Perspective

Pre-departure and Post-arrival Management of *P. falciparum* Malaria in Refugees Relocating from Sub-Saharan Africa to the United States

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Abstract. *Plasmodium* infection, often sub-clinical, is common in migrating sub-Saharan refugee populations. Refugees who subsequently develop clinical malaria suffer illness and exact a cost on state and local health care facilities. Untreated infection is also of public health concern because of the potential for local transmission. In response to increasing numbers of refugees originating in sub-Saharan Africa guidelines for the management of malaria in refugees migrating to the United States have been broadened and updated. The guidelines are based on available evidence-based literature and recent public health experience. These guidelines were critically reviewed, assessed, and approved by multiple National and State entities as well as outside experts. These consensus guidelines recommend that sub-Saharan African refugees relocating to the United States receive presumptive treatment of *P. falciparum* malaria before departure or during the domestic refugee medical screening after arrival. Presumptive therapy is not currently recommended for either non-falciparum malaria or for refugees relocating from areas outside sub-Saharan Africa.

FORMULATION OF RECOMMENDATIONS

The recommendations in this document provide revised guidance for presumptive treatment of asymptomatic/sub-clinical *Plasmodium* infection in refugees relocating to the United States and should replace those issued in 1999. These recommendations are the culmination of a consensus process based on available evidence-based data. The Centers for Disease Control Divisions of Global Migration and Quarantine and the Malaria Branch reviewed all available data regarding malaria importation to the United States attributable to migration. The limited data almost exclusively address malaria in refugee populations and are reviewed in this document. In addition, data on drug resistance patterns for malaria as well as anticipated departure points of future refugee populations migrating to the United States was taken into account. Disease experts drafted the recommendations for screening and presumptive therapy for malaria in migrating refugees. The draft recommendations were sent to 10 malaria and refugee health experts for critical review and comment. Subsequently, the domestic guidelines were reviewed and approved by the Office of Refugee Resettlement (ORR) Medical Screening Protocol Work Group. This work group, assembled by ORR, consists of representatives from ORR, Office of Global Health Affairs, Substance Abuse and Mental Health Services Administration, Department of State (Population, Refugees and Migration), and an selected body of State Refugee Health Coordinators.

BACKGROUND

Each year 50–70,000 refugees are accepted for resettlement to the United States. Refugees from sub-Saharan Africa ac-

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count for an increasing proportion of these newly arriving refugees and now constitute more than a third of new arrivals (Figure 1). The proportion of newly arriving refugees who originate in Africa has climbed from 9%, in 1998 to 39% in 2005. This shift in population has been accompanied by changing patterns of infection and illness in newly arriving refugees. Because of its potential virulence and dynamic epidemiology, including its high prevalence, malaria has emerged as a disease of particular concern in this population.

*Plasmodium* infection causes clinical disease in 350–500 million persons a year resulting in > 1 million deaths, predominately in sub-Saharan Africa. The acute clinical consequences of infection and disease are most severe in persons who are non-immune; as a result, in highly endemic areas, young children account for most deaths caused by malaria. Although four species of malaria infect humans, the burden and consequences of *Plasmodium falciparum* predominate. Among those with no immunity, *P. falciparum* infection may lead to death in < 12 hours after the onset of symptoms. In contrast, in highly endemic (hyper-, holoendemic) areas, a majority of the older individuals in the population have acquired partial immunity and thus may have few symptoms or sub-clinical infection. Areas with high endemnicity include most of west and central and portions of East Africa. *P. malariae* and the relapsing species of human malaria, *P. vivax* and *P. ovale*, also occur in sub-Saharan Africa; however, these species are found less frequently and generally do not result in severe disease or death.

Other areas, such as Central Asia, South Asia, Southeast Asia, and parts of Latin America and the Caribbean, have varying levels of malaria transmission, although rarely reaching hyper- or holoendemic levels. These areas also have varying ratios of *P. falciparum* and non-falciparum, although many areas outside sub-Saharan Africa have higher percentages of non-falciparum malaria, particularly *P. vivax*.

Malaria was endemic in most of the continental United States and much of Europe into the 20th century. Most of the
continental United States has Anopheles mosquitoes (particularly An. quadramaculatus and An. freeborni) that are competent vectors under favorable conditions. Local US vector-borne transmission has resulted in 156 known malaria cases in 63 US outbreaks over the past 50 years. In addition, >1,000 cases of malaria are reported annually in the United States with migration playing an important role in the importation of these cases.

In endemic areas, malaria has historically plagued displaced populations, and this situation continues in many contemporary refugee camps. Refugees are often not included in the host country’s national health programs, which may lead to higher rates of many diseases, including malaria and other parasitic infections.

Malaria pre-departure presumptive therapy in US-bound refugees. Several studies have shown that refugees arrive in North America with asymptomatic or sub-clinical malaria. Although it is unknown how many persons with sub-clinical infection will eventually develop clinical disease in this migrating population, there is data from Uganda, an endemic area, that suggest that a high percentage of persons asymptomatically infected with *P. falciparum* who reside in endemic areas will subsequently develop clinical disease. There are also data showing that certain refugees who arrive with sub-clinical *P. falciparum* infection will develop clinical disease largely in a bimodal pattern; early, usually in the first 3 weeks, or late, at ~3 months, after arrival. It was estimated in this study that 1 in 12 refugees arriving from a highly endemic area will develop clinical malaria after arrival to the United States. However, it is unclear why certain refugees will develop disease, whereas others will not.

Lack of knowledge of malaria among health care professionals in the United States frequently leads to delay in diagnosis and inappropriate treatment. This lack of familiarity has been linked with fatal outcomes. Furthermore, malarial illness may interfere with a refugee’s successful integration into a host community because of issues such as physical incapacity, added financial stresses, and social stigmatization.

Refugees resettling from areas of high endemicity could potentially act as reservoirs for malaria; because of the severity of disease, *P. falciparum* is of greatest concern. Although sustained malaria transmission would be unlikely, single autochthonous cases or small outbreaks would be possible with the potential for fatal outcomes, given that persons in the general US population have no immunity to *P. falciparum*. To date, however, no transmission has been conclusively traced to a newly arrived refugee.

Data collected from 1997 to 1999 showed that 60% of Liberian refugees, arriving from four primary countries of asylum in West Africa, were parasitemic on a single blood smear 4 weeks after arrival. In another study of untreated refugees arriving in Canada from an area of lower transmission in Tanzania, 18% of refugees had evidence of infection by polymerase chain reaction (PCR) 3 months after their arrival. In the late 1990s, concerns about the high prevalence of *Plasmodium* infection led the Centers for Disease Control and Prevention (CDC) to recommend that all refugees departing for the United States from malaria-endemic areas in sub-Saharan Africa receive presumptive therapy for malaria. These recommendations were issued to organizations and clinicians performing pre-departure examinations and management (panel physicians) in May 1999. The treatment recommendation issued at that time was for a presumptive treatment course of sulfadoxine-pyrimethamine (SP; Fansidar; Roche Laboratories, Basel, Switzerland). A retrospective study examining newly arrived refugees who developed clinical malaria before and after implementation of pre-departure presumptive therapy with SP estimated that there is cost savings for the host community if there is a *P. falciparum* prevalence rate > 1.5% in departing populations.

Since the implementation of pre-departure presumptive antimalarial treatment in 1999, few data have been specifically collected on *Plasmodium* imported to the United States by newly arriving refugees. In one recent study of 103 newly arrived Liberian refugees who were treated with SP before resettlement in the United States, the prevalence of *P. falciparum* infection was 8.7% by PCR 4 weeks after arrival. Although the recommendations for pre-departure presumptive SP treatment seemed to be associated with a substantial decrease in the prevalence of *P. falciparum* infection among West African refugees between 1999 and this 2004 study, nearly 9% of refugees continued to be infected with *P. falci-
parum malaria. This could be caused by several factors including resistance of the parasite to SP, failure to receive the medication (however, International Organization of Migration [IOM], the largest organization providing pre-departure services, reports > 95% treatment rates annually), poor drug absorption, and/or re-infection after treatment before departure. Although use of counterfeit, expired, or sub-potent drugs is frequently reported in Africa, this does not seem to be a cause because the IOM receives medications only through secure and dependable sources. Because of concerns over the rising rates of resistance of Plasmodium falciparum to SP in Africa, many African countries have adopted artemisinin-based combinations as the national standard for treatment based on World Health Organization (WHO) guidance (www.who.int/malaria/treatment_guidelines.html).

Currently, no refugee populations relocating to the United States from regions other than sub-Saharan Africa are from areas of hyper- or holoendemic malaria. Therefore, refugee populations relocating from other areas, except under special circumstances, do not currently receive presumptive malaria treatment.

RECOMMENDATIONS FOR PRE-DEPARTURE PRESCRIPTIVE AND DIRECTED TREATMENT OF Plasmodium falciparum INFECTION FOR REFUGEES FROM SUB-SAHARAN AFRICA

The revised regimen for pre-departure presumptive treatment is artemisinin-based combination therapy (ACT). The currently recommended ACT regimen is artemether-lumefantrine because it is available as a fixed combination tablet, is available in most refugee camp settings, has a wide therapeutic window, has a minimal adverse event profile, and is consistent with most national guidelines for treating clinical malaria (www.cdc.gov/ncidod/dq/refugee/index.htm). Malaria pre-departure presumptive therapy must be administered and documented as directly observed therapy. To be considered valid the presumptive therapy must be completed no sooner than 3 days before departure. All suspected and confirmed medication adverse effects must be documented and reported to the CDC by the organization or panel physician providing pre-departure care. Because artemether-lumefantrine requires six doses over 3 days, ensuring that all therapy be directly observed poses operational challenges.

Special populations including pregnant or lactating women and children < 5 kg require directed treatment after diagnostic testing and thus should not receive presumptive therapy. Individuals in these groups who lack signs and symptoms of malaria but have laboratory-diagnosed Plasmodium falciparum infection should be treated with either a combination of oral quinine and clindamycin (preferred) or a longer course of oral quinine (www.cdc.gov/ncidod/dq/refugee/index.htm).

Before departure, refugees who have signs or symptoms of clinical malaria should be evaluated and treated according to the host country’s national guidelines.

RECOMMENDATIONS FOR POST-ARRIVAL PRESCRIPTIVE AND DIRECTED TREATMENT OF MALARIA FOR REFUGEES FROM SUB-SAHARAN AFRICA

Refugees who have received recommended pre-departure presumptive or directed therapy. Refugees who have received pre-departure treatment with a recommended antimalarial drug or drug combination do not need further evaluation or treatment of malaria unless they have clinical signs or symptoms.

Refugees who have not received the recommended presumptive or directed pre-departure treatment. To facilitate successful refugee resettlement into the community and to protect public health, it is recommended that refugees originating in sub-Saharan Africa who have not received pre-departure therapy with a recommended regimen either receive presumptive treatment on arrival (preferred) or have laboratory screening to detect Plasmodium infection.

Post-arrival presumptive anti-malarial treatment. The medication of choice for presumptive post-arrival treatment of malaria is atovaquone-proguanil (AP; Malarone; GlaxoSmithKline, Research Triangle Park, NC). This antimalarial is recommended because it is highly effective for treatment of Plasmodium falciparum malaria (as well as P. malariae and the blood stages of P. vivax and P. ovale), there is little parasite resistance to the drug, the treatment regimen is short and simple, and it is generally well tolerated with few adverse effects. All other available medications have higher rates of adverse effects (e.g., mefloquine) or more complex dosing regimens of combination medications (e.g., quinine/quinidine plus a second agent) and are of limited use for presumptive treatment. Although artesunate is now available from the CDC as an investigational drug for the treatment of severe disease in the United States, it is not available for presumptive therapy. Therefore, newly arriving sub-Saharan refugees should receive presumptive therapy with AP (www.cdc.gov/ncidod/dq/refugee/index.htm) on arrival or during their new arrival refugee medical visit if they have not received pre-departure presumptive ACT treatment.

Medical and laboratory screening after arrival. A suboptimal alternative to presumptive therapy is to test newly arriving sub-Saharan refugees for malaria infection. Although microscopic examination of a properly stained blood smear remains the standard for diagnosis of Plasmodium infection in symptomatic individuals presenting in the United States, studies have shown that a single malaria thick-and-thin blood smear lacks sensitivity (< 40%) for detecting asymptomatic or sub-clinical malaria in these populations. Three separate blood films taken at 12- to 24-hour intervals, the standard recommendation for diagnosis of clinical malaria, has a greater sensitivity. However, this approach is rarely feasible for screening newly arriving refugee populations because of cost constraints and the need for multiple visits. A rapid diagnostic test (RDT) was recently approved by the US Food and Drug Administration (FDA; NOW-Malaria) for use in diagnosis of malaria in the United States. Although this test has excellent sensitivity for Plasmodium falciparum in symptomatic patients, preliminary data suggest it is < 30% sensitive in the diagnosis of asymptomatic Plasmodium falciparum in newly arrived refugees. This is not surprising given that data from endemic areas show that semi-immune adults, because of acquired immunity, are able to limit their parasitemia to very low levels, which are frequently below the detection level of RDT and routine blood smears. Although PCR seems to have greater sensitivity than RDT or a single blood smear and may be useful in diagnosis, it has limited availability. When a refugee does not receive presumptive therapy, they must be monitored for signs or symptoms of disease, particularly during the initial 3 months after arrival, regardless of post-arrival
testing if performed by RDT or peripheral blood smear (Table 3).

Although this document addresses individuals with no signs or symptoms of malaria, it is worth noting that hematologic and physical examination findings may show signs and symptoms that have a high positive predictive value for malaria. Two studies have shown that no parameters, including anemia and/or thrombocytopenia, consistently predict persons with infection (poor sensitivity and negative predictive value).17,18 However, when thrombocytopenia or splenomegaly is present among individuals in these populations, they frequently indicate malaria (high positive predictive value).18 Refugees with these clinical signs, even when not symptomatic, should receive appropriate evaluation for clinical malaria.

Precautions and contraindications to presumptive treatment. Atovaquone/proguanil and ACT are both pregnancy class C medications, and safety during breastfeeding has not been established; therefore, pregnant and lactating women are excluded from all presumptive regimens. In addition, persons with other contraindications such as allergy or hypersensitivity to medications should not receive presumptive therapy. Further, children < 5 kg should not receive presumptive therapy with either ACT or AP because safety and efficacy data are lacking. Before departure, individuals in these groups should undergo diagnostic laboratory testing and receive directed treatment. Overseas diagnostic testing should be performed with blood films or rapid diagnostic tests with a kit approved for use by CDC's Division of Global Migration and Quarantine in accordance with the Quality Assurance Program for Panel Physicians. Pregnant and lactating women and children weighing < 5 kg who test positive at overseas sites should have directed therapy with quinine/clindamycin or a prolonged quinine course.

Testing in the United States by malaria blood film is acceptable because the specificity is high, but any patient that tests negative must be followed clinically for occurrence of disease because of the poor sensitivity of the test. The FDA-approved rapid test in the United States has been shown to be neither sensitive nor specific in this setting of sub-clinical or asymptomatic infection.17 Testing by RDT may be performed; however, if it is negative, the patient must still be monitored for clinical disease; if positive, a confirmation test should be performed such as blood film or PCR. Given that *Plasmodium falciparum* malaria is known to be particularly severe in pregnant women and infants, and given the poor sensitivity and negative predictive value of blood film and RDT in the setting of asymptomatic infection, PCR should be considered for screening in these selected populations when it is available. Although availability is limited, PCR is commercially available and may also be accessed through some State Health Departments and the CDC. Pregnant and lactating women who test positive for *Plasmodium* infection on screening in the United States should be treated according to US standards and may need to be referred to a specialist for therapy (Table 2).

### REFUGEES FROM OTHER REGIONS

Refugees arriving from Southeast Asia, South Asia, Central Asia, and all areas in the Western Hemisphere generally

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**Table 1**

Summary of guidelines for pre-departure presumptive treatment, diagnosis, and directed treatment of malaria for refugees resettling to the US from sub-Saharan Africa

<table>
<thead>
<tr>
<th>Population</th>
<th>Presumptive treatment without testing</th>
<th>Test by blood smear or rapid diagnostic test approved by CDC</th>
<th>Test result</th>
<th>Treat</th>
<th>Medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>All adults and children weighing &gt; 5 kg (except pregnant and lactating women or known medication contraindication as listed in protocol)</td>
<td>Yes</td>
<td>No</td>
<td>Artemether-lumefantrine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pregnant women, Lactating women, children weighing &lt; 5 kg and those with other known contraindications</td>
<td>No</td>
<td>Yes</td>
<td>Positive</td>
<td>Yes</td>
<td>Quinine/clindamycin or quinine, see website for details*</td>
</tr>
<tr>
<td>Persons with other contraindications to recommended regimen</td>
<td>No</td>
<td>Yes</td>
<td>Positive</td>
<td>Yes</td>
<td>Discuss with CDC</td>
</tr>
</tbody>
</table>

* For details on dosing and management of special populations, see full guidance documents at www.cdc.gov/ncidod/dq/refugee/index.htm.

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**Table 2**

Summary of guidelines for post-arrival presumptive treatment, diagnosis, and directed treatment of malaria for refugees resettling to the United States from sub-Saharan Africa who have not received recommended pre-departure therapy

<table>
<thead>
<tr>
<th>Population</th>
<th>Presumptive treatment without testing</th>
<th>Testing</th>
<th>Test result</th>
<th>Treat</th>
<th>Medication</th>
</tr>
</thead>
<tbody>
<tr>
<td>All adults and children weighing ≥ 5 kg (except pregnant or lactating women or if known contraindication as listed in protocol)</td>
<td>Preferred</td>
<td>Malaria smear*</td>
<td>Atovaquone-proguanil. See website for details†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pregnant women, lactating women, and children &lt; 5 kg and those with other known contraindications</td>
<td>No</td>
<td>Yes, PCR preferred. Malaria smear*</td>
<td>Positive</td>
<td>Yes</td>
<td>Consult malaria guidelines, consider consultation with an expert</td>
</tr>
</tbody>
</table>

* Blood smear has high specificity. Both blood smear and RDT have poor sensitivity and those with a negative test must still be monitored for clinical disease.

† For details on dosing and management of special populations, see full guidance documents at www.cdc.gov/ncidod/dq/refugee/index.htm.

‡ Treatment information available at www.cdc.gov/malaria/diagnosis_treatment/tx_clinicians.htm. In addition, health care providers needing assistance with diagnosis or management of suspected cases of malaria may call the CDC Malaria Hotline: 770-488-7788 (M-F, 8:00 am to 4:30 pm, EST). Emergency consultation after hours, call: 770-488-7100 and request to speak with a CDC Malaria Branch clinician.

RDT = rapid diagnostic test; PCR = polymerase chain reaction.
come from areas with low or no malaria transmission. In contrast to the situation among refugees from sub-Saharan Africa, it is rare for persons from these areas to have asymptomatic or sub-clinical *P. falciparum* malaria infection. In these refugee populations, the risk and cost of post-arrival presumptive treatment currently outweighs the potential benefits. Furthermore, laboratory screening, especially given the issues with sensitivity, specificity, and availability of the testing, is not indicated. Therefore, currently, CDC does not recommend presumptive treatment or routine laboratory screening for malaria in refugees from areas other than sub-Saharan Africa. However, any refugee from an endemic area with signs or symptoms of malaria should receive diagnostic testing for *Plasmodium* and subsequent treatment of confirmed infections.

**Strategies to prevent non-falciparum malaria in newly arriving refugees.** Non-falciparum malaria (caused by *P. ovale*, *P. vivax*, and *P. malariae*) is rarely associated with severe illness or death. Two species, *P. ovale* and *P. vivax*, may form a parasite life stage (hypnozoite) that lies dormant in the liver for months to years before emerging to cause blood stage infection and subsequent clinical disease. Primaquine is the only FDA-approved medication in the United States to treat hypnozoites and must be administered for 14 days. Before the use of primaquine, additional testing for glucose-6-phosphate dehydrogenase (G6PD) enzyme level is necessary because of the potential risk of life-threatening hemolytic anemia in G6PD-deficient individuals. Therefore, presumptive therapy (also referred to as anti-relapse therapy) is more complicated. There are many variants of *P. vivax*; depending on the subtype and the geographic location, 14 days of primaquine dosed at 15 mg/day may cure only 20-80% of hypnozoite infections at the traditional dosing. Although a higher dosage has recently been recommended for both radical cure and presumptive anti-relapse therapy, the administration remains prolonged.

Laboratory testing by blood film and rapid testing has even lower sensitivity than for *P. falciparum* malaria and is of no value in screening asymptomatic individuals.

*Plasmodium malariae* may cause persistent infections, although there is no liver dormant stage. Infected individuals are frequently asymptomatic, and the parasite has been associated with blood transfusion acquired malaria in the United States years after migration. Because this organism is not common and will generally respond to currently recommended presumptive therapy for *P. falciparum*, there are no additional recommendations for this infection.

Therefore, given the low prevalence of infection in most areas, the prolonged course of treatment, potential adverse effects of medication, and the lack of useful laboratory screening tools, CDC does not currently recommend that newly arriving refugees receive presumptive treatment of non-falciparum malaria or laboratory diagnostic evaluation on arrival to the United States. CDC will monitor non-falciparum prevalence rates among future arriving refugee populations and will update this guidance if indicated.

**Presumptive malaria treatment in non-refugee immigrants**

Although guidance in non-refugee immigrants is greatly desired by clinicians, there are gaps in knowledge and practical reasons that, at this point, these recommendations have not been extended to include other populations of immigrants. There is currently a lack of information of rates of sub-clinical infection in non-refugee immigrants. Non-refugee immigrants originate from many regions including areas that may have high prevalence of relapsing malaria that would necessitate a different approach to presumptive therapy (anti-relapse therapy). Even within sub-Saharan Africa, non-refugee immigrants originate in literally thousands of communities where prevalence rates of malaria may vary extensively. On the other hand, refugees originate in less than two dozen common communities where rates of malaria are better defined. In addition, although it would be assumed that non-refugee immigrants originating from geographically similar regions would have similar prevalence rates of malaria, this may be a false assumption for several reasons. First, refugees are generally not included in national health programs (such as malaria control) and, although they receive services from non-governmental organizations (NGOs) and the United Nations High Commission for Refugees (UNHCR), the services may differ in the camps from the local communities. Second, other risk factors frequently vary between refugee and non-refugee immigrant populations. For example, most non-refugee immigrants have a higher socio-economic status before migration than refugees that may affect housing and access to preventive strategies and health care, among other factors that influence malaria exposure and immune status. Therefore, prevalence rates of infection in camps may vary even from the adjacent local community. Because pre-test probability is essential when determining sensitivity and specificity of testing (i.e., RDT and blood films), it is inappropriate to extrapolate the performance of screening tests in refugee populations, previously mentioned, to non-refugee populations. It may be that testing or monitoring for clinical disease in these populations would be preferable to presumptive treatment.

There are also practical reasons these recommendations have not been extended to non-refugee immigrants. Refugee movement is tightly controlled, and there is health care access to refugees immediately before and after migration. For example, immigrants rarely receive post-arrival medical screening, and when they do, there is no Federal Program to pay for care. Hence, non-refugee immigrants directly incur the costs of any testing or presumptive treatment programs. The pre-departure and post-arrival care of refugees allows direct observation for overseas regimens, monitoring for adverse effects, and evaluation of the effectiveness of the program.

However, once aware of the similarities and differences in these populations, it may be reasonable for a clinician to use the methods described in these recommendations on an individual patient basis. Further research to describe malaria prevalence rates, utility of screening modalities, and cost-effectiveness of presumptive therapy in the non-refugee immigrant population is desperately needed. In addition, improved access to medical care after arrival in the United States would substantially increase the opportunities of both public health and individual health interventions in this population.

**CONCLUSIONS**

Changing patterns of migration to the United States have altered the epidemiology of infection and disease in resettling refugees. Malaria, particularly *P. falciparum*, is prevalent among many sub-Saharan populations resettling to the United States years after migration. Because this organism is not common and will generally respond to currently recommended presumptive therapy for *P. falciparum*, there are no additional recommendations for this infection. Therefore, given the low prevalence of infection in most areas, the prolonged course of treatment, potential adverse effects of medication, and the lack of useful laboratory screening tools, CDC does not currently recommend that newly arriving refugees receive presumptive treatment of non-falciparum malaria or laboratory diagnostic evaluation on arrival to the United States. CDC will monitor non-falciparum prevalence rates among future arriving refugee populations and will update this guidance if indicated.

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United States. These recommendations are put forth in an attempt to decrease potential malaria-related morbidity and mortality among refugees resettling to the United States, facilitate successful integration of refugees into host communities, decrease public health risk to the US population, and decrease costs to host communities.

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