value in the 36 months, as 15% of the monthly values will be greater than or equal to this (36 * 15% = 5).

BOX 3.3. CONTINUED

Calculating an 85th percentile threshold to assess whether the numbers of cases are higher than usual

The 85th percentile threshold is derived by examining the previous 3 years of monthly case numbers and calculating the fifth largest number of cases that occurred in the past 3 years. In the example below, the previous 36 monthly values were:

	Number of confirmed cases			
	2008	2009	2010	2011
Jan		195	217	263
Feb		193	156	244
Mar		231	162	224
Apr		205	196	289
May		242	237	310
Jun	372	301	299	**411**
Jul	310	221	249	
Aug	251	216	210	
Sep	145	151	152	
Oct	199	188	76	
Nov	184	175	103	
Dec	188	158	118	

Current month
Four highest values in previous 3 years
Fifth highest value in previous 3 years (85th percentile)

The 85th percentile is the fifth highest value within the 36 months, as 15% of the monthly values will be greater than or equal to this (36 * 15% = 5).

Graphs of numbers of inpatients and deaths may also reveal trends, if there are sufficient numbers. Graphs can be particularly useful if diagnostic testing practices have changed over time. In these settings, trends in the total number of confirmed cases should be assessed along with the number of patients receiving a diagnostic test; it is difficult to assess trends in the total numbers of confirmed cases. An additional graph by month showing the test positivity rates at the health facility and observed by community agents should be prepared monthly if the data are available.

Do some areas have more malaria than others? Annually (or more frequently), it is useful to determine which villages are reporting the most cases; even in high-transmission settings, malaria can be concentrated in particular areas in which the environmental conditions are particularly suitable for transmission.[1] Health facility records of malaria cases are influenced by the distance patients have to travel to the health facility, so that more cases are generally from within 5 km of a facility than from further away. It is therefore useful to review data from health posts and community agents, if they are available. If an unusually large number of cases arise in one village in relation to the population served, it might be useful to review the availability of preventive measures and access to treatment and undertake measures to improve them if necessary.

[1] In Kenya, 20% of houses with parasites in the dry season yielded 65% of the cases in the following wet season. Bejon P et al. Stable and unstable malaria hotspots in longitudinal cohort studies in Kenya. *PLoS Medicine*, 2010, 7:e1000304. doi:10.1371/journal.pmed.

Low-transmission settings: In low-transmission settings, where there is a greater risk for epidemics or greater annual variation in the number of cases, the numbers of suspected, tested and confirmed malaria cases should be plotted weekly in order to detect unusual variations at an early stage. For weekly plots, the 85th percentile is obtained by examining the previous 3 years of weekly case numbers and calculating the 23rd highest number of cases that occurred in the past 3 years.[1] If the latest week's value exceeds the 85th percentile, the district level staff should be notified, and an investigation should be undertaken to determine whether further action is necessary (Box 3.2).

District level

Data should be reviewed at least monthly in two ways: for the district as a whole and for individual health facilities or geographical areas:

1. Trends in malaria should be examined throughout the district. This will enable managers to answer the following questions:

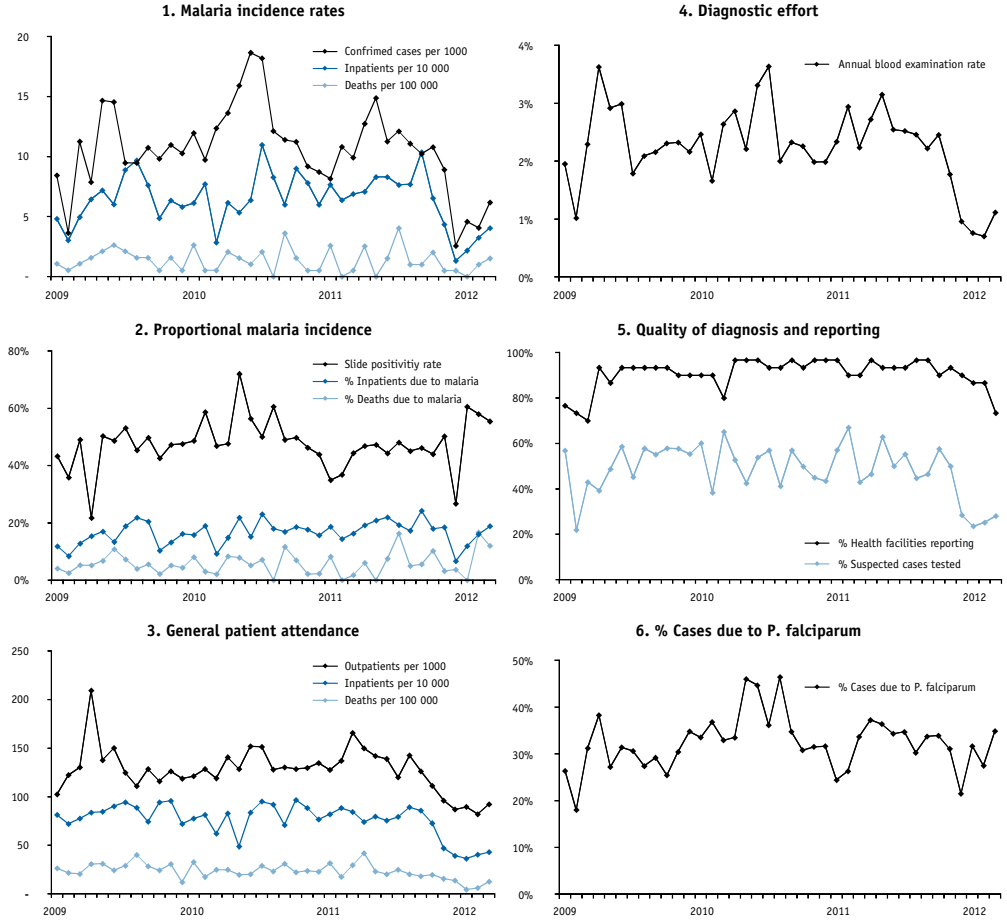
- Are testing and reporting targets being met; e.g. what percentage of suspected cases are tested, and what percentage of health facilities have submitted reports in a timely fashion?
- Are there trends in malarial disease that are of concern; e.g. a rise in the number of cases or an unusually large number of deaths in 1 month that suggest that control activities should be intensified.
- Are there unusual differences between indicators; e.g. does the number of deaths remain constant despite the number of cases falling?

In order to perform these analyses, districts should update five surveillance graphs every month to monitor trends in malaria cases and deaths (see Box 3.4). Data should be presented for the current year and the previous 3 years:

[1] In 3 years there are 156 weeks. The 85th percentile is the 23rd highest value within the 156 weeks, as 15% of monthly values will be greater than or equal to this (156 * 15% = 23).

BOX 3.4.

Examining trends in a district



Each month, districts should update five control charts showing trends in malaria incidence and other indicators (or six if more than one species of malaria is present). In the example presented, there has been a reduction in the numbers of malaria cases, inpatients and deaths in recent months, particularly at the beginning of 2012 (chart 1). This decrease appears to be related to lower outpatient attendance and admissions overall (chart 3) and a reduced rate of diagnostic testing (chart 4), which could also be due to lower reporting rates in recent months (chart 5). The slide positivity rate and percentages of inpatients and deaths due to malaria do not appear to follow the downward trend in the number of malaria cases (apart from a dip in early 2012) (chart 2). Similarly, there has been no marked changed in the percentage of cases due to *P. falciparum* (chart 6).

Hence, there appears to be no real decrease in the number of malaria cases; the apparent decrease is due to less reporting in recent months. Such a pattern, in which data are incomplete for the most recent months, is common in many reporting systems and suggests that effort is needed to improve the timeliness of reporting (otherwise, the reporting rates are reasonably good at > 90%). There is also scope to increase the percentage of suspected cases receiving a diagnostic test, and it might be necessary to determine why this has decreased in the most recent months (perhaps due to the selection of health facilities reporting).

(i) Malaria incidence rates. This chart shows trends in the numbers of confirmed malaria cases per 1000 population, malaria inpatients per 10 000 population and deaths per 100 000 population. It may be necessary to experiment with the size of the reference population (1000, 10 000 or 100 000) so that the lines fit conveniently on the same graph (or they may be plotted on a second axis or separate graphs). These indicators are basic measures of morbidity and mortality that reflect the success of preventive programmes and indicate demand for treatment in the public sector.

(ii) Proportional malaria incidence. This chart shows the positivity rate with slides and/or RDTs, the percentage of inpatients with a discharge diagnosis of malaria and the percentage of inpatient deaths due to malaria. These measures are affected less by fluctuations in reporting rate and total patient attendance and sometimes more reliably indicate the direction of change in malaria morbidity and mortality. Changes in test positivity rates and proportionate malaria cases or deaths (proportion of all-cause cases or deaths) do not, however, reflect the percentage change in malaria cases or incidence, as the number of malaria cases is part of the denominator. In areas where the percentage of deaths due to malaria is small and fluctuates erratically, it may not be useful to plot the percentage of deaths due to malaria.

(iii) General patient attendance. This chart shows the total number of outpatients per 1000 population, the total number of inpatients per 10 000 population and the number of deaths per 100 000 population. It may be necessary to experiment with the size of the reference population (1000, 10 000 or 100 000) so that the lines fit conveniently on the same graph (or they may be plotted on a second axis or separate graphs). These indicators provide information on overall use of health facilities, which can influence observed trends in malaria. This chart will also be useful for interpreting other disease-specific data that are collected and analysed regularly.

(iv) Diagnostic activity. This chart shows the annual blood examination rate, which reflects total diagnostic activity in a population. This can influence observed trends in malaria and is therefore important contextual information.

(v) Quality of diagnosis and reporting. This chart shows the percentage of suspected malaria cases receiving a diagnostic test and the percentage of health facilities submitting reports each month. The target for both indicators should be 100%. This can provide information on the extent of parasitological diagnosis and the completeness of reporting, both of which can influence observed trends in malaria.

(vi) Percentage of cases due to P. falciparum. In countries in which *P. vivax* and *P. falciparum* are present, an additional chart showing the percentage of cases due to *P. falciparum* should be drawn.

2. Indicators for different health facilities or geographical areas should be compared. This will enable managers to answer the following questions:

- Which health facilities are testing and reporting adequately and which are experiencing problems? For example, are some health facilities unable to increase the percentage of suspected cases tested?
- Are there unusual differences between health facilities for some indicators? For example, is the number of cases not decreasing despite an increase in ITN coverage?

Such comparisons can be made by three methods: by examining control charts for each health facility, by constructing surveillance tables for each indicator or by constructing a summary table of surveillance indicators by health facility with trend statistics.

Examining control charts for each health facility: This might take a prohibitively long time for districts with many health facilities; charts for health facilities that require additional attention should be examined selectively.

Constructing surveillance tables for each indicator. These tables are similar to the control charts described above:

- Table 1: Counts of total confirmed cases, inpatients and deaths by health facility and month. These tables can be maintained as wall charts and updated each month (see Box 3.5). For construction of the table and because different proportions of cases of fever attend each health facility, it is easier to record absolute counts of cases rather than incidence rates.

BOX 3.5.

Examining trends in health facilities: counts of total numbers of confirmed cases, inpatients and deaths by health facility and month

Wall charts should be kept at the district office showing monthly numbers of confirmed cases, inpatients and deaths by health facility in order to track unexpected changes and identify health facilities experiencing particular problems. The examples show seasonality in the incidence of malaria with possibly higher than normal number of cases in health centre M in October.

Confirmed cases	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hospital A	730	613	389	341	419	398	380	294	628	557		
Hospital B	277	275	152	173	176	122	88	66	159	302		
Health centre A	2	0	0	18	0	15	2	2	0	0		
Health centre B	11	0	0	0	0	0	0	0	5	18		
Health centre C	97	0	67	0	0	0	102	95	137	92		
Health centre D	24	18	8	20	14	6	9	11	19	25		
Health centre E	13	15	5	3	11	6	2	0	0	0		
Health centre F	0	53	23	0	78	10	12	11	23	20		
Health centre G	1	0	0	0	0	0	0	0	0	0		
Health centre H	1	0	0	4	3	0	0	0	0	0		
Health centre I	0	3	5	3	1	4	7	10	0	0		
Health centre J	41	43	17	12	28	24	29	4	15	40		
Health centre K	2	1	6	4	4	0	1	2	3	5		
Health centre L	10	1	10	79	111	8	7	0	0	0		
Health centre M	7	0	0	0	0	0	5	4	24	21		
Health centre O	12	12	13	9	4	4	2	4	6	13		
Total	**1228**	**1034**	**695**	**666**	**849**	**597**	**646**	**503**	**1019**	**1093**		

BOX 3.5. CONTINUED

Examining trends in health facilities: counts of total numbers of confirmed cases, inpatients and deaths by health facility and month

Inpatients	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hospital A	12	15	9	4	12	4	7	3	31	6		
Hospital B	33	13	3	2	2	2	39	4	2	28		
Health centre A						1						
Health centre B												
Health centre C	1		1				2	3	11	26		
Health centre D	3		1	1						1		
Health centre E		1										
Health centre F		13	10		5	2						
Health centre G												
Health centre H					1							
Health centre I												
Health centre J					1				1			
Health centre K												
Health centre L				1	2							
Health centre M									1	1		
Health centre O												
Total	**49**	**42**	**24**	**7**	**22**	**8**	**48**	**9**	**45**	**61**		

Deaths	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hospital A	1	1	1						3			
Hospital B	1				1		2					
Health centre A												
Health centre B												
Health centre C												
Health centre D												
Health centre E			1									
Health centre F												
Health centre G												
Health centre H												
Health centre I												
Health centre J												
Health centre K					1							
Health centre L												
Health centre M												
Health centre O												
Total	**2**	**1**	**2**		**2**		**2**		**3**			

- Table 2: Microscopic slide and/or RDT positivity rate and percentage of inpatients with a discharge diagnosis of malaria. Given the low frequency of malaria deaths, it is generally not useful to show the percentage of deaths due to malaria by health facility.
- Table 3: Annual blood examination rate, percentage of suspected cases tested, health facility report submitted or not (or date submitted or number of days delay in submission).
- Table 4: Total numbers of outpatients, inpatients and deaths.

Such charts allow inspection of the results of all health facilities and identification of unusual trends. When examining the results, it might be helpful to calculate a summary trend statistic for each health facility to determine whether the latest month's result is unusual. This is relatively straightforward to do if control tables are maintained in an electronic spreadsheet but may be cumbersome if wall charts are maintained by hand.

Four possible trend statistics, in increasing order of complexity, are:

Latest month versus a reference value: The latest month's results can be compared with a baseline value, such as the same month 5 years previously. This procedure can be useful in assessing progress towards targets in a national health plan, e.g. to reduce cases by half between 2010 and 2014 or since commencement of control activities (see Box 3.6 for application to district data).

BOX 3.6.

Examining trends in health districts: summary table of surveillance indicators by health facility with trend statistics

A table of surveillance indicators by district, with trend statistics, can used to examine trends in several districts simultaneously. Over short periods with relatively small changes in population size, counts of the number of cases are likely to be adequate for assessment. Over longer periods (> 5 years), when population growth has a greater effect on population size, incidence rates are preferable. Trends in completeness of reporting, percentage of suspected cases tested and annual blood examination rates can be used to assess whether changes in reporting or diagnostic practice are responsible for any changes in incidence or if the trend in case incidence is likely to be real. In the example below, there are large decreases in the number of malaria cases, case incidence and test positivity rate. The annual blood examination rate and the percentage of suspected cases have decreased since the baseline period, but these cannot explain the full change in incidence or in slide positivity rate. The investigation should begin by determining the reasons for the decreases in the percentage of suspected cases tested and the annual blood examination rate.

BOX 3.6. CONTINUED

Examining trends in health districts: summary table of surveillance indicators by district with trend statistics

	Current indicator values								Change from 5 years previously[1] (%)					
Region/District	Population (1000s)	No. of health facilities	Confirmed cases	Incidence rate / 1000 population	Test positivity rate (%)	ABER	Tested / suspected (%)	Reporting completeness (%)	Confirmed cases	Incidence rate / 1000 population	Test positivity rate (%)	ABER[2]	Tested / suspected (%)	Reporting completeness (%)
Province A														
District 1	287	12	22,747	79	28	28	76	97	-19	-23	-44	-37	-8	-3
District 2	342	15	28,199	83	24	34	82	100	18	12	-54	-142	-1	17
District 3	249	12	20,681	83	24	34	83	100	-7	-12	-56	-98	-28	4
District 4	272	13	5,788	21	16	13	64	99	-48	-51	-76	-107	24	10
District 5	270	13	6,126	23	9	27	71	100	-73	-74	-86	-84	-19	18
District 6	318	17	49,358	155	34	46	72	100	125	114	-49	-320	14	15
District 7	250	11	21,194	85	26	33	70	100	-30	-34	-62	-72	-30	0
sub total	**1,986**	**93**	**154,093**	**78**	**25**	**31**	**75**	**100**	**-4**	**-9**	**-57**	**-114**	**-10**	**9**
Province B														
District 1	388	10	9,647	25	15	17	80	100	-61	-70	-66	13	-35	0
District 2	240	6	8,595	36	13	28	87	100	-49	-34	-59	-60	-58	9
District 3	241	6	4,230	18	6	31	75	100	-79	-71	-82	-58	-55	0
sub total	**869**	**22**	**22,472**	**26**	**11**	**24**	**80**	**100**	**-64**	**-61**	**-69**	**-27**	**-49**	**3**
Province C														
District 1	312	11	2,938	9	8	12	94	91	-81	-82	-82	-4	-16	-9
District 2	326	20	2,707	8	4	23	96	100	-91	-93	-92	18	-22	18
District 3	351	21	5,582	16	18	9	89	74	-42	-39	-51	-25	41	-8
District 4	323	12	759	2	3	9	75	94	-95	-96	-94	39	-44	2
District 5	258	16	5,959	23	10	22	88	100	-72	-75	-79	-21	-19	1
sub total	**1,570**	**80**	**17,945**	**11**	**8**	**15**	**90**	**93**	**-80**	**-83**	**-82**	**2**	**-17**	**2**
Province D														
District 1	271	13	38,816	143	34	42	80	100	-25	-28	-41	-21	-22	5
District 2	281	13	22,567	80	20	41	85	100	-48	-51	-60	-23	-18	0
District 3	281	11	8,184	29	16	18	94	100	-72	-73	-74	-2	33	1
District 4	292	14	1,972	7	5	13	80	98	-94	-94	-89	46	-9	-2
District 5	304	14	1,503	5	6	9	69	100	-76	-77	-81	-21	-36	0
District 6	256	13	18,491	72	25	29	80	92	-10	-15	-46	-59	-40	1
District 7	250	13	1,367	5	6	9	76	85	-89	-90	-88	14	-3	-14
District 8	274	14	7,976	29	13	22	76	99	-74	-76	-76	0	-21	12
sub total	**2,209**	**105**	**100,876**	**46**	**20**	**23**	**81**	**100**	**-55**	**-58**	**-61**	**-8**	**-15**	**4**
Province E														
District 1	286	18	3,633	13	7	19	80	100	-74	-75	-82	-37	-25	0
District 2	304	9	3,613	12	16	7	61	100	0	-5	-65	-169	-6	0
District 3	291	12	769	3	5	5	79	100	-60	-62	-85	-154	-32	12
District 4	335	17	1,946	6	4	14	72	89	-89	-90	-87	16	-37	-10
District 5	340	9	402	1	2	8	79	100	-85	-86	-94	-127	-49	24
District 6	348	12	9,611	28	15	19	77	100	-71	-72	-67	17	-5	0
District 7	289	16	875	3	4	8	79	100	-81	-82	-90	-75	-4	29
sub total	**2,193**	**93**	**20,849**	**10**	**8**	**11**	**75**	**100**	**-73**	**-74**	**-78**	**-19**	**-20**	**8**
Total	**8,828**	**393**	**316,235**	**36**	**18**	**20**	**79**	**100**	**-49**	**-51**	**-63**	**-32**	**-21**	**7**

[1] Negative numbers indicate decrease

[2] ABER: Annual blood examination rate

Latest 3 months versus previous 6 months: A weighted total of the values for the latest 3 months is calculated in relation to that for the previous 6 months.

$$\frac{(X_{t-2} + 2^* X_{t-1} + 3^*X_t)}{(X_{t-5} + X_{t-4} + X_{t-3} + X_{t-2} + X_{t-1} + X_t)}$$

where X_t = latest month's value, X_{t-1} = previous month's value, X_{t-2} = value 2 months earlier, etc.

If this ratio is larger than 1.1, it can indicate that the results for the past 3 months are unusually high in comparison with a recent reference period. A ratio lower than 0.9 can indicate that the results for the past 3 months are unusually low (different thresholds can be explored, e.g. 1.2 or 0.8, depending on the sensitivity required). The statistic is most useful in situations in which short-term changes are considered worthy of attention; it is less useful for indicators that are expected to fluctuate seasonally.

Latest month versus 85th percentiles for previous 3 years. 85th percentile thresholds are derived by examining the values of an indicator for the previous 3 years and calculating the fifth highest value that occurred in the past 3 years (Box 3.3).[1] The value for the latest month might be considered unusually high if it is higher than the 85th percentile.

Latest month versus similar months in previous years. The latest month's value is compared with an average of values for the same month in the previous 5 years, the previous months in the previous 5 years and the following month in the previous 5 years. Thus, if the latest month is April, an average of results for the months March to May in the previous 5 years is calculated, with the standard deviation. If the latest month's value is greater than or lower than one standard deviation from the mean, the value may be unusually high or low in relation to the previous 5 years. The statistic may be useful for detecting outbreaks.[2]

Constructing a summary table of surveillance indicators by health facility with trend statistics. A table showing values for indicators in the latest month, with a trend statistic to indicate changes that have occurred, can be constructed, as shown in Box 3.6.

Programme managers may not be able to explore all the options for data presentation. At the very least, the control charts for the district as a whole should be updated each month, together with the control tables showing the numbers of malaria cases, inpatients and deaths by health facility, completeness of reporting and the percentage of cases receiving a diagnostic test.

Low-transmission areas

Districts in which severe cases and deaths are increasingly rare can intensify their analysis and response to inpatient malaria cases and deaths. Every inpatient malaria case and all malaria deaths should be investigated by location, age, season, parasite species and intervention factors (possession and use of LLINs, indoor residual spraying, type and timing of treatment) to identify weaknesses in the public health system and to understand why the severe cases were not prevented or adequately treated (see Annex 10 for the type of data to be reviewed). District managers should also consider whether some villages are not covered by the public health system and may still be experiencing severe cases and deaths (by examining the extent to which all villages are represented in outpatient registers).

As the incidence of cases decreases further and districts can build up a register of all cases, it will be possible to examine the risk factors associated with malaria infection (e.g. age, sex, location, occupation) in order that programmes can be more closely targeted to the populations most affected (see Annex 11 for the type of data to be reviewed).

[1] In 3 years there are 36 months. The 85th percentile is the fifth highest value within the 36 months, as 15% of monthly values will be greater than or equal to this (36 * 15% = 5).

[2] Teutsch SM, Churchill RE. *Principles and practice of public health surveillance*. Oxford, Oxford University Press, 2000.

National level

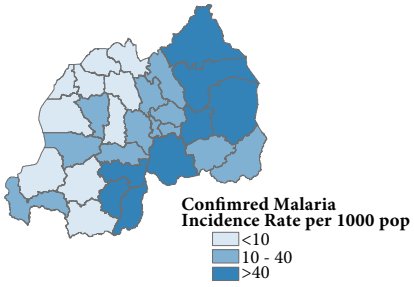
National-level programmes should conduct analyses similar to those in districts: (i) analysis of overall trends nationally on the five control charts, (ii) comparison of districts from the control tables and (iii) comparison of districts from summary tables of surveillance indicators. In addition, districts can be compared using maps (see Box 3.7).

BOX 3.7.

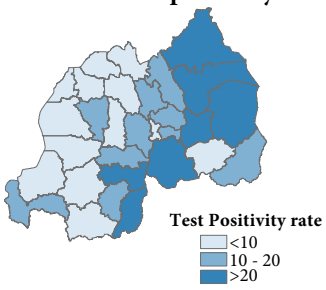
Examining trends in health districts: using maps

Mapping of indicators allows programme managers to assess whether programme performance or malaria trends vary by geographical area and to determine whether malaria prevention, testing or treatment activities should be focused in particular geographical areas. Regional differences in the numbers of cases and deaths due to malaria might reflect the underlying epidemiology, the extent of malaria interventions or diagnostic and case reporting practices. In the example below, higher case incidence rates are observed in eastern parts of the country, with higher annual blood examination rates and percentages of cases tested. Nonetheless, a higher incidence rate is suggested by higher test positivity rates in the same areas. Variation in the completeness of reporting may be due to communication delays or resource gaps in particular regions.

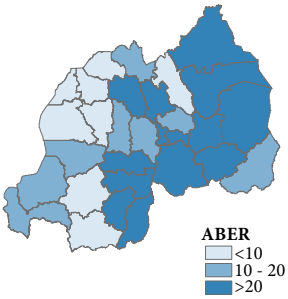
Incidence of confirmed malaria cases



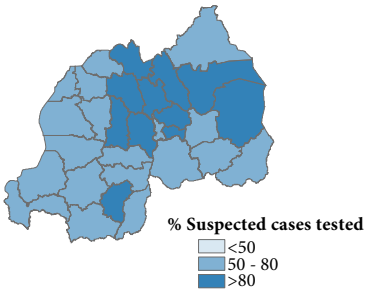
Malaria test positivity rate



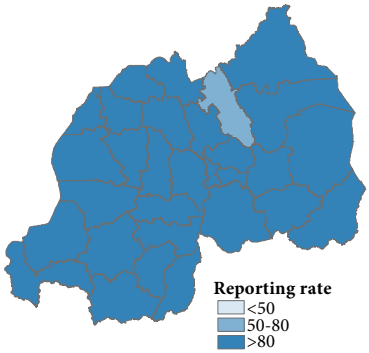
Annual blood examination rate



Percentage of suspected cases tested



Rate of completeness of reporting by health facilities



Analysis is most likely to be done quarterly and annually, as reports are submitted by districts at different times. The aims are to ascertain whether targets are being met, whether there are trends in disease that are of concern, which districts are reducing the number of cases and which are experiencing problems and any unusual differences between indicators (e.g. failure of the number of cases to decrease despite an increase in ITN coverage). When necessary, individual district control charts can be inspected to explore issues in more detail, and data can be retrieved from individual health facilities.

3.4 Using data for making decisions

Formal meetings. If the data generated by a surveillance system are to be used to improve the operation of malaria control programmes, programme managers must make sure there are regular opportunities for review. A schedule of meetings should be established to review malaria trends, such as the following:

- community with health facility staff: monthly or quarterly
- health facility staff with district malaria control programme staff: monthly
- district staff with national malaria control programme staff: quarterly. Meetings might have to held less frequently or held regionally in order to create opportunities for national staff to meet with all district staff during a year.

Supervision. Supervision from national and district level is needed to support building of the information system, ensure the completeness of reporting, ensure analysis and discussion of data and follow-up of recommended actions. During visits to health facilities and district team offices, supervisors should check that registers are kept up to date, with all fields completed, that data on report forms correspond to the information in registers and tally sheets, that core analysis graphs and tables are up to date and that discussions are held about interpretation of the trends and potential action (see Annex 12 for an example of a malaria surveillance supervisory checklist). Health facility staff should be encouraged to investigate all inpatient malaria cases and deaths.

Feedback. District managers should prepare feedback for health facilities monthly or quarterly, including private health facilities that provide data. This should not simply reflect the data submitted by the health facility but should include comparisons with other health facilities in the district and summary statistics for the district as a whole. A regular bulletin can be produced in a standard format to present district results (based on control charts) and comparisons of health facilities.

A national feedback bulletin should be produced each quarter, showing indicators by district (Annex 13). As transmission is reduced, mapping could be extended to subdistricts in order to present more detailed epidemiological information on remaining locations and population groups affected. The bulletin should be widely circulated, not only as feedback to districts, but also as information for other government departments, institutions and implementing partners. Elected leaders should also be presented with the bulletin on malaria, possibly showing the malaria situation according to political boundaries, to instil understanding and support for malaria control at the highest level of leadership.

4. Establishing surveillance systems in the control phase

Surveillance systems consist of the tools, procedures, people and structures required to generate information for planning, monitoring and evaluating malaria programmes.

- The tools include: report forms, tally sheets, registers, patient cards, computer hardware and software, documentation and training materials.
- Procedures include: case definitions, reporting frequency, pathways of information flow, data quality checks, incentive schemes, data analysis, mechanisms for review of performance, methods for disseminating results, using data for making decisions, supervision and planning.
- The people include: decision-makers both inside and outside the health service who use data from surveillance systems, the health staff who gather or use the data and the community whose details are registered.
- The structures include the ways staff are organized to manage, develop and use the system.

Deficiencies in any of these components can limit the capacity of a malaria control programme to undertake disease surveillance effectively. Therefore, the building of a functioning, sustainable surveillance systems must usually address each of these areas.

4.1 Tools

Suggestions for registers and forms are included in this manual, which should be adapted for use by countries. Registers should include space to record essential data elements, such as test results, and the inclusion of additional variables should be avoided. The more variables used in registers and forms, the less likely the forms will be completed accurately, if at all. When possible, forms should reflect existing guidance, such as that provided in standard treatment manuals.

In the control phase, malaria surveillance systems are often part of communicable disease surveillance or health information system. Health information systems should be adapted to include the basic data elements suggested in this manual (Annex 9). It is important to involve all stakeholders during discussions about revising systems, especially those involved in data collection at health care level, who may provide valuable input into the constraints faced by health workers and practical suggestions for moving forward. An inclusive process also creates greater ownership and encourages the adoption and use of forms later. In low-transmission settings, especially where malaria is relatively rare and confined to particular locations, there may be a separate malaria reporting system (allowing a timely response to individual cases of malaria), which should be adapted according to the recommendations in this manual.

If new forms are designed or existing forms are revised, they should be tested on a small scale (e.g. one district for 6 months) before widespread implementation. After final adjustments have been made, documentation on use of the forms should be updated and data collectors trained in their use. As training will be required in each district, changes cannot be implemented at one time but must be staggered over the course of a year. It is usually advantageous to link training in malaria surveillance systems with other training activities in order to save costs and to avoid occupying too much of health workers' time. When possible, training in malaria surveillance should accompany training on malaria case management, particularly the use of diagnostic testing.

As new forms are introduced, old ones should be removed from health facilities or destroyed, so that health workers do not use previous systems when there are disruptions to supplies of stationary or because they are not familiar with the new forms. In order to maintain consistent supplies of stationary, the cost of forms might be borne centrally rather than by individual districts. It might also be useful to liaise with local printing companies to ensure that they are familiar with the latest form designs and do not print old forms when a district submits an order. Pre-service curricula of medical and nursing schools should also be updated to reflect the latest data recording and reporting practices.

4.2 Procedures

Procedures for recording, collating, storing, securing, cleaning, querying and analysing data should be documented. In addition, procedures for reporting and feeding back information should be documented, so that all staff using the system are clear about their responsibilities. Particular attention should be paid to ensuring that all health facilities report accurately and in a timely fashion. Programmes should have an up-to-date inventory of all health facilities that are expected to report and should follow up delays. District staff should undertake regular supervision of health facilities to ensure that surveillance activities are being conducted properly and that control activities are driven by analysis of surveillance data.

4.3 People

Adequate human resource capacity is required to run and maintain malaria surveillance systems. Particular attention should be given to the time and training required. District malaria focal points need sufficient time to conduct analyses and follow up 10–50 health facilities each month. In addition, the move to case-based analysis requires that more person-time will be spent on village-level analyses and analyses by age, sex, occupation and other risk factors. At national level, sufficient person-time is needed for data acquisition from health information departments; importing, merging, cleaning and analysing data; mapping; and producing a national feedback bulletin. If sufficient resources are available, dedicated personnel for malaria monitoring and evaluation should be placed at all levels (district, regional and national) to coordinate all monitoring and evaluation and ensure that the tools, procedures and competent, adequately trained personnel are in place. Disease surveillance requires epidemiological, statistical and computer skills; district staff need specific training in data analysis by health facility and analysis of case-based data. Training may be institutionalized in an annual workshop for district malaria programme managers or surveillance officers, with the aim of conducting training, reviewing progress in implementing surveillance systems, reviewing the latest data and preparing work plans for the coming year.

4.4 Structures

Structures for implementing surveillance systems vary by country. In some countries, data functions are undertaken by a single health information unit rather than being split among separate programmes. This arrangement can ensure greater coordination in system design and reduce duplication in requests for data. Malaria programme managers must liaise closely with health information staff to ensure prompt access to relevant data. In other countries, much data management is undertaken by programme staff. In these cases, there should be coordination with information units to ensure use of common data sets, such as population projections, health facility lists and coding systems. Opportunities should be created to undertake consolidated analysis of information with other programmes, so that progress in malaria control can be put

into perspective. Efforts should be made to coordinate system developments across programmes, perhaps by establishing a 'health information system development committee' with representation from a variety of heath programmes and senior management. Such a committee could ensure that a ministry of health prepares a coherent strategy for developing information systems and not a system that is incompatible, unnecessary or unsustainable.

Annexes

ANNEX 1.
Types of malaria diagnostic test

Parasite-based diagnostic testing for malaria

This section presents a brief summary of information on malaria diagnostic testing. More detailed information can be found in *Universal access to malaria diagnostic testing: an operational manual*[1] and the other documents cited below.

For the management of symptomatic cases, RDT and microscopy are usually sensitive enough at any level of malaria transmission. In some settings asymptomatic *P. falciparum* infections may persist at very low parasite densities, below the threshold of detection by microscopy or RDTs, and can be detected only by molecular methods such as PCR.

Microscopy

Light microscopy has been the standard for malaria diagnosis for many decades and is still the primary method of malaria diagnosis in health clinics and hospitals throughout the world. It is the only widespread method of differentiating between all major *Plasmodium* species, *P. falciparum*, *P. vivax*, *P. malariae* and *P. ovale*, as well as for detecting gametocytes of *P. falciparum* and mixed infections. Microscopy can provide parasite counts (i.e. estimates of parasite density in peripheral blood) and can therefore be used to monitor response to treatment. Microscopy requires functioning equipment, regular provision of laboratory supplies, well-trained laboratory technicians at all levels, regular supervision and a functional quality management system. For this reason, it is generally more widely available in countries with more resources and more robust health systems. In areas where microscopy is not available, especially in high-burden countries, RDTs are becoming increasingly available as the standard for malaria testing in outpatient settings.

The sensitivity and specificity of light microscopy are directly related to the time available to read a blood film, the quality of the stained film and the competence of the microscopist. Good microscopists in health facilities can detect 100–200 parasites per microlitre, and expert microscopists can detect 50 parasites per microlitre. In most endemic areas, nearly all clinical illness truly due to malaria is thought to correspond to > 100 parasites per microlitre; therefore, a good microscopist should detect parasites in nearly all true clinical malaria cases.[2] Occasionally, clinical cases may occur at lower parasite densities, particularly very early in the course of an infection.

WHO has suggested competence levels for microscopists, with those at the expert level expected to achieve 90% detection, 90% correct species identification and a high level of quantification (to be within 25% of the true value 90% of the time), and acceptable levels of clinical competence below this value.[3] In low-transmission settings, high specificity is vital but is hard to maintain. Field

[1] *Universal access to malaria diagnostic testing: an operational manual*. Geneva, World Health Organization, 2011. http://whqlibdoc.who.int/publications/2011/9789241502092_eng.pdf.

[2] *Parasitological confirmation of malaria diagnosis: report of a WHO technical consultation*. Geneva, World Health Organization, 2010.

[3] *Malaria microscopy quality assurance manual*. Manila, WHO Regional Office for the Western Pacific, 2009.

microscopy standards are often low, and rigorous quality management systems are necessary to maintain sufficient performance for both malaria case management and surveillance.

Rapid diagnostic tests

Several RDTs currently on the market can consistently detect over 95% of parasite infections at 200 parasites per microlitre, with 95% specificity. There is growing experience of nationwide deployment of RDTs. Recently, batch-to-batch quality issues have been raised, emphasizing the need for post-procurement lot testing at regional centres established by WHO[1] and regular assessment of RDT performance against expert microscopy at health facilities.

WHO has published the results of RDT performance evaluations against panels of wild-type parasites diluted at specific densities and assessed for stability at high temperatures and ease of use.[2] The evaluations show wide variation in the performance of different products, and procurement should be undertaken in the light of good evidence. An interactive guide designed to help national malaria control programmes select malaria RDTs with specific performance characteristics is available.[3] Training, supervision and performance evaluations of health workers using RDTs are also a necessary part of RDT programmes.

The three main groups of antigens detected by RDTs are:

- histidine-rich protein 2, which is specific to *P. falciparum*;
- *Plasmodium* lactate dehydrogenase (pLDH), currently used in products that include *P. Òfalciparum*-specific (pLDH-Pf), pan-specific (pLDH-Pan), present in all human malaria species, and *P. vivax*-specific pLDH (pLDH-Pv), and non-falciparum specific (pLDH-vom) antibodies; and
- aldolase, which is pan-specific.

Different products on the market have different combinations of antibodies that can detect the above antigens. RDTs that detect both *falciparum*-specific and non-*falciparum* (or pan-specific) target antigens are commonly called 'combination' or 'combo' tests. The commonest formats of RDT products are a plastic cassette and dipsticks; cassettes tend to be simpler to use than dipsticks and have been deployed on a wider scale.

PCR tests

New methods for routine PCR-based surveillance of malaria infections are being used for research and field studies, which are more sensitive than light microscopy or RDTs in detecting submicroscopic infections, especially with rare species (*P. malariae, P. ovale* and *P. knowlesi)*, mixed infections and low-density infections. In Cambodia, for example, in a national survey in 2007 in which the populations of 76 villages were screened, 13 more villages with malaria cases were identified with PCR than with microscopy.[4] During screening and treatment in Pailin, Cambodia, in 2008–2009, use of PCR with feedback and treatment of positive cases made it possible to treat 86 asymptomatic carriers (*P. vivax* in most cases) among the 928 people screened, instead of six when only RDTs were used (S. Hoyer, personal communication).

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[1] Malaria Rapid Diagnostic Test Evaluation Programme, World Health Organization. http://www.wpro.who.int/sites/rdt/who_rdt_evaluation/lot_testing.htm.

[2] *Results of WHO product testing of malaria RDTs: round 3 (2010–2011)*. Geneva, World Health Organization, 2011. http://www.who.int/tdr/publications/documents/rdt3.pdf.

[3] Foundation for Innovative New Diagnostics. *Malaria RDT product testing: interactive guide*. http://www.finddiagnostics.org/programs/malaria/find_activities/product_testing/malaria-rdt-product-testing/

[4] *Parasitological confirmation of malaria diagnosis*. Geneva, World Health Organization, 2009.

The relation between the incidence of symptomatic malaria and the prevalence of symptomatic infections in a population (called the 'reservoir') is not fully understood. It depends partly on the prevalence of low-density infections: the lower the overall parasite prevalence in a population, the more additional infections will be found by PCR than by microscopy.[1] It also depends on the speed at which malaria transmission decreases: when the decrease in transmission is more rapid than loss of immunity in a population, the reservoir of asymptomatic carriers can be significant, and mass screening is potentially appropriate. For example, in Cambodia, microscopy suggested a 3% prevalence, whereas PCR resulted in a prevalence of 7%. When transmission has decreased over many years, however, most people with parasitaemia are symptomatic because they have no immunity, and the reservoir is minimal; e.g. a prevalence of 0% by microscopy, 0.5% by PCR for *P. falciparum* and 1.5% by PCR for *P. vivax* in the Brazilian mountains outside Amazonia;[2] a prevalence of 0% by PCR in two districts in Sri Lanka.[3] In this situation, mass screening will probably not be cost-effective.

The potential programme value of detecting low-density infections that are microscopy-negative but PCR-positive is unclear.

Quality management systems for microscopy and RDT

Quality assurance of both microscopy and RDTs is an essential component of programmes to strengthen and expand parasitological confirmation of malaria diagnosis. Data on cases of malaria confirmed by either microscopy or RDT in countries without functioning laboratory quality assurance systems may not be reliable. Variations over time in the implementation of laboratory quality management systems may also influence trends in the numbers of confirmed malaria cases (or malaria test positivity rates), and, with coverage of laboratory services, must be taken into account in data interpretation. Further guidance on quality management systems is available in the references below.[4,5]

[1] Okell LC et al. Submicroscopic infection in *Plasmodium falciparum*-endemic populations: a systematic review and meta-analysis. *Journal of Infectious Diseases*, 2009, 200:1509–1517.

[2] Cerruti C Jr. et al. Epidemiologic aspects of the malaria transmission cycle in an area of very low incidence in Brazil. *Malaria Journal*, 2007, 6:33.

[3] Rajakaruna RS et al. Pre-elimination stage of malaria in Sri Lanka: assessing the level of hidden parasites in the population. *Malaria Journal*, 2010, 9:25.

[4] *Malaria microscopy quality assurance manual. Version 2*. Geneva, World Health Organization, 2009.

[5] *Universal access to malaria diagnostic testing: an operational manual*. Geneva, World Health Organization, 2011. http://whqlibdoc.who.int/publications/2011/9789241502092_eng.pdf.

ANNEX 2.
Definition of severe malaria[1]

In a patient with *P. falciparum*, asexual parasitaemia and no obvious cause of symptoms, the presence of one or more of the following clinical or laboratory features classifies the patient as suffering from severe malaria:

Clinical features

- impaired consciousness or unrousable coma;
- prostration, i.e. generalized weakness so that the patient is unable to walk or sit up without assistance;
- failure to feed;
- multiple convulsions: more than two episodes in 24 h;
- deep breathing, respiratory distress (acidotic breathing);
- circulatory collapse or shock, systolic blood pressure < 70 mm Hg in adults and < 50 mm Hg in children;
- clinical jaundice plus evidence of other vital organ dysfunction;
- haemoglobinuria;
- abnormal spontaneous bleeding; or
- pulmonary oedema (radiological)

Laboratory findings

- hypoglycaemia (blood glucose < 2.2 mmol/l or < 40 mg/dl);
- metabolic acidosis (plasma bicarbonate < 15 mmol/l);
- severe normocytic anaemia (Hb < 5 g/dl, packed cell volume < 15%);
- haemoglobinuria;
- hyperparasitaemia (> 2% or 100 000/µl in low-intensity transmission areas or > 5% or 250 000/µl in areas of high, stable malaria transmission intensity);
- hyperlactataemia (lactate > 5 mmol/l); or
- renal impairment (serum creatinine > 256 µmol/l).

[1] *Guidelines for the treatment of malaria*, 2nd Ed. Geneva, World Health Organization, 2010:35.

ANNEX 3.
Core surveillance indicators for malaria control

1. Confirmed malaria cases (number and rate per month or per year)	
Formula	1000 * $\frac{\text{Number of confirmed malaria cases}}{\text{Population at risk of malaria}}$
Numerator	The number of people with suspected malaria confirmed by either microscopy or RDT. The number should include both outpatient and inpatient cases. The number should include cases detected passively (attending health facilities or seen by community health workers) or actively (sought in the community); it is often useful to provide a breakdown of cases detected passively and actively. Regardless of transmission setting, any person with a positive result in a parasite-based test (microscopy or RDT), irrespective of clinical symptoms, should be considered to have a (confirmed) case of malaria.
Denominator	The number of people living in areas where malaria transmission occurs. Areas with malaria transmission can be defined as those from which locally acquired, confirmed cases of malaria are reported. Population sizes should be adjusted for population growth according to projections from the national census or, when not available, United Nations Population Division projections. It is sometimes useful to use the total population of an area or country as the denominator in order to compare overall levels of risk among geographical areas or countries. If rates are calculated per month, as when plotting rates on a graph, the population size should be divided by 12 to obtain an annual incidence rate.
Breakdown	High and moderate transmission: Age group (all ages, < 5 years), parasite species, geographical area, time (year and month) Low transmission: Sex, 5-year age groups, type of detection (passive, active, community) Elimination: Foci, village, source of infection: imported, local (introduced, indigenous, relapsing), induced
Purpose	To measure trends in malaria morbidity and to identify locations of ongoing malaria transmission. This indicator is the most important measure of progress and management in low-incidence areas.
Interpretation	Trends can be affected by: • completeness of reporting: trends can change if the percentage of health facilities reporting in a month changes or if different sets of health facilities are included e.g. including health posts or private hospitals. • number of tests undertaken (slides examined, RDTs performed) • changes in use of health facilities owing to greater availability of antimalarial drugs or implementation of user fees • actual changes in the incidence of malaria In order conclude that changes in the value of the indicator reflect a real change in the incidence of malaria in the community, indicators for completeness of reporting, annual blood examination rate and total number of outpatient visits per 1000 population must be examined, to confirm that they are reasonably constant over time.
Other	The indicator is also known as the annual parasite index.

2. Inpatient malaria cases (number and rate per month or per year)	
Formula	10 000 * $\frac{\text{Number of inpatient malaria cases}}{\text{Population at risk of malaria}}$
Numerator	The number of inpatients with a primary diagnosis of malaria at discharge or death. Patients who have absconded or been transferred should be excluded. All cases should have had a parasite-based test for malaria (microscopy and/or RDT) and a discharge diagnosis based on this test result. Malaria inpatient numbers should include patients from both hospitals and other facilities with beds.
Denominator	The number of people living in areas where malaria transmission occurs. Areas with malaria transmission can be defined as those in which locally acquired, confirmed cases of malaria are reported. Population sizes should be adjusted for population growth according to projections from the national census or, when not available, United Nations Population Division projections. It is sometimes useful to use the total population of an area or country as the denominator in order to compare overall levels of risk among geographical areas or countries. If rates are calculated per month, as when plotting rates on a graph, the population size should be divided by 12 to obtain an annual incidence rate.
Breakdown	Age group (all ages, < 5 years), geographical area, time (year and month)
Purpose	To monitor the impact of programmes on severe disease. This indicator may reflect the impact of treatment, as treatment attenuates clinical progression from uncomplicated to severe disease.
Interpretation	Inpatient cases are markers of severe disease and death and indicate failure of the health system to either prevent or effectively treat malaria. The numbers of inpatient cases are much larger than those of health facility deaths, allowing trends to be more easily discerned. This indicator is most useful in high- and moderate-transmission settings in which the rates of severe morbidity are significant. In some countries, inpatient cases may also include uncomplicated *P. falciparum* cases (according to national guidelines) to ensure full treatment, recovery and parasite clearance. Trends can be affected by: • completeness of reporting: trends can change if the percentage of health facilities reporting in a month changes or if different sets of health facilities are included e.g. including private hospitals. • changes in diagnostic practice e.g. introduction of more diagnostic testing may reduce the number of inpatients in whom malaria is diagnosed. • changes in use of health facilities owing to greater availability of antimalarial drugs or implementation of user fees • actual changes in the incidence of severe malaria. In order to conclude that changes in the value of the indicator reflect a real change in the incidence of severe malaria in the community, indicators must be examined for completeness of reporting, changes in the percentage of cases that have had a diagnostic test and total number of inpatient visits per 10 000, to confirm that they are reasonably constant over time.

3. Inpatient malaria deaths (number and rate per month or per year)	
Formula	100 000 * $\frac{\text{Number of inpatient malaria cases}}{\text{Population at risk of malaria}}$
Numerator	Cases in which the underlying cause of death is malaria. All recorded malaria deaths should have had a parasite-based test for malaria (microscopy and/or RDT) and a diagnosis based on the test result. Data on malaria deaths from hospitals and other facilities with beds should be included.
Denominator	The number of people living in areas where malaria transmission occurs. Areas with malaria transmission can be defined as those in which locally acquired, confirmed cases of malaria are reported. Population sizes should be adjusted for population growth according to projections from the national census or, when not available, United Nations Population Division projections. It is sometimes useful to use the total population of an area or country as a denominator in order to compare the overall level of risk among geographical areas or countries. If rates are calculated per month, as when plotting rates on a graph, the population size should be divided by 12 to obtain an annual incidence rate.
Breakdown	Age group (all ages, < 5 years), geographical area, time (year and month)
Purpose	To monitor the impact of programmes on the number of malaria deaths
Interpretation	Inpatient deaths are markers of very severe disease and indicate failure of the health system to either prevent or effectively treat malaria. The numbers of deaths are generally small, and trends may be difficult to discern, but clusters of deaths may occur in time and space. This indicator is most useful in high-transmission settings in which malaria death rates are high. Trends can be affected by: • completeness of reporting: trends can change if the percentage of health facilities reporting in a month changes or if different sets of health facilities are included e.g. including private hospitals. • changes in diagnostic practice e.g. the introduction of more diagnostic testing may reduce the number of malaria deaths diagnosed. • changes in use of health facilities owing to greater availability of antimalarial drugs or implementation of user fees • actual changes in the number of malaria deaths In order to conclude that changes in the value of the indicator reflect a real change in malaria mortality in the community, indicators should be examined for completeness of reporting, changes in the percentage of cases that had a diagnostic test, total number of inpatient visits per 10 000 and number of deaths per 100 000, to confirm that they are reasonably constant over time.

4. Malaria test positivity rate (RDT and/or blood slide)	
Formula	1000 * $\frac{\text{Number of confirmed malaria cases}}{\text{Number of patients receiving a parasitological test}}$
Numerator	Number of cases of suspected malaria confirmed by either microscopy or RDT. The number should include both outpatient and inpatient cases. The number should include cases detected passively (attending health facilities or seen by community health workers) or actively (sought in the community); it is often useful to provide a breakdown of cases detected passively and actively. Any person with a positive result in a parasite-based test (microscopy or RDT), irrespective of clinical symptoms, should be considered to have confirmed malaria case.
Denominator	Total number of suspected malaria cases tested
Breakdown	Type of diagnostic test (microscopy or RDT), parasite species, geographical area, time (year and month), type of detection (passive, active, community)
Purpose	To reflect trends in malaria morbidity and identify areas with the most intense malaria transmission. Partially 'corrects' for incompleteness of reporting and RDT stock-outs because the numerator is derived from the same source as the denominator.
Interpretation	RDT and slide positivity rates can differ and should therefore be reported separately. RDTs reflect the presence of antigens and may remain positive after parasites have been cleared by treatment. Test positivity rates can change if parasitological diagnosis has been extended to populations living in intense transmission areas that previously did not have access to testing. Care should be taken, therefore, to take into account possible confounding factors when interpreting trends. Changes in test positivity rates do not reflect percentage changes in malaria cases or incidence, as the number of malaria cases is part of the denominator.

5. Percentage of cases due to *P. falciparum*	
Formula	100 * Number of confirmed *P. falciparum* malaria cases / Number of confirmed malaria cases
Numerator	Number of *P. falciparum* cases confirmed by either microscopy or RDT. The number should include both outpatient and inpatient cases. Mixed infections with *P. falciparum* should be counted as *P. falciparum*. The number can include cases detected passively (attending health facilities or seen by community health workers) or actively (sought in the community); it is often useful to provide a breakdown of cases detected passively and actively.
Denominator	Total number of cases of malaria confirmed by either microscopy or RDT. The number should include both outpatient and inpatient cases. The number should include cases detected passively (attending health facilities or seen by community health workers) or actively (sought in the community); it is often useful to provide a breakdown of cases detected passively and actively.
Breakdown	Type of diagnostic test (microscopy or RDT), geographical area, time (year and month), type of detection (passive, active, community)
Purpose	To reflect the proportion of cases due to *P. falciparum* and provide information on the likelihood of observing severe cases
Interpretation	Can provide information on the likelihood of observing severe cases and the extent to which programmes should be adjusted to address *P. vivax* or other species Can provide information on the degree of malaria control, as, in areas where control measures are scaled up, the proportion of cases due to *P. falciparum* may decrease; *P. vivax* appears to be respond less quickly to control measures because it can tolerate a wider range of environmental conditions and because the dormant liver stage (hypnozoite) enables infections to persist in the absence of mosquito transmission. *P. ovale* and *P. malariae* may also become more frequent, but these are rare in most settings. As the ability to detect *P. falciparum* may vary by type of test (microscopy or RDT), care should be taken to ensure that the proportion of cases due to *P. falciparum* is not influenced by changes in the ratio of different types of test used, i.e. the results of microscopy and RDTs should be analysed separately.

6. Percentage of inpatient cases with a discharge diagnosis of malaria	
Formula	100 * Number of inpatient cases with a discharge diagnosis of malaria / Total number of inpatients
Numerator	Number of inpatients with a primary diagnosis of malaria at discharge or death. Patients who have absconded or been transferred should be excluded. All cases should have had a parasite-based test for malaria (microscopy and/or RDT) and a discharge diagnosis based on this test result. Malaria inpatient numbers should include patients from both hospitals and other facilities with beds.
Denominator	Total number of inpatients discharged or died (inpatients who have absconded or been transferred should be excluded). Total inpatient numbers should include patients from both hospitals and other facilities with beds.
Breakdown	Age group (all ages, < 5 years), geographical area, time (year and month)
Purpose	To monitor the impact of programmes on severe disease. Partially 'corrects' for incompleteness of reporting because the numerator is derived from the same source as the denominator.
Interpretation	Inpatient cases are markers of severe disease and death and indicate failure of the health system to either prevent or effectively treat malaria. The number of inpatient cases is generally larger than the number of health facility deaths, so that trends can be more easily discerned. This indicator is most useful in high- and moderate-transmission settings in which the rates of severe morbidity are significant. In some countries, inpatient cases may also include uncomplicated *P. falciparum* (according to national guidelines) in order to ensure full treatment, recovery and parasite clearance. Trends can be affected by: • completeness of reporting: trends can change if different sets of health facilities are included, e.g. private hospitals with different proportions of inpatients due to malaria. • changes in diagnostic practice e.g. introduction of more diagnostic testing may reduce the number of malaria inpatients diagnosed. • changes in attendances for conditions other than malaria e.g. malaria inpatient proportions may decrease if the number of skilled deliveries increases. • actual changes in the incidence of severe malaria. In order to conclude that changes in the value of the indicator reflect a real change in the incidence of malaria, indicators should be examined for completeness of reporting, percentage of cases that had a diagnostic test and the numbers of inpatient cases of malaria and other conditions, to confirm that they are reasonably constant over time. Changes in the percentage of inpatients with a discharge diagnosis of malaria do not reflect changes in the number of malaria inpatient cases or inpatient case incidence as the number of malaria cases is part of the denominator.

7. Percentage of inpatient deaths due to malaria	
Formula	100 * Number of inpatient deaths due to malaria / Total number of inpatient deaths
Numerator	Number of inpatients with a primary diagnosis of malaria at death. All cases should have had a parasite-based test for malaria (microscopy and/or RDT) and a diagnosis based on this test result. The numbers of malaria deaths should include patients from both hospitals and other facilities with beds.
Denominator	Total number of inpatient deaths The numbers of deaths should include patients from both hospitals and other facilities with beds.
Breakdown	Age group (all ages, < 5 years), geographical area, time (year and month)
Purpose	To monitor the impact of programmes on the number of malaria deaths. Partially 'corrects' for incompleteness of reporting because the numerator is derived from the same source as the denominator.
Interpretation	Inpatient deaths are markers of very severe disease and indicate failure of the health system to either prevent or effectively treat malaria. The numbers of deaths are generally small, and trends may be difficult to discern, but clusters of deaths may occur in time and space. This indicator is most useful in high-transmission settings, in which malaria death rates are high. Trends can be affected by: • completeness of reporting: trends can change if different sets of health facilities are included, e.g. private hospitals with different proportions of deaths due to malaria. • changes in diagnostic practice e.g. introduction of more diagnostic testing may reduce the number of cases of malaria diagnosed in inpatients. • changes in attendance for conditions other than malaria e.g. malaria inpatient proportions may decrease if the number of skilled deliveries increases. • actual changes in malaria death rates. In order to conclude that changes in the value of the indicator reflect a real change in malaria death rates, the indicators must be examined for completeness of reporting, percentage of cases that had a diagnostic test and the numbers of deaths from malaria and other conditions, to confirm that they are reasonably constant over time. Changes in test positivity rates do not reflect percentage changes in the number of malaria cases or incidence, as the number of malaria cases is part of the denominator.

8. Annual blood examination rate	
Formula	100 * Number of patients receiving a parasitological test / Population at risk of malaria
Numerator	Total number of suspected malaria cases tested. This can include active and passive case detection. Patients tested by both RDT and microscopy should be counted only once.
Denominator	Number of people living in areas where malaria transmission occurs. Areas with malaria transmission can be defined as those in which locally acquired, confirmed cases of malaria are reported. Population sizes should be adjusted for population growth according to projections from the national census or, when not available, United Nations Population Division projections. If rates are calculated per month, as when plotting a graph, the population size should be divided by 12 to obtain an annual rate.
Breakdown	Type of diagnostic test (microscopy or RDT), geographical area, time (year and month), type of detection (passive, active, community)
Purpose	To reflect the extent of diagnostic testing in a population; aids interpretation of other surveillance indicators.
Interpretation	Higher annual blood examination rates generally reflect more complete malaria surveillance. Some past guidance suggests that the annual blood examination rate should be about 10% in order to provide reliable trends, but the empirical evidence for such a target is not strong. In high-transmission settings, the rate is likely to greatly exceed 10% due to passive case detection alone.

9. Percentage of suspected malaria cases that have had a diagnostic test	
Formula	100 * Number of patients receiving a parasitological test / Number of suspected cases of malaria
Numerator	Total number of suspected malaria cases tested. This should include those found by passive case detection only; patients identified by active case detection should be excluded. Patients tested by both RDT and microscopy should be counted only once.
Denominator	Number of suspected malaria cases attending health facilities (i.e. passive case detection).
Breakdown	Type of diagnostic test (microscopy or RDT), geographical area, time (year and month)
Purpose	WHO recommends that all suspected malaria cases should receive a diagnostic test by microscopy or RDT, regardless of age. The indicator reflects the extent to which malaria programmes are able to achieve this goal and where further effort may be required.
Interpretation	A value less than 100% may indicate problems in data recording, policy adoption, financing, stock-outs of RDT at national or health facility level or clinician adherence.

10. Completeness of health facility reporting	
Formula	100 * Number of health facilities reports received / Number of health facilities expected
Numerator	Number of monthly reports received from health facilities. It may be necessary to consider the number of health facility reports for different data elements e.g. if outpatient cases are reported on different forms from inpatient cases. If a health facility does not submit a report, e.g. because it is temporarily closed, a null report showing zero cases and activities should be created and the reported marked as received.
Denominator	Number of health facility reports expected. Generally, this is the number of health facilities expected to report multiplied by the number of months considered.
Breakdown	Geographical area, time (year and month), report type (e.g. inpatient, outpatient)
Purpose	Regular monitoring and follow-up can improve the completeness of reporting until all health facilities are consistently reporting every month. Aids interpretation of other surveillance indicators.
Interpretation	The completeness of reporting of health facilities should be near 100%. Values < 100% may indicate problems with supplies of stationary, communications, staff availability, motivation or skills. The indicator gives equal weight to all health facilities and therefore may not reflect the completeness of case reporting; missing reports from district hospitals are likely to account for a larger number of missing cases than missing reports from remote rural health facilities.
Other	If data reported from district to regional or national level are summarized by district (rather than by health facility), the district summary form should contain two variables: number of health facilities expected to report and number of health facilities that reported. If community workers report malaria information to health facilities every month, the completeness of reporting by community workers should also be calculated. The health facility reporting form should contain two additional data elements: number of community workers expected to report and number that reported during the month.

ANNEX 4.
Suggested register for community health workers, health posts and outpatient departments of health centres and hospitals

No.	Date	Name	Residence (village, neighbour-hood)	Sex	Age in years	Provisional diagnosis	New visit?	Malaria test result	Final diagnosis	Treatment
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

(6) Age in years: Age should be recorded as < 1 or 0 for children < 1 year of age.

(7) Provisional diagnosis: may be amended in column 11 if the result of a malaria diagnostic test result is negative.

(9) Malaria test result: The result should be recorded as +ve, –ve, or not done. If more than one species is possible, the parasite species (*P.f.*, *P.v.*, *P.m.*, *P.o.*) should be recorded for positive test results.

(11) Final diagnosis: Will include presumed malaria if no test was performed.

(12) Treatment: Specify if artemesinin-based combination therapy or other antimalarial treatment was given and if patient referred.

The number of suspected malaria cases can be derived from column 7. The number of confirmed cases can be derived from column 9. The number of presumed malaria cases can be derived by subtracting the number of confirmed malaria cases in column 9 from the number of malaria diagnoses in column 10. Counts should apply only to new visits, which are indicated in column 8; sometimes, columns for repeat visits are added to the right of column 11.

ANNEX 5.
Sheet for tallying outpatient attendance at health centres and hospitals

Patient attendance											**Total**
Suspected malaria	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	47
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
Microscopy											
Patients tested by microscopy	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	42
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
P. falciparum	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	16
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
P. vivax	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	6
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
P. malariae	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
P. ovale	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
Mixed	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
Positive tests (confirmed malaria) <5	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	12
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
Positive tests (confirmed malaria) ≥5	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	10
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
RDT testing											
Patients tested with RDT	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	4
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
Positive tests (confirmed malaria) <5	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	1
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
Positive tests (confirmed malaria) ≥5	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
Treatment											
Confirmed cases receiving antimalarial	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	22
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
Presumed cases receiving antimalarial *(presumed cases = cases not tested)*	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	
	00000	00000	00000	00000	00000	00000	00000	00000	00000	00000	

A tally sheet can be used to make counts from records in registers or to keep a running total of patients in clinics. Each circle can be viewed as a patient's head, and a circle is crossed when a patient satisfies particular criteria. The tally sheet can be used for daily or weekly totals. At the end of the day or week, the crossed circles are added and the totals transferred to a daily or weekly summary book or chart.

The tally sheet should be locally adapted. For example, if there is no *P. vivax* or *P. ovale*, those can be removed. In settings where a multi-species RDT is used, the RDT section should be adapted to report those results.

ANNEX 6.
Daily and weekly records of outpatient attendance at health centres and hospitals

Month: April 2012	1	2	3	4	5	6	7	Weekly total	8	9
Day:	S	M	T	W	T	F	S		S	M
Patient attendance										
Suspected malaria	8	59	47							
Microscopy										
Patients examined		56	42							
P. falciparum		18	16							
P. vivax		3	6							
P. malariae										
P. ovale										
Mixed										
Positive tests (confirmed malaria) <5		8	12							
Positive tests (confirmed malaria) ≥5		13	10							
RDT testing										
Patients tested with RDT	8	2	4							
Positive tests (confirmed malaria) <5	2	0	1							
Positive tests (confirmed malaria) ≥5	1	0	0							
Treatment										
Confirmed cases receiving antimalarial	2	0	1							
Presumed cases receiving antimalarial *(presumed cases = cases not tested)*	1	0	0							

Totals from tally sheets can be copied into a daily and weekly summary book, so that there is a permanent record of the daily counts of outpatient attendance. These can be used to assess daily or weekly changes in the incidence of disease and to calculate monthly totals, to be transcribed onto a monthly report. The order of rows and their height should be the same as those of the tally sheets to facilitate transcription.

The tally sheet should be locally adapted. For example, if there is no *P. vivax* or *P. ovale*, those can be removed. In settings where a multi-species RDT is used, the RDT section should be adapted to report those results.

ANNEX 7.
Discharge register for inpatient departments of health centres and hospitals

No.	Date	Name	Residence (village, neighbourhood)	Sex	Age	YMD	Diagnosis	Length of stay (days)	Reason for leaving
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

(7) YMD: units in which age is recorded: days should be used for children < 1 month, months for children < 1 year, years for others).

(8) Diagnosis: Should follow ICD classifications as far as possible; some facilities may add a column for the ICD code.

(10) Reason for leaving: discharged, died, transferred or absconded

The total number of malaria inpatient cases should be the number discharged plus died, i.e. excluding transferred and absconded, as a final diagnosis will not have been made.

ANNEX 8.
Reports from health posts and community health workers to health facilities

Patient attendance	
Suspected malaria	
Testing	
Patients tested with RDT	
Confirmed malaria <5 years	
Confirmed malaria ≥5 years	
Treatment	
Confirmed malaria treated with antimalarial medicine	
Cases not tested treated with antimalarial medicine	
Cases referred	

The number of variables to be reported each month should be kept to a minimum, to enhance the completeness and quality of reporting. All health workers should understand the terms used, i.e. 'confirmed malaria': suspected malaria cases with a positive test. Notes can be placed at the bottom of a form and in standard treatment manuals as a reminder.

ANNEX 9.
Reports from health facilities to the district level

Areas with P. falciparum *only*

Outpatients

Suspected malaria	
Total outpatients	

Testing

Patients tested by microscopy	
Confirmed malaria <5 years	
Confirmed malaria 5+ years	
Patients tested with RDT	
Confirmed malaria <5 years	
Confirmed malaria 5+ years	

Inpatients

Malaria <5	
Malaria 5+	
Total inpatients <5	
Total inpatients 5+	

Deaths

Malaria <5	
Malaria 5+	
Total deaths <5	
Total deaths 5+	

Treatment

Confirmed malaria treated with antimalarial medicine	
Cases not tested treated with antimalarial medicine	

Areas with more than one species of Plasmodium

Outpatients	
Suspected malaria	
Total outpatients	
Testing	
Patients with microscopic slide examination	
P. falciparum	
P. vivax	
P. malariae	
P. ovale	
Mixed	
Total confirmed malaria <5 years	
Total confirmed malaria 5+ years	
Patients tested with RDT	
Confirmed malaria <5 years	
Confirmed malaria ≥5 years	
Inpatients	
Malaria <5	
Malaria ≥5	
Total inpatients <5	
Total inpatients ≥5	
Deaths	
Malaria <5	
Malaria ≥5	
Total deaths <5	
Total deaths ≥5	
Treatment	
Confirmed malaria treated with antimalarial medicine	
Cases not tested treated with antimalarial medicine	

The number of variables to be reported each month should be kept to a minimum, to enhance the completeness and quality of reporting. All health workers should understand the terms used, i.e. 'confirmed malaria': suspected malaria cases with a positive test. Notes can be placed at the bottom of a form and in standard treatment manuals as a reminder.

The tally sheet should be locally adapted. For example, if there is no *P. vivax* or *P. ovale*, those can be removed. In settings where a multi-species RDT is used, the RDT section should be adapted to report those results.

ANNEX 10.

Line lists of inpatient malaria cases and deaths to be reported to district level in low-transmission settings

(7) Type of test: RDT, microscopy or none

(8) Species: If only *P. falciparum* is present, this column is not needed. If more than one species might be involved, the parasite species (*P.f.*, *P.v.*, *P.m.*, *P.o.*) should be recorded for positive test results.

(9) ITN: insecticide-treated net.

(10) IRS: indoor residual spraying.

(15) Medicines used: Specific details to be provided to determine possibility of expired or counterfeit medicines.

No.	Date admitted	Name	Residence (village, neighbourhood)	Sex	Age	Pregnant? (Y/N)?	Type of test (RDT/ micr.)	Species	Malaria prevention			Antimalarial treatment					Reason for leaving (discharged/ died/ absconded/ transferred)
									ITN owned by household (Y/N)?	ITN used in 2 weeks before admission (all nights some/ none)?	House received IRS (Y/N)?	Date of onset of symptoms	Date contacted health system	Receieved antimalarial treatment (Y/N)	Date started	Medicines used (ACT, CQ, others)	
1																	
2																	
3																	
4																	
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	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)

ANNEX 11.

Line lists of all confirmed malaria cases to be reported at district level in low-transmission settings

(7) Species: If only *P. falciparum* is present, this column is not needed. If more than one species might be involved, the parasite species (*P.f.*, *P.v.*, *P.m.*, *P.o.*) should be recorded for positive test results.

(8) ITN, insecticide-treated net;

(10) IRS, indoor residual spraying; (9)Type of test: RDT, microscopy or none

(15) ACT, artemisinin-based combined therapy; CQ, chloroquine

								Malaria prevention			Antimalarial treatment				
No.	Date admitted	Name	Residence (village, neighbour-hood)	Sex	Age	Type of test (RDT/ micr.)	Species	ITN owned by house-hold (Y/N)?	ITN used in 2 weeks before admission (all nights some/ none)?	House received IRS (Y/N)?	Date of onset of symp-toms	Date contacted health system	Receieved antimalarial treatment (Y/N)	Date started	Medicines used (ACT, CQ, others)
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	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)

ANNEX 12.
Supervisory checklist for countries with high or moderate transmission

During visits to health facilities, supervisors should check that registers are kept up to date, with all fields completed, that data on report forms correspond to information in registers and tally sheets, that core analysis graphs and tables are up to date and that discussions are held about interpretation of the trends and potential action. Health facility staff should be encouraged to investigate all malaria inpatient cases and deaths. An example of a supervisory checklist for surveillance for malaria is shown below.

Record keeping	**Not present**	**Present but not up to date**	**Present and up to date**	**Present, up to date and no mistakes**
Outpatient register				√
Discharge register				√
Daily attendance summary book				√
Monthly attendance summary book				√
Graph of suspected cases	√			
Graph of number of tests performed	√			
Graph of number of confirmed cases				√
Graph of test positivity rate			√	
Reporting	**None**	**1**	**2**	**3**
Number of monthly reports sent on time in last 3 months				√
Investigations performed in past 3 months	**Not done**	**Done**	**Done & action taken**	
Malaria deaths			√	
Malaria inpatients			√	
Malaria cases	√			
Disease or progamme delivery issues that need attention				
Large number of inpatient cases still from Lacienda village				
Recommendations				
Calculate test positivity rates as demonstrated. Work with Laceienda village chief to encourage residents to use LLINs and attend health centre promptly if ill with fever.				

ANNEX 13.
Example quarterly bulletin for countries with high or moderate transmission

A national feedback bulletin should be produced each quarter, with data by district. The bulletin should be widely circulated, not only as feedback to districts but also as information for other government departments and institutions. Elected leaders should also be given the bulletin on malaria, possibly showing the malaria situation according to political boundaries, to instil understanding and support for malaria control at the highest level of leadership.

Bulletins can draw on the control charts described in Box 4.4 but should be tailored to country circumstances, e.g. programme priorities or availability of data. In addition to surveillance charts, country bulletins should include some measures of intervention coverage. An example of the first page of a country bulletin is shown below (other pages show tables of indicators calculated for districts). The format allows the sharing of a large amount of information in a small space. It should be noted that figures with more than three trend lines may be difficult to interpret.

Rwanda National Malaria Programme
Monthly Surveillance and Logistics Report
Based on data available at the end of December 2008

Commentary:

Stock for public sector at national level		
ACT	Stock at end of month	Data collection in process
	Stock needed for next month	
LLIN	Stock at end of month	
	Stock needed for next month	
RDT	Stock at end of month	
	Stock needed for next month	

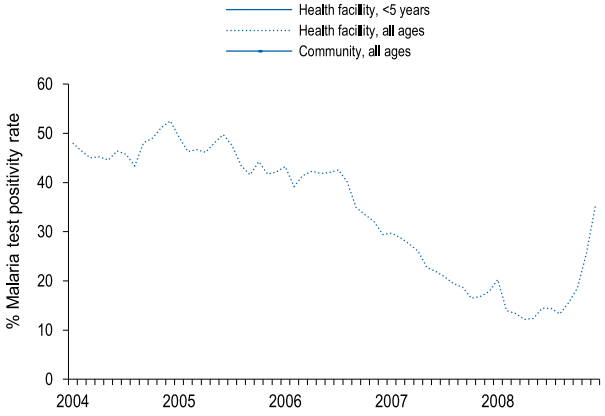
National IRS data, 2008	
No. houses targeted for ≥1 round	152 072
No. houses sprayed with ≥1 round	152 072
No. persons at risk of malaria	9 292 654
No. persons protected with ≥1 round	705 035
% protected with ≥1 round	8%

Estimated national coverage (possession) with LLIN	
No. of persons at risk for malaria	9.3 mil
No. of LLIN distributed in past 2 years	2 176 691
No. of LLIN district this year (year-to-date)	161 457
Estimated coverage with LLIN	25%

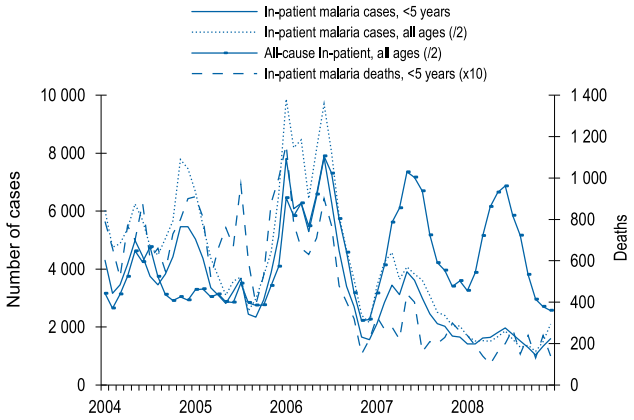
National-level surveillance data, 2008, Year-To-Date (YTD)			
	Reference period 2004	YTD 2008	% Reduction
In-patient malaria cases, all ages	136 446	37 557	72
In-patient malaria cases, <5 yo	50 931	18 424	64
In-patient malaria deaths, all ages	1 933	624	68
In-patient malaria deaths, <5 yo	857	220	74
Out-patient malaria test positivity rate		18%	

TRENDS IN SURVEILLANCE/IMPACT INDICATORS

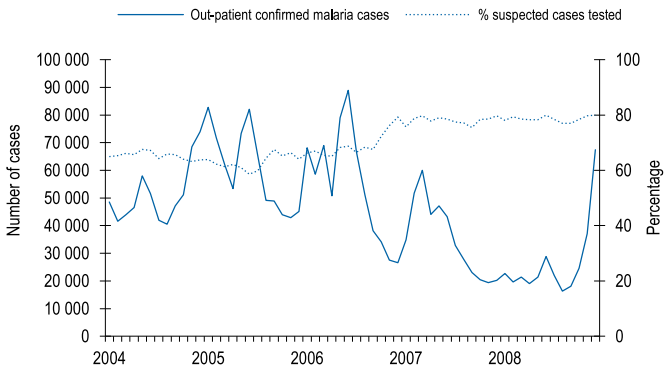
Out-patient : Malaria test positivity rate, by age group



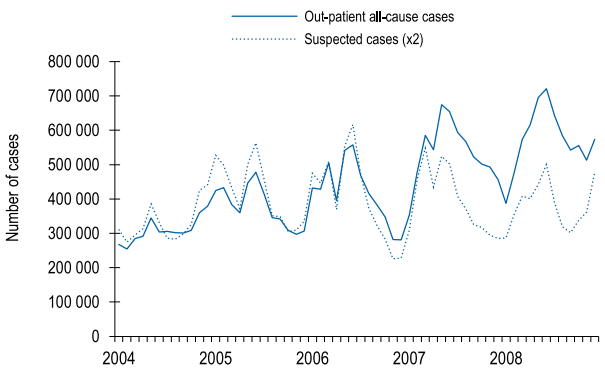
In-patient malaria and non-malaria cases and deaths



Out-patient: Confirmed cases and % of suspected cases

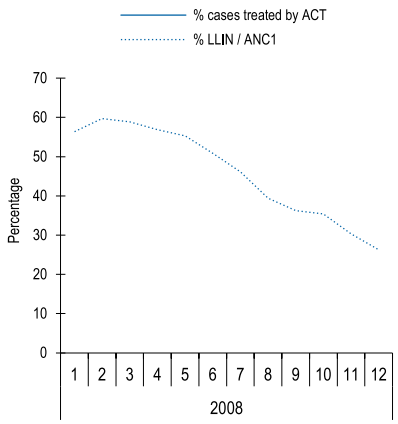


Out-patient: all causes and suspected malaria

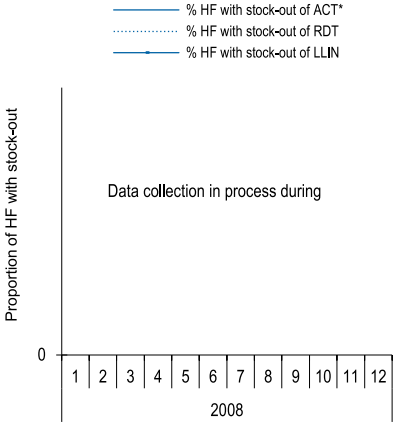


TRENDS IN LOGISTICS AND REPORTING COMPLETENESS INDICATORS

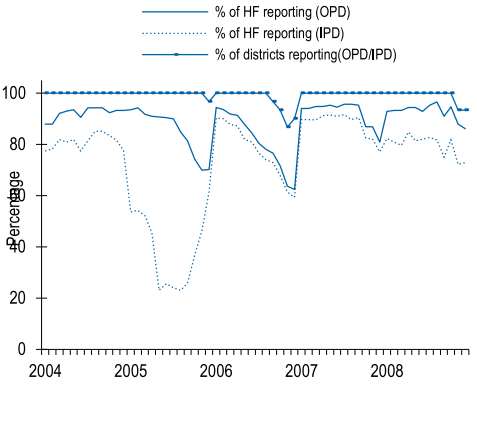
Coverage of % ACT, LLIN, IPT



Proportion health facilties with stock-outs



Reporting completeness



- Health facility, all ages: data collection in process

HF: Health Facility

IRS: Indoor residual spraying

Disease Surveillance for Malaria Control

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World Health Organization
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http://www.who.int/malaria/en/

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