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## Malaria

### Overview<sup>1, 2, 3, 5, 7</sup>

Malaria is an overwhelming problem in tropical developing countries, accounting for 243 million cases and 863,000 reported deaths each year.<sup>2</sup> It is estimated that up to 40% of the world's population is at risk for acquiring malaria. Most deaths occur in young children. Every year about 1500 cases of malaria and 5 deaths occur among international travelers from the United States.

Malaria is a mosquito-borne disease caused by protozoa of the genus *Plasmodium* (e.g., *P. falciparum*, *P. vivax*, *P. ovale*, and *P. malariae* among other species). The first two species cause the most infections worldwide. *P. falciparum* is the agent that most commonly causes severe and potentially fatal malaria. *P. vivax* and *P. ovale* may have dormant liver stage parasites, which can reactivate and cause malaria several months or years after the infecting mosquito bite. *P. malariae* can result in long-lasting infections and if untreated can persist asymptotically in the human host for years, even a lifetime.


Usually, people get malaria by being bitten by an infective female [Anopheles mosquito](#); the incubation period in most cases varies from 7 to 30 days. Only *Anopheles* mosquitoes can transmit malaria and they must have been infected through a previous blood meal taken from an infected person. When a mosquito bites an infected person, a small amount of blood is taken in which contains microscopic malaria protozoa. About 1 week later, when the mosquito takes its next blood meal, these protozoa mix with the mosquito's saliva and are injected into the person being bitten.

Because the malaria protozoa are found in red blood cells of an infected person, malaria can also be transmitted through blood transfusion, organ transplant, or the shared use of needles or syringes contaminated with blood. Malaria may also be transmitted from a mother to her unborn infant before or during delivery "congenital" malaria.

Symptoms of malaria include fever and flu-like illness, including shaking chills, headache, muscle aches and tiredness. Nausea, vomiting, and diarrhea may also occur. Malaria may cause anemia and jaundice (yellow coloring of the skin and eyes) because of the loss of red blood cells. If not promptly treated, the infection can become severe and may cause kidney failure, seizures, mental confusion, coma and death. Malaria disease can be categorized as [uncomplicated](#) or [severe](#).

If you plan to visit an area where malaria is a problem; you and your family can prevent malaria by taking these important measures:

- Taking antimalarial medication (or chemoprophylaxis) to kill the parasites and prevent becoming ill.
- Keeping mosquitoes from biting you, especially at night.
- Sleeping under insecticide-treated bed nets, using insect repellent and wearing long-sleeved clothing if out of doors at night.

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For a complete description of malaria, refer to the following references:

- *Control of Communicable Diseases Manual (CCDM)*, American Public Health Association, 19<sup>th</sup> ed. 2008.
- American Academy of Pediatrics. *Red Book: 2012 Report of the Committee on Infectious Diseases*. 29<sup>th</sup> ed. 2012.
- *Principles and Practice of Infectious Diseases*, 7<sup>th</sup> ed., Pennsylvania: Churchill Livingstone Elsevier, 2010.

### **2014 Case Definition – Malaria**<sup>4</sup>

#### ***Clinical Description***

The first symptoms of malaria (most often fever, chills, sweats, headaches, muscle pains, nausea and vomiting) are often not specific and are also found in other diseases (such as influenza and other common viral infections). Likewise, the physical findings are often not specific (elevated temperature, perspiration, tiredness). In severe malaria (caused by *P. falciparum*), clinical findings (confusion, coma, neurologic focal signs, **severe** anemia, respiratory difficulties) are more striking and may increase the suspicion index for malaria.

#### ***Laboratory Criteria for Diagnosis***

- Detection of circulating malaria-specific antigens using rapid diagnostic test (RDT).  
OR
- Detection of species specific parasite DNA in a sample of peripheral blood using a Polymerase Chain Reaction (PCR) test. (Note: Laboratory-developed malaria PCR tests must fulfill Clinical Laboratory Improvement Amendments [CLIA] requirements, including validation studies).  
OR
- Detection of malaria parasites in thick or thin peripheral blood films, determining the species by morphologic criteria, and calculating the percentage of red blood cells infected by asexual malaria parasites (parasitemia).


#### **Criteria to Distinguish a New Case from an Existing Case**

A subsequent attack experienced by the same person but caused by a different *Plasmodium* species is counted as an additional case. A subsequent attack experienced by the same person and caused by the same species in the United States may indicate a relapsing infection or treatment failure caused by drug resistance or a separate attack.

#### ***Case Classification***

##### **Suspected**

- Detection of *Plasmodium* species by rapid diagnostic antigen testing without confirmation by microscopy or nucleic acid testing in any person (symptomatic or asymptomatic) diagnosed in the United States, regardless of whether the person experienced previous episodes of malaria while outside the country.

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### Confirmed

- Detection and specific identification of malaria parasite species by microscopy on blood films in a laboratory with appropriate expertise in any person (symptomatic or asymptomatic) diagnosed in the United States, regardless of whether the person experienced previous episodes of malaria while outside the country.  
OR
- Detection of *Plasmodium* species by nucleic acid test\* in any person (symptomatic or asymptomatic) diagnosed in the United States, regardless of whether the person experienced previous episodes of malaria while outside the country.  
OR
- Detection of unspiciated malaria parasite by microscopy on blood films in a laboratory with appropriate expertise in any person (symptomatic or asymptomatic) diagnosed in the United States, regardless of whether the person experienced previous episodes of malaria while outside the country.


\* Laboratory-developed malaria PCR tests must fulfill CLIA requirements, including validation studies.

### *Case Classification Comment(s)*

Clinical samples including Blood smears or EDTA whole blood from all cases can be referred to the CDC Division of Parasitic Diseases and Malaria Diagnostic Laboratory for confirmation of the diagnosis and antimalarial drug resistance testing. Any questionable cases should be referred to the CDC Division of Parasitic Diseases and Malaria Diagnostic Laboratory for confirmation of the diagnosis.

**Comment(s):** Blood smears from questionable cases should be referred to the CDC Division of Parasitic Diseases Diagnostic Laboratory for confirmation of the diagnosis. Cases also are classified according to the following World Health Organization categories:

- **Autochthonous:**
  - *Indigenous:* malaria acquired by mosquito transmission in an area where malaria is a regular occurrence
  - *Introduced:* malaria acquired by mosquito transmission from an imported case in an area where malaria is not a regular occurrence
- *Imported:* malaria acquired outside a specific area (e.g., the United States and its territories)
- *Induced:* malaria acquired through artificial means (e.g., blood transfusion, common syringes, or malariotherapy)
- *Relapsing:* recurrence of disease after it has been apparently cured. In malaria, true relapses are caused by reactivation of dormant liver-stage parasites (hypnozoites) of *P. vivax* and *P. ovale*.
- *Cryptic:* an isolated case of malaria that cannot be epidemiologically linked to additional cases.

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### **Information Needed for Investigation**

**Verify the diagnosis.** Obtain demographic, clinical, laboratory information, and other epidemiological information necessary to complete the [Disease Case Report \(CD-1\)](#) and the [Malaria Case Surveillance Report \(CDC 54.1\)](#) from the attending physician, hospital, and/or laboratory and patient or a knowledgeable family member. **NOTE:** Determine the type of antimalarial chemoprophylaxis, if used.

**Establish the extent of illness.** Determine if household, traveling companions or other close contacts are, or have been ill, by contacting the health care provider, patient or family members. Strongly urge persons with a malarial-like illness to contact their physician for a medical evaluation.


**Identifying the source of infection.** Determine if the case-patient has a history of foreign travel. If yes, carefully record the travel history when interviewing the patient: record the date of departure, destinations and length of stay, routes, or other details that would identify the time and location of infection. The incubation period is approximately 9-14 days for *P. falciparum*, 12-18 days for *P. vivax* and *P. ovale*; and 18-40 days for *P. malariae*. However, some strains of *P. vivax* from more temperate areas may have longer incubation periods and the disease may not appear for up to 6 to 12 months after exposure. With infection through blood transfusion, incubation periods depend on the number of parasites infused and are usually short, but may range up to 2 months.<sup>1</sup>

Occasionally, malaria relapses will be reported. A relapse may occur if the disease was not adequately treated initially. If the case was previously investigated and the same *Plasmodium* species identified, no further investigation is necessary.

If there is no history of foreign travel consistent with acquisition of malaria, determine the case-patient's recent medical history, including blood transfusions, or medical treatments received outside the United States. Determine if the case-patient lives, works or has visited international airports, shipyards or other areas in which shipments from foreign sources may have been located. **NOTE:** *Contact the District Communicable Disease Coordinator immediately if an in-state malaria exposure is suspected.*

**Provide information about malaria to persons at risk of infection.** Efforts should be made to promote malarial awareness among international travelers and persons visiting family and friends in other countries. People who are or will be exposed to mosquitoes in malarious areas should know the **ABCDs**-of malaria protection:<sup>1</sup>

- ✓ Be **A**ware of the risk, the incubation period, the possibility of delayed onset, and the main symptoms of malaria.
- ✓ Avoid being **B**itten by mosquitoes, especially between dusk and dawn.
- ✓ Take antimalarial drugs (**C**hemoprophylaxis) when appropriate, to prevent infection developing into clinical disease.
- ✓ Immediately seek **D**iagnosis and treatment if a fever develops one week or more after entering an area where there is a malaria risk and (up to 1 year after returning

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home).<sup>6</sup> **NOTE:** CDC's [Malaria Information by Country Table](#) provides detailed information about the specific parts of countries where malaria transmission does or does not occur.

The Centers for Disease Control and Prevention (CDC) maintains a website of malaria fact sheets, brochures, and posters at:

[http://www.cdc.gov/malaria/references\\_resources/fsp.html](http://www.cdc.gov/malaria/references_resources/fsp.html). An excellent traveler's fact sheet, "[Travel? Make Sure You Protect Yourself from Malaria](#)" is also available.

**Malaria Surveillance.** Medical providers should report malaria cases promptly. Information obtained through the [Malaria Case Surveillance Report \(CDC 54.1\)](#) is used to assess progress toward disease elimination goals. The information is also used to identify the possible source of infection and to characterize persons or geographic areas in which additional efforts may be needed to raise awareness and reduce disease incidence.

### **Notification**


- Contact the [District Communicable Disease Coordinator](#), the [Senior Epidemiology Specialist](#) for the District, or the Missouri Department of Health and Senior Services (MDHSS) - BCDCP, phone (573) 751-6113, Fax (573) 526-0235, or for afterhours notification contact the MDHSS/ERC at (800) 392-0272 (24/7) if malaria is suspected.
- If a case(s) is associated with a childcare center, BCDCP or the LPHA will contact the Bureau of Environmental Health Services (BEHS), phone (573) 751-6095, Fax (573) 526-7377 and the Section for Child Care Regulation, phone (573) 751-2450, Fax (573) 526-5345.
- If a case(s) is associated with a long-term care facility, BCDCP or the LPHA will contact the Section for Long Term Care Regulation, phone (573) 526-8524, Fax (573) 751-8493.
- If a case is associated with a hospital, hospital-based long-term care facility, or ambulatory surgical center, BCDCP or the LPHA will contact the Bureau of Health Services Regulation phone (573) 751-6303, Fax (573) 526-3621.

### **Control Measures**<sup>1, 2, 5, 6, 7</sup>

Malaria prevention/control consists of a combination of mosquito avoidance measures, pre-exposure chemoprophylaxis and the effective treatment of malaria cases. The interventions used to prevent malaria can be very effective when used properly, but none of them are 100% effective.

An individual risk assessment should be conducted for every traveler leaving the United States, taking into account not only the destination country but also the detailed itinerary, including specific cities, types of accommodation, season and style of travel. This assessment should occur as a pre-travel conversation with a health care provider, travel or tropical medicine specialist which can be an excellent source of guidance when making



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these decisions. In addition, conditions such as pregnancy or antimalarial drug resistance at the destination may modify the risk assessment. Questions to ask when assessing an individual traveler's risk for malaria may be found on CDC's website at:

[http://www.cdc.gov/malaria/travelers/risk\\_assessment.html](http://www.cdc.gov/malaria/travelers/risk_assessment.html).

CDC's [Malaria Information by Country Table](#) provides detailed information about the specific parts of countries where malaria transmission does or does not occur. It also provides additional information including the species of malaria that occur there, the presence of drug resistance and the specific medicines that CDC recommends for use for malaria prevention in each country where malaria transmission occurs. Another way of finding this information is through the CDC [Malaria Map Application](#). This web-based tool is particularly useful for obtaining information about malaria transmission in specific parts of countries.


**Mosquito Avoidance Measures:** Mosquitoes that transmit malaria bite between dusk and dawn. Contact with mosquitoes can be reduced by remaining in well-screened areas, using mosquito bed nets (preferably insecticide-treated nets), using an effective insecticide spray in living and sleeping areas during evening and nighttime hours and wearing clothes that cover most of the body. If out-of-doors, wear a long-sleeved shirt, long pants and a hat. Apply insect repellent to exposed skin only; do not use under clothing. Additional information on the "Protection against Mosquitoes, Ticks, & Other Insects & Arthropods" may be found on CDC's website at:

<http://wwwnc.cdc.gov/travel/yellowbook/2014/chapter-2-the-pre-travel-consultation/protection-against-mosquitoes-ticks-and-other-insects-and-arthropods>.

**Chemoprophylaxis:** All recommended primary chemoprophylaxis regimens involve taking a medicine before, during and after travel to an area with malaria. Beginning the drug before travel allows the antimalarial agent to be in the blood before the traveler is exposed to malaria parasites. Additional information on malarial chemoprophylaxis may be found on CDC's website at: <http://www.cdc.gov/malaria/travelers/drugs.html> and <http://wwwnc.cdc.gov/travel/yellowbook/2014/chapter-3-infectious-diseases-related-to-travel/malaria>. *NOTE: More than 80% of malaria-infected patients reported in the United States did not follow a CDC-recommended prophylaxis regimen.*<sup>2</sup>

**Other:** Any traveler to an area where malaria transmission occurs, who becomes ill with a fever or flu-like illness while traveling, and up to 1 year after returning home, should immediately seek professional medical care. You should tell your health-care provider that you have been traveling in an area where malaria transmission occurs and ask to be tested for malaria infection.

People who have been in an area where malaria transmission occurs are not permitted to donate blood in the United States for a period of time after returning from the malarious area to prevent transmission of malaria through blood transfusion.

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**NOTE:** CDC provides, on a 24-hour basis, consultations for clinicians needing guidance on diagnosis, management of malaria cases, access to antimalarial medication, or urgent issues related to adverse antimalarial drug reactions. Assistance can be provided through the CDC Malaria Hotline (770) 488-7788) from 9:00 am to 5:00 pm Eastern Time. After hours or on weekends and holidays, call the CDC Emergency Operation Center at (770) 488-7100 and ask to page the person on call for the Malaria Branch. Do not use email to ask for clinical advice; email is not constantly monitored and there may be delays in answering.

### **Laboratory Procedures**

Malaria should be considered a potential medical emergency and should be treated accordingly. Delay in diagnosis and treatment is a leading cause of death in malaria patients in the United States.

Testing for malaria is available through commercial clinical laboratories. Assistance is provided by the Missouri State Public Health Laboratory (MSPHL) in identification and speciation of presumptive positive blood smears for malaria. Malaria testing to be performed by the MSPHL should go through the Microbiology Unit, phone (573) 751-3334 before submission. For information on the collection or shipment of specimens to the MSPHL, refer to their website at: <http://health.mo.gov/lab/bloodparasites.php>.

Additional information on the diagnosis of malaria may be found on CDC's website at: [http://www.cdc.gov/malaria/diagnosis\\_treatment/diagnosis.html](http://www.cdc.gov/malaria/diagnosis_treatment/diagnosis.html) or [DPDx - Laboratory Identification of Parasitic Diseases of Public Health Concern](#).

### **Reporting Requirements**


Malaria is a Category 3 disease and should be reported to the [local health authority](#) or to the MDHSS within three calendar days of first knowledge or suspicion. The MDHSS may be contacted afterhours through the MDHSS/ERC by calling (800) 392-0272 (24/7).

As a Nationally Notifiable Condition, **confirmed** and **suspected** malaria cases are a **STANDARD** report to the CDC. **STANDARD** reporting requires MDHSS to report to CDC by electronic transmission via WebSurv within the next normal reporting cycle.

1. For all reported cases of malaria complete a [Disease Case Report \(CD-1\)](#).
2. Entry of the completed CD-1 into MOHSIS negates the need for the paper CD-1 to be forwarded to the District Health Office.
3. For confirmed malaria cases complete a [Malaria Case Surveillance Report \(CDC 54.1\)](#) and send the completed form to the [District Health Office](#).
4. MDHSS will report to CDC following the above reporting criteria (see box).
5. All outbreaks or "suspected" outbreaks must be reported as soon as possible (by phone, fax or e-mail) to the [District Communicable Disease Coordinator](#). This can be accomplished by completing the [Missouri Outbreak Surveillance Report \(CD-51\)](#).





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6. Within 90 days from the conclusion of an outbreak, submit the final outbreak report to the [District Communicable Disease Coordinator](#).

## **References**

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