



Complete Summary

GUIDELINE TITLE

Locally acquired mosquito-transmitted malaria: a guide for investigations in the United States.

BIBLIOGRAPHIC SOURCE(S)

Centers for Disease Control and Prevention, Filler SJ, MacArthur JR, Parise M, Wirtz R, Eliades MJ, Dasilva A, Steketee R. Locally acquired mosquito-transmitted malaria: a guide for investigations in the United States [published erratum appears in MMWR Morb Mortal Wkly Rep 2006 Oct 6;55(39):1075]. MMWR Recomm Rep 2006 Sep 8;55(RR-13):1-9. [20 references] [PubMed](#)

GUIDELINE STATUS

This is the current release of the guideline.

COMPLETE SUMMARY CONTENT

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SCOPE

DISEASE/CONDITION(S)

Locally acquired mosquito-transmitted malaria

GUIDELINE CATEGORY

Diagnosis
Evaluation
Management
Prevention

CLINICAL SPECIALTY

Family Practice
Infectious Diseases
Internal Medicine
Pediatrics
Preventive Medicine

INTENDED USERS

Advanced Practice Nurses
Allied Health Personnel
Health Care Providers
Hospitals
Physician Assistants
Physicians
Public Health Departments

GUIDELINE OBJECTIVE(S)

To describe the steps that should be taken to:

- Investigate a case of malaria that has been potentially acquired locally
- Prevent a small focus of malaria cases from becoming a source of sustained transmission
- Inform clinicians regarding the process of an investigation so they can effectively address concerns and questions from patients

TARGET POPULATION

- Individuals living in the United States with suspected locally acquired malaria
- Individuals living in communities in the United States in which locally acquired mosquito-transmitted malaria is suspected

INTERVENTIONS AND PRACTICES CONSIDERED

Initial Investigation

1. Confirmation of cases of malaria
2. Preliminary patient interviews
3. Involvement of state health departments and Centers for Disease Control and Prevention (CDC)

Epidemiologic Investigation

1. Confirmation that case definition has been met
2. In-depth patient interview(s)
3. Confirmation that all diagnosed cases of malaria have been reported
4. Active case finding (of undiagnosed malaria)
5. Community sensitization (including medical and nonmedical populations)

Environmental Investigation

1. Site visits to patients' homes
2. Entomologic assessment
3. Assessment of climatic conditions
4. Investigation of possible airport malaria

Laboratory Investigation

1. Species confirmation
2. Performance of molecular techniques with assistance from CDC

Other interventions

1. Determination that an outbreak is over
2. Measures to prevent reestablishment of malaria

MAJOR OUTCOMES CONSIDERED

Not stated

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

Not stated

NUMBER OF SOURCE DOCUMENTS

Not stated

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Not stated

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not applicable

METHODS USED TO ANALYZE THE EVIDENCE

Review

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

Not stated

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Not stated

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

A formal cost analysis was not performed and published cost analyses were not reviewed.

METHOD OF GUIDELINE VALIDATION

Not stated

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Not applicable

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

Checklist for Investigations of Locally Acquired Mosquito-Transmitted Malaria

Tasks for local health departments

Task A. Confirm case

- Laboratory confirmation
- Preliminary patient interview(s)

Task B. Initiate Investigation

- Involve state health department
- Contact with the Centers for Disease Control and Prevention (CDC) can be initiated by the state health department

Task C. Conduct epidemiologic investigation

- Case definition has been met
 - Determined by blood smear
- In-depth interviews with patients
- Case reporting
 - Confirm that laboratories and providers have reported cases
- Active case finding
- Community sensitization

Task D. Conduct environmental investigation

- Site visit to patients' homes
- Entomologic assessment
 - Breeding habits and vector surveillance
- Assessment of climatic conditions
 - Use of temperature and rainfall data to predict viability of competent vector
- Airport malaria
 - Assess distance of patients' homes from airport

Task E. Conduct laboratory investigation

- Species confirmation
 - Use reference laboratory (i.e., state health department and CDC) as needed
 - Perform polymerase chain reaction test if slide microscopy is inconclusive
- Molecular techniques with assistance from CDC
 - Link outbreak cases
 - Investigate geographic origin of strain

Task F. Avoid potential pitfalls

- Mass screening; low yield, expensive and labor intensive
 - Blood films
 - Serosurveys
- Entomology resources
 - Trapping; data frequently already available
 - Vector control; unclear value

Task G. Determine outbreak is over

- No new cases identified for two completed parasite life cycles (i.e., 8 weeks)

Task H. Attempt to prevent reestablishment of malaria

- Health-care availability for immigrant and migrant workers
- Personal protective measures; wear proper clothing (e.g., long-sleeved shirts and long trousers), use N, N-diethyl-m-toluamide (DEET)-based (DEET concentration $\leq 50\%$) insect repellants, and avoid outdoor activities from dusk until dawn

Investigation

Case Confirmation

When a case of malaria is suspected to have been locally acquired, the initial step is to confirm the diagnosis. Individual hospitals might not have extensive experience in microscopic parasitic diagnoses, but the majority of state laboratories can assist in confirming diagnoses. For states that do not maintain such expertise or that would like further assistance, CDC can provide microscopy evaluation either by reviewing the slides or (in a near-real-time manner) through tediagnosis (submission of digital images through the Internet at <http://www.dpd.cdc.gov/dpdx>). The diagnosis should be confirmed in a timely manner to ensure that proper treatment is administered and that appropriate measures are initiated to prevent continued transmission. CDC also offers a confirmatory polymerase chain reaction (PCR) test, which is based on the amplification of a portion of the small subunit rRNA gene (ssrRNA). PCR can provide a definitive parasite and species diagnosis when these diagnoses cannot be determined upon microscopic examination (e.g., cases in which the morphology of the parasites is atypical).

Preliminary Patient Interview

The investigation should begin with a careful interview with the patient, and risk factors for acquiring malaria should be explored (i.e., recent travel to an area where malaria is endemic, a history of previous malaria infection, recent blood transfusion or organ transplant, or contaminated needle use). If no link can be made to these risk factors, the index of suspicion for a locally acquired mosquito-transmitted illness increases.

Even if one of the previously mentioned risk factors for malaria is present, locally acquired mosquito-borne transmission is not ruled out. The risk must be examined in the context of the species and the timing of the infection. For example, a *Plasmodium falciparum* infection will rarely present >2 to 3 years after primary exposure. Therefore, a case of *P. falciparum* identified with a remote travel history (>3 years) cannot easily be classified as an imported case. In contrast, an absence of risk factors does not always imply local acquisition. *P. malariae* has been reported to cause symptoms long after exposure, even up to 40 years later. Health departments can contact CDC's Malaria Hotline (770-488-7788) for assistance with species-specific information and to help determine whether local transmission should be considered.

Initiation of Investigation

After a case has been confirmed by blood smear and the history suggests no alternative explanation, the full investigation of a locally acquired mosquito-transmitted case should be conducted. The investigation should include an epidemiologic, environmental, and laboratory component. During this phase of the investigation, the local health department should usually involve the state health department. This collaboration can assist in the allocation of resources and prepare the state in the event of further transmission across counties. The state health department can then request the assistance of CDC, which can provide malaria expertise and prepare for the unlikely event that the outbreak involves several states and requires a multistate coordinated effort.

Epidemiologic Investigation

The epidemiologic investigation has several components. The first step, ensuring that the case definition has been met, is critical. A malaria case is confirmed by demonstrating malaria parasites in a blood film. Suspect cases include patients with fevers of unclear etiology.

In-Depth Interviews

Cases identified during an outbreak require in-depth interviews to identify risk factors for malaria acquisition. If locally acquired mosquito-borne transmission is a possibility, the case-patients should be questioned about outdoor activities that might have placed them in contact with *Anopheles* vectors, which typically bite between dusk and dawn. An assessment of local travel, including to surrounding counties, might help identify possible sites of acquisition.

Case Reporting

A primary goal of an outbreak investigation is to promptly identify all cases of malaria in the local community, both retrospectively and prospectively. The health department should confirm that health-care providers or laboratories have reported all cases of malaria that have been diagnosed. Any cases identified should be carefully reviewed to assess their potential connection to the outbreak.

Active Case Finding

One characteristic of malaria is that it causes an acute febrile illness with nonspecific symptoms. Because no distinctive clinical features are associated with malaria, the condition of patients who seek medical care through the health-care system might not be appropriately diagnosed, especially if history of travel to an area where malaria is endemic has not occurred. During an outbreak, the local health department can help identify patients whose conditions are undiagnosed by taking several steps.

First, all health-care sites need to be identified, including hospitals, emergency departments, urgent-care clinics, and physicians' offices. Second, each of these points-of-care should collect all charts of patients with febrile illnesses for which a clear alternative explanation for their symptoms cannot be determined. The *International Classification of Diseases (ICD) Ninth and Tenth Revision* codes can be used to assist in identifying these charts, by targeting charts with certain diagnoses (e.g., fever, nonspecified; fever, unknown origin or viral syndrome; and fever, unspecified). A reasonable time frame to look retrospectively for undiagnosed cases is 8 weeks before the first recognized case. This time frame represents a biologically plausible time interval for one to two generations of local transmission, given the parasite and vector life cycles. Infection-control practitioners at the selected health facility can frequently help coordinate this process.

After the chart review, the investigation team should communicate with health-care workers regarding each potential case to request that they contact their respective patients and assess whether the patients are still symptomatic. This contact should be done, if possible, through the health-care workers to protect the integrity of the patient-physician relationship. Patients who have been identified and who have persistent symptoms should be reexamined, and samples should be

drawn for malaria evaluation (thick and thin blood films for diagnosis and whole blood for further testing, if required).

Community Sensitization

Finally, an additional component of enhanced case detection is to alert the medical community and the nonmedical population to the possibility that local transmission of malaria might be occurring. This community sensitization increases the likelihood of the identification of active or future cases that have not yet entered into the health-care system. Clinicians in the community need to be on alert to consider malaria in the differential diagnosis of patients who have a fever. Visits to select clinicians' offices might be helpful if a substantial likelihood exists that they might treat infected patients. The alert to health-care providers can be combined with a request for the reporting of confirmed cases and of cases in which persons with a nonspecific febrile illness might seek medical care.

Alerting the nonmedical population to the possibility of being infected with malaria will encourage patients with symptoms consistent with malaria to seek care and educate others on how to avoid infection. The risk for infection will differ depending on characteristics of the outbreak (e.g., the number of persons infected and climatic changes). This alert needs to be tailored to the community in question. Local health departments have used reverse 911 calling (a community notification system) to reach persons who have a telephone or have conducted door-to-door canvassing. Settings in the community where large numbers of persons congregate (e.g., church) should be targeted to communicate risk messages. Various media outlets can be considered for communicating messages regarding the possible risk for malaria, including television, radio, and newspapers. Every effort should be made to convey the information in the languages of the local community and to consider the educational level of the population. CDC has designed a malaria outbreak response tool kit that can help communicate the messages. The tool kit is available on CDC's website (<http://www.cdc.gov/malaria/references.htm>) (see table 2 of the original guideline document.)

Environmental Investigation

An environmental investigation includes 1) a site visit to the home of each patient, 2) an entomologic assessment, 3) a review of meteorologic data, and 4) an investigation of any nearby airports or seaports that might be possible sources of infective persons or vectors.

Site Visit

A site visit to patients' homes to conduct a general review of the household, including a search for anopheline larval habitats, can help determine the probability of whether these persons had contact with a competent mosquito vector. This information can corroborate a history of time spent outdoors and demonstrate the possibility for vectors being in the home (e.g., a lack of screens and air conditioning in the home).

Entomology

An entomologic assessment during a locally acquired mosquito-transmitted outbreak serves multiple potential goals. Mosquito-trapping can identify the presence of competent vectors that would make local transmission possible. Data on mosquito densities and breeding locations can guide control of adult and larval mosquitoes and activities to reduce numbers of larval habitats. Local and state health departments might already have surveillance data on vectors in the area that is being assessed.

Trapping with the intent of identifying malaria-infected mosquitoes has limited use. If infected mosquitoes are present, they are likely to be in a small focus, which would be difficult to find within the large uninfected background pool. Molecular and immunologic-based methods are available for identification of infected mosquitoes, and efforts are underway to address the utility of confirmation of positive mosquito pools using PCR-based methods.

County mosquito abatement personnel can coordinate surveillance- and vector-control efforts. If these resources are not available, the following actions can be taken to seek needed resources: 1) entomologists at local universities can be contacted for assistance, 2) a private company can be contracted to conduct mosquito surveillance and control, or 3) the state department of health can request entomologic consultation from CDC.

Climate and Weather

Meteorologic data are frequently available for the county where the outbreak has occurred. Temperature and rainfall levels throughout the year can be used to predict the viability and abundance of the competent vector. Analysis of weather data also can indicate whether climatic conditions are favorable for the maturation of *Plasmodium* species within the anopheline mosquitoes. This analysis might then be used to guide the decision to scale-back control activities, if the temperature is outside of a given range. For example, for *P. vivax*, the temperature window for sporogony to occur during the life span of the anopheline mosquito is 60 degrees F to 91 degrees F (16 degrees C to 33 degrees C). A local health department that wants to prioritize the use of resources might decide against the use of control measures requiring substantial logistic capacity (e.g., spraying of insecticide or reduction of breeding habitats) if the temperature has moved outside of this range.

Airport Malaria

A remote possibility of a source for a malaria outbreak is that an infective mosquito was transported on an aircraft or in baggage that arrived from an area where malaria is endemic. The distance from the airport to the patient's home should be ascertained and must be within a reasonable flight path distance of the competent vector to consider this mode of transmission as a possibility (i.e., approximately 1 mile), although this distance can vary substantially, depending on terrain, wind, and weather patterns. CDC has not documented any cases attributed to airport malaria in the United States.

Laboratory Investigation

Laboratory tools can assist and complement the epidemiologic and environmental investigations. Techniques used in these investigations include microscopy of blood films, PCR rRNA gene analysis, molecular analysis of parasite DNA, and detection of antibodies produced against parasites in the patient's sera.

Slide microscopy is an essential part of the case definition. If species identification is initially uncertain, a patient should receive treatment for *P. falciparum* while definitive speciation occurs. In addition to blood for microscopy, whole blood (preferably pretreatment) should be stored in case additional tests are required.

After the species has been identified by microscopy or by PCR, additional molecular techniques (e.g., DNA sequencing) can elucidate the parasite genotype or strain. These data can be used to track and link the cases in an outbreak. The usefulness of this process has been demonstrated in the latest mosquito-transmitted locally acquired malaria outbreak in the United States, which occurred in Palm Beach County, Florida, in 2003. All eight cases were linked by genetic analysis and were the same strain of *P. vivax*. Molecular analysis might also assist in determining the geographic origin of the parasite. However, the reliability of this approach depends on the genotypic database that is accumulated from strains obtained from specific geographic regions. This new technique is being developed further at CDC and will continue to provide a useful adjunct to these investigations. In the Palm Beach County outbreak, all eight *P. vivax* parasites matched genetic patterns consistent with a New World origin (the Americas), implicating this region as the original source of the parasite responsible for this outbreak.

CLINICAL ALGORITHM(S)

None provided

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The type of evidence supporting the recommendations is not specifically stated.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

- Timely and accurate identification of malaria outbreak
- Timely and accurate identification of malaria cases in an outbreak
- Effective containment of malaria outbreaks
- Effective prevention of reestablishment of an outbreak

POTENTIAL HARMS

Not stated

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Patient Resources
Resources
Tool Kits
Wall Poster

For information about [availability](#), see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Staying Healthy

IOM DOMAIN

Effectiveness
Patient-centeredness
Timeliness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

Centers for Disease Control and Prevention, Filler SJ, MacArthur JR, Parise M, Wirtz R, Eliades MJ, Dasilva A, Steketee R. Locally acquired mosquito-transmitted malaria: a guide for investigations in the United States [published erratum appears in MMWR Morb Mortal Wkly Rep 2006 Oct 6;55(39):1075]. MMWR Recomm Rep 2006 Sep 8;55(RR-13):1-9. [20 references] [PubMed](#)

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

2006 Sep 8

GUIDELINE DEVELOPER(S)

Centers for Disease Control and Prevention - Federal Government Agency [U.S.]

SOURCE(S) OF FUNDING

United States Government

GUIDELINE COMMITTEE

Not stated

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Prepared by: Scott J. Filler, MD, Global AIDS Program, National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention (proposed), CDC, Atlanta, Georgia; John R. MacArthur, MD, Division of Parasitic Diseases, National Center for Zoonotic, Vector-Borne, and Enteric Diseases (proposed), CDC, Atlanta, Georgia; Monica Parise, MD, Division of Parasitic Diseases, National Center for Zoonotic, Vector-Borne, and Enteric Diseases (proposed), CDC, Atlanta, Georgia; Robert Wirtz, PhD, Division of Parasitic Diseases, National Center for Zoonotic, Vector-Borne, and Enteric Diseases (proposed), CDC, Atlanta, Georgia; M. James Eliades, MD, Division of Parasitic Diseases, National Center for Zoonotic, Vector-Borne, and Enteric Diseases (proposed), CDC, Atlanta, Georgia; Alexandre Dasilva, PhD, Division of Parasitic Diseases, National Center for Zoonotic, Vector-Borne, and Enteric Diseases (proposed), CDC, Atlanta, Georgia; Richard Steketee, MD, PATH, Seattle, Washington

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

GUIDELINE AVAILABILITY

Electronic copies: Available from the Centers for Disease Control and Prevention (CDC) Web site:

- [HTML Format](#)
- [Portable Document Format \(PDF\)](#)

Print copies: Available from the Centers for Disease Control and Prevention, MMWR, Atlanta, GA 30333. Additional copies can be purchased from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325; (202) 783-3238.

AVAILABILITY OF COMPANION DOCUMENTS

The following is available:

- Outbreaks of locally transmitted malaria health information toolkit, including fact sheets, brochures, contact letters, postcards, posters, and media press releases.

Electronic copies: Available from the [Centers for Disease Control and Prevention \(CDC\) Web site](#).

PATIENT RESOURCES

The following is available:

- Outbreaks of locally transmitted malaria health information toolkit, including fact sheets, brochures, contact letters, postcards, posters, and media press releases.

Electronic copies: Available from the [Centers for Disease Control and Prevention \(CDC\) Web site](#).

Please note: This patient information is intended to provide health professionals with information to share with their patients to help them better understand their health and their diagnosed disorders. By providing access to this patient information, it is not the intention of NGC to provide specific medical advice for particular patients. Rather we urge patients and their representatives to review this material and then to consult with a licensed health professional for evaluation of treatment options suitable for them as well as for diagnosis and answers to their personal medical questions. This patient information has been derived and prepared from a guideline for health care professionals included on NGC by the authors or publishers of that original guideline. The patient information is not reviewed by NGC to establish whether or not it accurately reflects the original guideline's content.

NGC STATUS

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