MODULE 11:

MALARIA SURVEILLANCE

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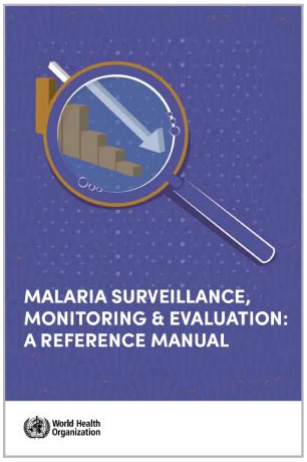


This module describes malaria surveillance in the global context and defines basic concepts. It describes how malaria surveillance is conducted in various transmission settings, high and moderate, low, very low, and elimination, according to WHO guidelines. It takes into account risk factors that affect malaria surveillance. Finally, it discusses the importance of assessing the performance of a malaria surveillance system. Note that this module is not intended to duplicate the guidance provided in WHO's *Malaria Surveillance, Monitoring & Evaluation: A Reference Manual* (2018). Please refer to that document for more detail at https://www.who.int/malaria/publications/atoz/9789241565578/en/.

Module Objectives

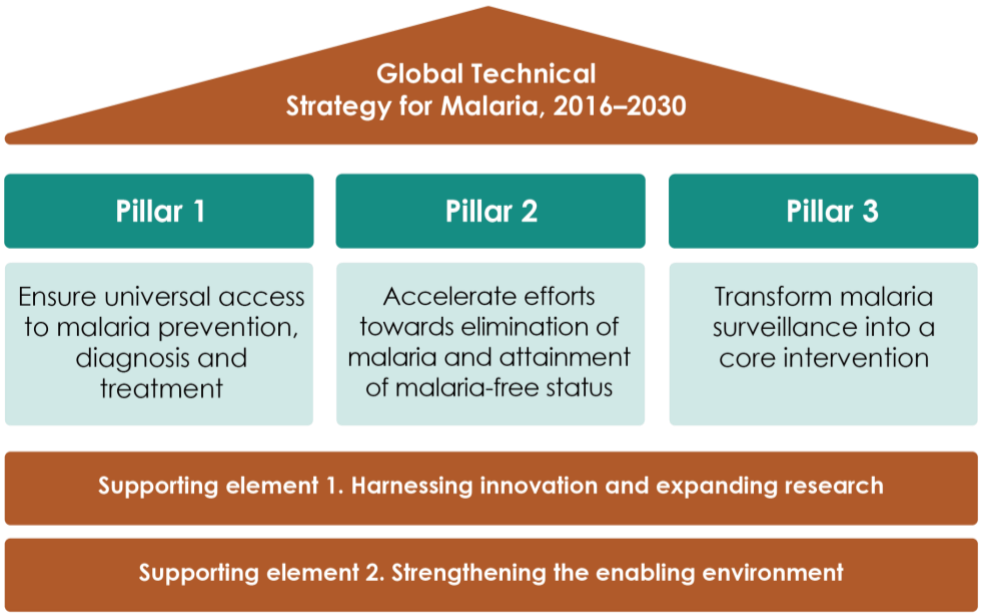
By the end of this module, you will be able to:

- Appreciate the global context of malaria surveillance
- Define basic concepts of malaria surveillance
- Understand malaria surveillance in various transmission settings
- Recognize risk factors
- Assess the performance of a malaria surveillance system

The Global Context

In 2015, WHO's Global Technical Strategy (GTS) transformed malaria surveillance into a core intervention under Pillar 3. This method of surveillance is to be used as a form of aggressive monitoring to guide malaria programs for action. More details on the GTS can be found at http://www.who.int/malaria/publications/atoz/9789241564991/en/.

Figure 32. WHO's Global Technical Strategy for Malaria, 2016–2030



Source: Framework for the WHO GTS

Basic Concepts

Definition of Malaria Surveillance

Malaria surveillance systematically collects relevant data, consolidates information, and delivers it quickly to guide decisions toward action to control or prevent malaria. It provides timely, malaria-specific data and information at a national scale or for specific geographical areas.

> "Surveillance as an intervention encompasses tracking of disease [malaria] and programmatic responses and taking action in response to data received."
>
> *—WHO GTS–Malaria*

Malaria surveillance must be adapted to the transmission context to account for different data and action requirements. Figure 33 shows the WHO Malaria SME operational guidance for malaria surveillance across various transmission settings.

Figure 33. WHO/GTS SME operational guidance for malaria surveillance by transmission setting

		High	Moderate	Low	Very low	Zero	Maintaining zero
		≥ 35% PfPR or ~450 per 1,000 API	10–35% PfPR or 250–450 per 1,000 API	1–10% PfPR or 100–250 per 1,000 API	> 0 but <1% PfPR or 100 per 1,000 API	No transmission	
Pillar 3 of the GTS 2016–2030 Transform malaria surveillance into a core intervention	Case detection	Passive case detection			Passive and active case detection		
	Recording	Outpatient and inpatient registers			Individual patient forms		
	Reporting frequency	Monthly		Weekly		Immediate case notification	
	Resolution of reported data	Aggregate cases by sex and age category			Case report, age, sex, residence, travel history, and case classification		
	Data use: health facilities	Data analyzed monthly		Weekly		Data analyzed in real time	
	Data use: intermediate levels	Data analyzed monthly		Weekly		Data analyzed weekly	
	Data use: national	Data analyzed monthly or quarterly		Weekly		Data analyzed weekly	
	Response time	Monthly or quarterly		Weekly		Case investigation within 24–48 hrs, focus investigation with 1 week	
	Feedback frequency to upper and lower levels	Annually or quarterly		Monthly		Every two weeks	
	Surveillance system monitoring	Every two years		Annually		Annually or more frequently	

Source: WHO Malaria SME Reference Manual, 2018, p. 13

Objectives of Malaria Surveillance

The GTS recommends that information from malaria surveillance be used for policy and program evidence-based decision making and to inform program implementation. Objectives include the following:

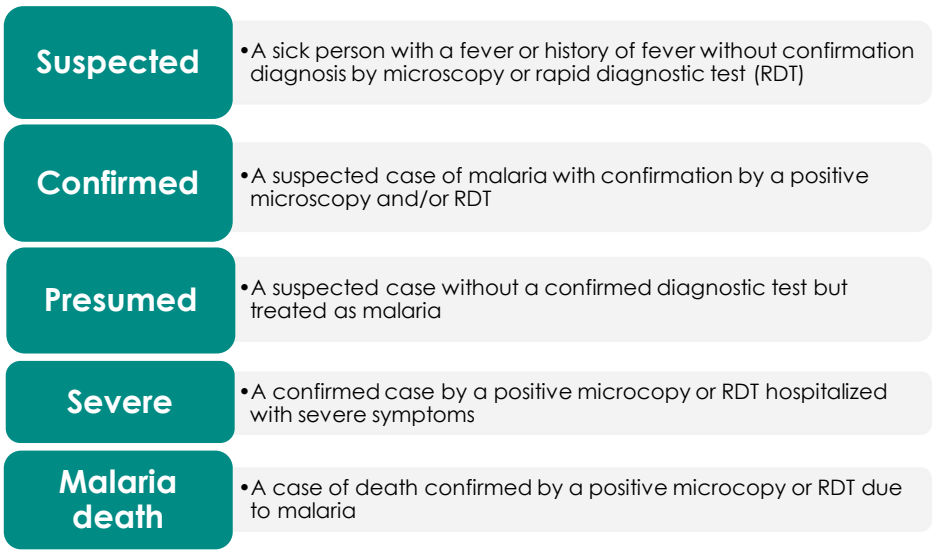
- **Plan:** To provide an evidence-based framework that organizes actions and tracks progress
- **Contribute:** To use early detection and fast response to improve health outcomes and allow the healthcare community to move resources to places where they are needed most
- **Alert:** To detect abnormal trends that can indicate epidemics and use this evidence to take preventive action
- **Describe:** To describe the possible magnitude of increase in cases by analyzing trends and patterns in diseases and reporting the evidence to stakeholders who can use the information to take action

- **Evaluate:** To measure the effectiveness of interventions and pinpoint areas that need strengthening
- **Hypothesize:** To analyze available information and interpret it to form a working hypothesis that can be tested through research and refined during actions
- **Research:** To identify disease elements that need answers through scientific research

Case Definition

Malaria surveillance detection follows established criteria—a standard case definition to ensure that every case is diagnosed in the same way. Malaria cases are defined as shown in Figure 34.

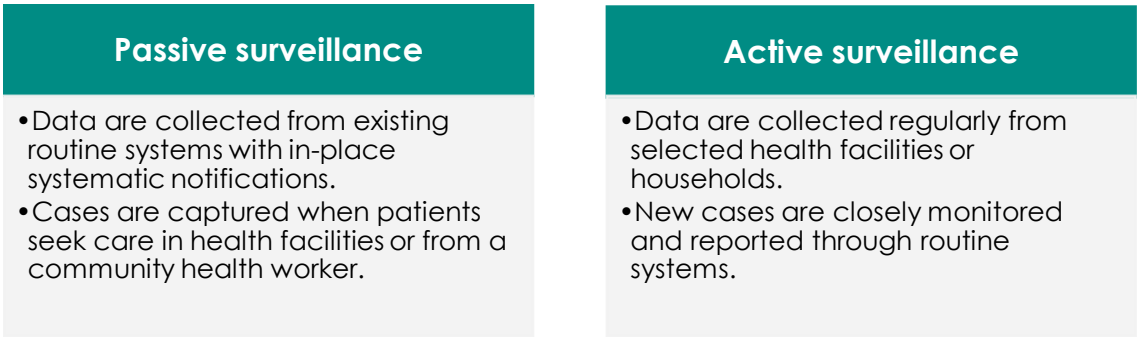
Figure 34. Standard malaria case definitions



Case Detection

Malaria surveillance can be passive or active, as shown in Figure 35.

Figure 35. Comparison of passive and active malaria surveillance



Passive surveillance is less burdensome on the health system and costs less because it uses the existing routine health information system. It provides useful data that show trends over time; however, it may not be representative because not all cases are captured in the routine health information system. It may also fail to identify outbreaks and is limited by variability and incompleteness of reporting.

Active surveillance often validates passive reports, ensures more complete reporting, identifies outbreaks, and can be used with specific investigations for brief periods of time. There are two types of active

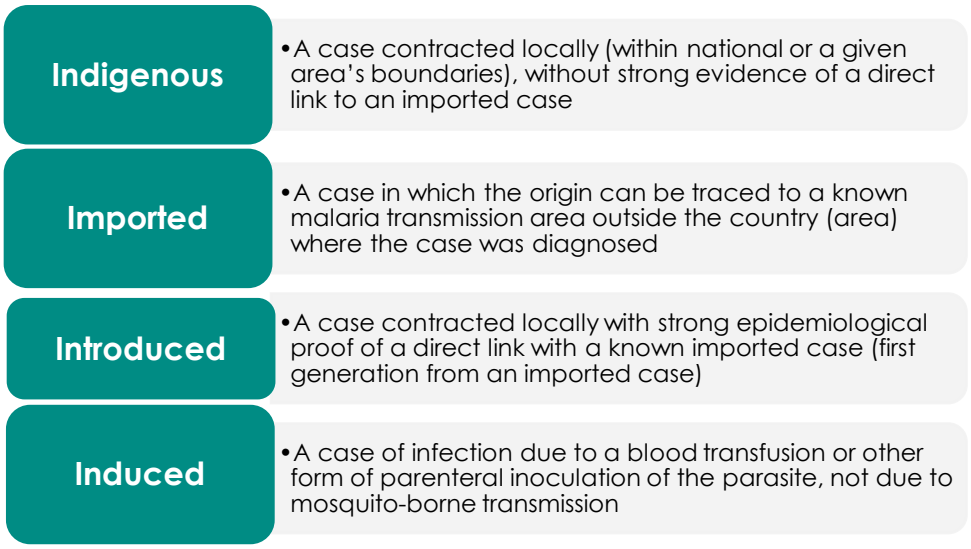
surveillance, proactive and reactive. During a proactive approach, a health worker tests an entire population in a given area for malaria. During a reactive approach, a health worker goes household to household to test a population for malaria. Both approaches are burdensome on health staff and expensive to maintain.

Case Investigation and Classification

Case investigation is performed to determine the origin of the infection (local or imported) and document related factors. Detailed information on the history of the index case is collected from the service delivery point where it was reported to initiate the investigation. Case investigation is conducted most often in very low transmission settings, as part of reactive case detection. Information collected will help classify the case as indigenous, imported, introduced, or induced.

After a case has been investigated, it is classified into one of the categories shown in Figure 36.

Figure 36. Classifications of malaria cases



Response

Every epidemic investigation and case investigation must end with a response. Programs often set levels of thresholds for actions. An alert threshold suggests the need for further investigation, and an epidemic threshold triggers a specific response through lab confirmation or the implementation of an urgent investigation. Thresholds are set according to transmission settings and the human and financial resources available for response. Malaria control programs set response activities, such as resource mobilization, multisector communications, and other interventions. Programs are also responsible for maintaining adequate stocks of case definition forms, equipment, medicines, and RDT kits to be used for immediate response.

Malaria Surveillance in High- and Moderate-Burden Settings

High-burden settings are defined as having a *Plasmodium falciparum* parasite rate (*Pf*PR) of more than 35 percent or an annual parasitic incidence (API) of 450 per 1,000. Moderate-burden settings are defined as having a *Pf*PR of 10–35 percent or an API of 250–450 per 1,000. The priority for malaria surveillance in these settings is to reduce malaria burden, cases, and deaths.

Table 12. Characteristics of a malaria burden reduction setting

Profile of malaria control in a burden reduction setting	
Parasite prevalence/API	• High: *Pf*PR>=35%, API=450 per 1,000 • Moderate: *Pf*PR=10–35%, API=250–450 per 1,000
Incidence	• Most cases occur in children under five • Limited temporal variation • Limited geographical variation
Deaths	• Most malaria deaths occur in children under five
Fevers	• High proportion due to malaria
Health facility attendance	• High proportion due to malaria
Parasite	• Most cases due to *P. falciparum*
Vectors	• Efficient and stable anopheline activities
Health systems	• Weak, poor accessibility of services • Low ratios of staff to patients • Frequent stockouts of supplies (RDT, microscopy)

A malaria surveillance system in a burden reduction setting collects data on malaria epidemiology to provide information for planning, implementing, and monitoring and evaluating malaria control interventions. Data on individual cases and deaths are recorded on outpatient department and inpatient registers, then aggregated into a monthly report for analysis. Data are collected through routine health information systems, integrated disease surveillance and response systems, program parallel surveillance systems, and sentinel sites. Household surveys, such as the Demographic and Health Surveys, Multiple Indicator Cluster Surveys, and Malaria Indicator Surveys, can also provide supplementary data on the prevalence of parasitemia and intervention coverage at the population level.

Data analysis in this setting requires observing trends in aggregated data. Health facilities graph cases and deaths monthly and monitor trends. Subnational and national levels use aggregated data on cases and deaths to identify trends over time, assess the efficacy of malaria control interventions, and make programmatic adjustments.

Examples of key indicators collected in high- and moderate-burden settings include the following:

- Number of confirmed malaria cases per 1,000 population per month/year
- Number of inpatient malaria cases per 10,000 population per month/year
- Number of inpatient malaria deaths per 100,000 per month/year
- Malaria test positivity rate (RDT and/or slide positivity rate)
- Percentage of cases due to *P. falciparum*
- Percentage of inpatients cases due to malaria
- Percentage of inpatient deaths due to malaria
- Annual blood examination rate

- Percentage of suspected malaria cases receiving a diagnostic test
- Completeness of reporting

Additional indicators for burden reduction are available in the WHO malaria SME manual (WHO, 2018, Table 14 and Annex 17).

Malaria Surveillance in a Low-Burden Setting

Low-burden settings are defined as having a *Pf*PR of 1–10 percent or an API of 100–250 per 1,000. These settings are classified into two groups: (1) areas that are transitioning moderate transmission to low transmission and (2) areas that show seasonal environmental changes that cause vectors to be inefficient. The priority in this setting is to collect information to monitor for changes that may indicate an irregular increase in malaria cases and prepare a response. The national malaria program goal in this setting is to reduce malaria incidence to very low, using passive case detection and reactive case detection when needed.

Table 13. Characteristics of a low malaria burden setting

Profile of malaria control in a low-burden setting	
Parasite prevalence/API	• *Pf*PR=1–10% (children ages 2–9) • API=100–250 per 1,000
Incidence	• Uniform in age groups • Most cases occur in marginalized populations with higher exposure • Significant proportion of imported cases
Case distribution	• Seasonal malaria, high risk of epidemics • More focal within districts
Deaths	• Few (most cases in populations with higher exposure)
Fevers	• Small proportion due to malaria
Health facility attendance	• Low proportion due to malaria
Parasite	• Higher proportion of *P. vivax*
Vectors	• Unstable seasonal anopheline activities
Health systems	• Usually stronger than high and moderate burden settings • Better availability of supplies (RDT, microscopy)

Programs use SME data collected on incidence, mortality, and patient attendance; diagnostic results; and the quality of health facility reporting to inform planning, monitoring, and evaluation of control interventions in focal areas.

Data collected at the health facility level identify trends, indicate population groups with the highest incidence, and pinpoint the source of infection. Health facility information is plotted weekly to identify trends, pinpoint population groups with the highest incidence, seek the source of the infection, and report to the subnational level. Any irregular changes are investigated immediately. The subnational level conducts a monthly data review and further analysis. The national level analyzes the impact of malaria control interventions in the area affected.

Surveillance in a low-burden setting considers country heterogeneity. Analysis is disaggregated accordingly based on a clearly defined threshold that can trigger an alert for further investigation. Surveillance data are

compared to the thresholds over time. If the number of cases reaches or goes beyond the threshold, a further investigation is conducted to confirm the epidemic and prepare an adequate response. There are many different approaches for calculating alert and epidemic thresholds, including constant malaria case count, percentiles over the median or third quartile, the mean number of malaria cases +2 standard deviations (mean+2SD), the cumulative sum (C-SUM), and the weekly slope or doubling of cases during three consecutive weeks (7–9). Countries can choose the best approach based on their settings.

Malaria Surveillance in Very Low-Burden Settings

Very low-burden settings are defined as having a *Pf*PR more than 0 but below 1 percent or an API of less than 100 per 1,000. In this setting, the priority is to interrupt local transmission of malaria. The malaria surveillance system detects all malaria infections, with or without symptoms, to ensure an immediate response with prompt treatment to prevent secondary cases. The system captures an entire country or region with focused attention on areas with ongoing or recent transmission.

Table 14. Characteristics of a very low malaria burden setting

Profile of malaria control in a very low-burden setting	
Parasite prevalence/API	• *Pf*PR=>0 but <1% • API=<100 per 1,000
Incidence	• Cases sporadic • Imported cases common
Case distribution	• Focal distribution • High risk of epidemics
Deaths	• Very few (in populations with higher exposure)
Fevers	• Small proportion due to malaria (except in specific populations)
Health facility attendance	• Very low proportion due to malaria
Parasite	• Mostly *P. vivax* but not always
Vectors	• Vector activities controlled and inefficient (most cases are imported)
Health systems	• Strong • Availability of supplies (RDT, microscopy) and resources to investigate every case

High-quality data are required on all individuals with a suspected case of malaria, confirmed through a parasitological test. Every case and focus area is investigated fully, and results are reported immediately and completely. Records are kept for all tests and investigations to guide program implementation. Every malaria case reported through a passive surveillance system is important and requires the following immediate actions:

1. Confirm all malaria cases in public- and private-sector health facilities.
2. Investigate individual cases to determine whether the infection was acquired locally or imported.
3. Identify the foci, investigate to document the characteristics of transmitted cases, and intensify response and surveillance activities in the focus area.

More information on key indicators for very low transmission settings can be found in the WHO malaria SME manual (WHO, 2018, Table 14 and Annex 17).

Malaria Surveillance for Elimination

Elimination status is achieved when there is zero incidence of locally acquired malaria in an area due to deliberate efforts to prevent reestablishment of transmission. Malaria surveillance is essential to successful elimination of malaria through diligent data collection and recording. In this setting, the malaria surveillance system must confirm all malaria cases from public and private facilities and investigate each case to determine whether it is locally acquired or imported. An investigation of the focus area, or foci, is done to document characteristics and intensify response and surveillance activities. National support for policy legislation is needed as well as resources for additional staff, up-to-date laboratories for diagnostics, and treatment centers. Staff need to be properly trained on recognition of malaria symptoms, diagnostic testing procedures, appropriate treatments, and accurate data recording. The private sector must also be involved to ensure that the surveillance system is capturing cases from all facilities, public and private.

Key indicators for elimination focus on process, output, and impact. Table 15 lists selected common indicators.

Table 15. Common indicators for malaria elimination

Process and output Indicators	Impact indicators
• Annual blood examination rate by district and focus • Percentage of expected monthly reports received from health facilities and labs • Percentage of confirmed cases fully investigated • Percentage of foci fully investigated and registered • Time from first symptom (fever) to first contact with health system • Time from first contact to testing • Time from positive test result to start of treatment • Time from positive test result to notification of the national malaria program • Percentage of malaria testing labs participating in a quality management system • Percentage of past five years with national annual malaria program report	• Number and incidence rate of confirmed malaria cases by classification, sex, age group, risk group, etc. • Number of foci by classification (Incidence) • Number of imported cases (Incidence)

More information on key indicators for elimination is available in the WHO malaria SME manual (WHO, 2018, Table 14 and Annex 17).

Monitoring Risk Factors

A strong malaria surveillance system requires monitoring risk factors that affect vector breeding, transmission risk, and effective diagnostics and treatment. These risk factors can be environmental or anthropogenic.

Environmental Factors

Environmental factors that influence the vector life cycle include temperature, rainfall, humidity, wind, and topography.

Ambient temperature, the measure of heat in a volume of air, is registered at 2 p.m. for maximum temperature and at 6 a.m. for minimum temperature. Maximum and minimum temperatures affect the vector survival in larvae and adult stages, the parasite development in the vector, and the frequency of blood meals. The ideal mean temperature for malaria transmission is between 20 and 30 degrees Celsius.

Rainfall creates vector breeding sites by increasing water surface. Relative humidity, the ratio of air to water vapor, affects surface water dissipation and adult vector survival. Higher humidity increases mosquito survival. For example, an adult anopheles needs more than 60 percent humidity to survive.

Wind direction and speed distribute the vector. The topography, slopes, valleys, and wetlands affect water source formation and can affect vegetation coverage, which affects the vector habitat. The following table shows common environmental factors, the measurement tools used, and the effect that the factor has on malaria transmission.

Table 16. Effects and measurement of common environmental factors on malaria transmission

Environmental factors	Measurement tools	Effects on malaria transmission
Temperature (min, max, mean)	Thermometer	• Vector survival (larval and adult) • Development of the parasite in the vector • Frequency of blood meals
Relative humidity (%)	Hygrometer	• Vector survival (adult) • Creates surface water
Pluviometry	Pluviometer	• Creates habitat for the vector • Can flash off vector larval
Wind (direction and speed-m/s, km/h)	Anemometer and wind vane	• Facilitates spatial distribution of the vector
Vegetation coverage (NDVI, vegetation map)	SPOT/VG, field validation	• Vector habitat
Water surface (%)	Cartography	• Vector survival • Breeding sites
Topography (slope, valley, wallows, wetlands)	Contour map	• Affects the formation of water sources—potential breeding sites
Type of soil	Soil map	• Affects the availability of surface water for mosquito breeding sites

Anthropogenic Factors

Anthropogenic factors are factors influenced by human activity, which affect vector and parasite breeding. Land use, such as irrigation schemes, farming, and mining, can create or increase the surface water for breeding sites. Water sources, such as wells and boreholes, can provide breeding sites, even during the dry season. Urbanization affects vector survival by creating breeding sites in trash and puddles on pavement; however, it also reduces transmission by making treatment more accessible. Finally, the type of habitat, such as crowded housing or open villages, affects vector contact with humans.

Additional factors that influence malaria transmission include uncertainty of the health system, failure of health interventions, socio-political and economic instability, individual susceptibility (age, occupation), and housing conditions. Understanding the relationship between factors can build successful surveillance.

Assessing the Performance of a Malaria Surveillance System

An assessment of the surveillance system should be conducted periodically to ensure that the system is following program priorities. An assessment documents system effectiveness and linkages between the surveillance system and other existing health information systems. Outcomes from the assessment provide opportunities to introduce new surveillance methods to strengthen the system. An assessment of the performance of a surveillance system comprises four components: structure, core functions, support functions, and quality outputs. More details on what should be assessed in each component are found in the WHO malaria SME manual.

Module 11 Assessment

Questions

Correct answers are provided on page 137.

1. Malaria surveillance involves which of the following:

    a. A systematic and continuous process
    b. Collecting relevant data
    c. Analyzing and interpreting data
    d. All of the above
    e. None of the above

2. *True or False:* Presumed is a sick person with a fever or history of fever without confirmation of diagnosis by microscopy or RDT.

    a. True
    b. False

3. Match the following classification categories used in case investigation.

a. Imported	• A case contracted locally with strong epidemiological proof of a direct link with a known imported case (first generation from an imported case)
b. Indigenous	• A case in which the origin can be traced to a known malaria transmission area outside the country (area) where the case was diagnosed
c. Induced	• A case contracted locally (within national or a given area's boundaries), without strong evidence of a direct link to an imported case
d. Introduced	• A case of infection due to a blood transfusion or other form of parenteral inoculation of the parasite, not due to mosquito-borne transmission

4. What triggers a precise response for urgent implementation of interventions for epidemic management/control?

    a. Alert threshold
    b. Epidemic threshold
    c. Red light threshold
    d. All the above

5. Malaria surveillance in high and moderate burden settings focuses on which of the following:

    a. Confirming every case from public and private health facilities and determining whether each case is locally acquired or imported through a case investigation
    b. Collecting information to monitor for changes that indicate an irregular increase in malaria cases and preparing a response
    c. Reducing malaria burden, including cases and deaths
    d. Detecting all malaria cases, with or without infections, and ensuring an immediate response with prompt treatment to prevent secondary cases

6. Which is NOT true of passive case detection:

    a. Health worker tests an entire population in a given area for malaria.
    b. Data are collected from existing routine systems.
    c. Cases are captured when patients seek care in health facilities or from a community health worker.
    d. Passive case detection may be limited by incompleteness of reporting.

7. There are two forms of active surveillance. These are:

    a. Proactive and retroactive
    b. Proactive and reactive
    c. Reactive and retroactive
    d. None of the above

8. *True or false:* Malaria transmission anthropogenic-related factors are factors influenced by human activity, which affect vector and parasite breeding.

    a. True
    b. False

9. With which periodicity should malaria surveillance be conducted?

    a. Never
    b. Once every 20 years
    c. Every 10 years
    d. Periodically

Correct Answers

Correct answers are noted in bold.

1. Malaria surveillance involves which of the following:

   d. All of the above
   Malaria surveillance systematically collects relevant data and includes analyses and interpretation to inform decisions for action.

2. *True or False:* Presumed is a sick person with a fever or history of fever without confirmation of diagnosis by microscopy or RDT.

   False: Presumed is a suspected case without a confirmed diagnostic test but treated as malaria.

3. Match the following classification categories used in case investigation.

   Correct answers:

a. Imported	• A case in which the origin can be traced to a known malaria transmission area outside the country (area) where the case was diagnosed
b. Indigenous	• A case contracted locally (within national or a given area's boundaries), without strong evidence of a direct link to an imported case
c. Induced	• A case of infection due to a blood transfusion or other form of parenteral inoculation of the parasite, not due to mosquito-borne transmission
d. Introduced	• A case contracted locally with strong epidemiological proof of a direct link with a known imported case (first generation from an imported case)

4. What triggers a precise response for urgent implementation of interventions for epidemic management/control?

   b. Epidemic threshold
   An epidemic threshold triggers a specific response through lab confirmation or implementation of an urgent investigation.

5. Malaria surveillance in high and moderate burden settings focuses on which of the following:

   c. Reducing malaria burden, including cases and deaths

6. Which is NOT true of passive case detection:

   a. A health worker tests an entire population in a given area for malaria.

7. There are two forms of active surveillance. These are:

   b. Proactive and Reactive

8. *True or false:* Malaria transmission anthropogenic-related factors are factors influenced by human activity, which affect vector and parasite breeding.

   True: Anthropogenic factors are factors influenced by human activity, which affect vector and parasite breeding).

9. With which periodicity should malaria surveillance be conducted?

   d. Periodically
   Surveillance should be conducted periodically to ensure that the system is following program priorities.