

cause exposure and health effects information was insufficient to satisfy the case definition in some instances (e.g., approximately 68 reports were excluded because information on TRF ingredients were not available, and approximately 100 NYCPC reports were excluded because health effects data were missing or sparse). Finally, although all cases were consistent with case definition criteria, the possibility of false positives cannot be excluded. Because clinical findings of pesticide poisoning often are nonspecific and no standard diagnostic test exists, some illnesses related temporally to TRF exposures might be coincidental and not caused by TRFs.

TRFs can reduce pest populations and often are used by consumers as a low cost alternative to professional pest control services. However, because of their design to broadcast pesticides, they have a substantial potential for unintended exposures, especially when the pesticide label is ignored or misunderstood. Greater efforts are needed to promote safer alternatives to TRFs. Integrated pest management (IPM) control strategies need to be promoted and adopted. IPM can reduce indoor insect populations and minimize the need for insecticides.<sup>8</sup>

The public also should be warned about TRF dangers through broad media campaigns that explain the importance of reading and understanding the pesticide label, using the correct number of TRFs, and taking necessary precautions (e.g., turning off ignition sources and promptly leaving the premises). TRF labels should be improved to make information easier to find and understand. Current TRF labels indicate the number of cubic feet that one container will treat effectively for pests, which requires the user to employ arithmetic to calculate both the volume of space to be treated and the number of TRFs needed to treat a space of that size. Use of delayed-release TRFs also might prevent illnesses and injuries by allowing the user to vacate the premises before the insecticide is released. Notices should be posted on the exterior of spaces where

TRFs are used, indicating when the TRF treatment will be made and when reentry into the space is permitted. Coinhabitants (and nearby neighbors, when multiunit housing is treated) also should be informed at least 24 hours before a TRF treatment is started.

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\*Under the Sentinel Event Notification System for Occupational Risk (SENSOR)-Pesticides program, CDC provides cooperative agreement funding and technical support to state health departments to conduct surveillance of acute, occupational, pesticide-related illness and injury. Funding support also is provided by the Environmental Protection Agency. Health departments in 10 states (Arizona, California, Florida, Louisiana, Michigan, New Mexico, New York, Oregon, Texas, and Washington) participated through 2006. Additional information is available at <http://www.cdc.gov/niosh/topics/pesticides>.

†Severity for SENSOR and CDPR cases was coded using standardized criteria (available at <http://www.cdc.gov/niosh/topics/pesticides>). Low-severity illnesses or injuries consist of illnesses and injuries that generally resolve without treatment and where minimal time (<3 days) is lost from work. Such cases typically manifest as eye, skin, and/or upper respiratory irritation. Moderate severity illnesses and injuries consist of non-life-threatening health effects that are generally systemic and require medical treatment. No residual disability is detected, and time lost from work is <6 days. High-

severity illnesses and injuries consist of life-threatening health effects that usually require hospitalization, involve substantial time lost from work (>5 days), and can result in permanent impairment or disability. Deaths are fatalities resulting from exposure to one or more pesticides. NYCPC uses similar criteria for coding severity.

‡EPA classifies pesticide products into one of four toxicity categories based on established criteria (40 CFR part 156). Pesticides with the greatest toxicity are in category I, and those with the least are in category IV.

## Malaria in Refugees From Tanzania—King County, Washington, 2007

*MMWR*. 2008;57:869-872

*1 table omitted*

RECENT IMMIGRANTS AND REFUGEES constitute a substantial proportion of malaria cases in the United States, accounting for nearly one in 10 imported malaria cases involving persons with known resident status in 2006.<sup>1</sup> This report describes three cases of *Plasmodium falciparum* malaria and two cases of *Plasmodium ovale* malaria that occurred during June 27–October 15, 2007 in King County, Washington. The infections were diagnosed in Burundian refugees who had recently arrived in the United States from two refugee camps in Tanzania. Since 2005, CDC has recommended presumptive malaria treatment with artemisinin-based combination therapy (ACT) (e.g., artemether-lumefantrine) for refugees from sub-Saharan Africa before their departure for the United States.<sup>2</sup> Rising levels of resistance to the previous mainstays of treatment, chloroquine and sulfadoxine-pyrimethamine, prompted CDC to make this recommendation. Implementation has been delayed in some countries, including Tanzania, where predeparture administration of presumptive ACT for refugees started in July 2007. The cases in this report highlight the need for health-care providers who care for recently arrived Burundian and other refugee populations to be vigilant for malaria, even among refugees previously treated for the disease.

Washington state law requires health-care providers, hospitals, and laboratories to report malaria and certain other conditions to the local health department.\* This report summarizes the findings from five cases reported to the local health department by health-care providers and laboratories. After these cases were reported, the patients' medical records were obtained from two local hospitals and reviewed to assist in case investigations. Initial investigations were limited to case investigation forms completed by public health officials based on available medical records.

### Case 1

A female aged 3 years was diagnosed with *P. falciparum* malaria in May 2007 while in Tanzania. At that time, she was placed on a quinine-based regimen (formulation, date of administration, and method of administration unknown) and clinically recovered. During an overseas predeparture exam, a requirement for entry into the United States, she received presumptive malaria treatment, with a course of sulfadoxine-pyrimethamine. She arrived in the United States on June 12, 2007, and became ill on June 25, 2007, with fevers, chills, and cough. On June 27, 2007, she was admitted to the local children's hospital. A blood smear revealed 7% hyperparasitemia (>5% = hyperparasitemia) with *P. falciparum*. Other laboratory findings included anemia, thrombocytopenia, and elevated aspartate aminotransferase. She received oral atovaquone-proguanil, clinically improved, and was discharged July 2, 2007 after 5 days in the hospital.

### Case 2

A female aged 9 years arrived in the United States on July 23, 2007. Before leaving Tanzania, she received presumptive 3-day treatment of twice daily artemether-lumefantrine; the last doses were administered on July 19, 2007. She became ill on August 11, 2007, with fever, headache, malaise, and cough. She was evaluated in the local county hospital emergency department on August 14, 2007. Blood smear (percent parasitemia unknown) and polymerase chain reaction (PCR) test results

were positive for *P. ovale*. Other laboratory findings included anemia, elevated alanine and aspartate aminotransferase, and hypoalbuminemia. The patient recovered after outpatient treatment with mefloquine and primaquine.

### Case 3

A male aged 6 years arrived in the United States on July 23, 2007. Before leaving Tanzania, he received presumptive 3-day treatment of twice daily artemether-lumefantrine, with last doses given on July 19, 2007. He became ill on August 13, 2007, with fever, headache, and malaise. He was evaluated in the local county hospital emergency department on August 15, 2007. Laboratory evaluation revealed anemia and *P. ovale* on blood smear (percent parasitemia unknown) and by PCR. He was treated with chloroquine and primaquine as an outpatient and recovered.

### Case 4

A male aged 6 years arrived in the United States on September 28, 2007. He received presumptive treatment of artemether-lumefantrine before departure from Tanzania. The last doses were administered on September 24, 2007. He became ill on October 1, 2007, with fever, cough, and decreased energy. He was admitted to a local children's hospital on October 15, 2007. A blood smear revealed *P. falciparum* with 6.3% hyperparasitemia. Anemia was the other notable laboratory finding. The patient received quinidine and clindamycin, recovered, and was transitioned to atovaquone-proguanil before discharge. He was discharged on October 19, 2007 after spending 4 days in the hospital.

### Case 5

A female aged 2 years arrived in the United States on September 28, 2007. She received artemether-lumefantrine as presumptive treatment before departure from Tanzania, with the last doses administered on September 24, 2007. She became ill on October 8, 2007, with fever, vomiting, and nonbloody diarrhea. She worsened clinically

over the following week, eventually developing respiratory distress and lethargy. She was admitted to the intensive care unit of a local children's hospital on October 15, 2007. Her blood smear revealed 7.4% hyperparasitemia with *P. falciparum*. Other laboratory findings included anemia, thrombocytopenia, and elevated alanine and aspartate aminotransferase. The patient was treated with quinidine and clindamycin, recovered, and was transitioned to atovaquone-proguanil before discharge on October 19, 2007. She spent a total of 4 days in the hospital.

Blood smears from cases 2 through 5 were sent to CDC for confirmation of test results. In cases 2 and 3, blood smears were positive for *Plasmodium* spp. (without percent parasitemia noted), and PCR was positive for *P. ovale*. In case 4, the blood smear was notable for a 10% *P. falciparum* hyperparasitemia. In case 5, the blood smear was negative, but PCR was positive for *P. falciparum*.

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**CDC Editorial Note:** CDC recommends presumptive treatment of *P. falciparum* malaria in United States-bound refugees at high risk for infection rather than waiting for development of symptoms and risking severe complications or death after arrival in the United States.<sup>2</sup> To be considered adequate presumptive therapy, the regimen must be completed no sooner than 3 days before departure.<sup>2</sup> This approach reduces the risk for malaria-related morbidity and mortality among these refugees. Refugees are typically a medically underserved population with difficulty accessing care, which can lead to delays in diagnosis and treatment. Even if refugees are able to obtain care, health-care providers in the United

States might not be familiar with recommended malaria treatment regimens. For example, the patient in case 1 did not receive adequate treatment for severe infection with *P. falciparum*. Instead, she received oral atovaquone-proguanil, which would have been appropriate for uncomplicated malaria. The recommended regimens for severe infection with *P. falciparum* include either intravenous quinidine or artesunate.<sup>3</sup> The latter is available from CDC via an investigational new drug protocol. Presumptive predeparture treatment for malaria in a geographically clustered population of refugees, as in a refugee camp, is easier logistically and less costly than treatment of symptomatic cases dispersed throughout the United States after arrival. Presumptive treatment also can reduce the risk for reintroduction of malaria into the United States. Reintroduction is a concern given that the malaria vector, the female *Anopheles* mosquito, is widespread in the United States. A recent malaria outbreak in the Caribbean resulting from reintroduction is an example of this possibility.<sup>4</sup>

The International Organization for Migration (IOM) is an intergovernmental agency that screens and treats most refugees bound for the United States. This is done at the request of the United States in an effort to reduce the incidence of infectious disease among refugees after they reach the United States. IOM administers presumptive treatment against *P. falciparum* malaria (and intestinal parasites) to refugees resettling from Tanzania before departure for the United States. In 2005, CDC recommended ACT as presumptive *P. falciparum* treatment for refugees resettling in the United States from sub-Saharan Africa. However, presumptive *P. falciparum* malaria treatment using sulfadoxine-pyrimethamine was used for Tanzanian refugees until July 7, 2007.

CDC surveillance data indicate that among 1,805 Burundian refugees from Tanzania who resettled to 34 U.S. states during May 4–July 7, 2007, 29 symptomatic cases of malaria were identified in 12 states, including Washington.

Twenty-six of these refugees (including the patient in case 1) were infected with *P. falciparum* alone, and two had mixed infections (*P. falciparum* and *P. ovale* or *Plasmodium malariae*). Speciation was not performed for the remaining case. Twenty-four of the 29 (82%) patients were hospitalized; none died (CDC, unpublished data). These 29 refugees departed for the United States before July 7, 2007, the date when IOM implemented the CDC recommendations that refugees from Tanzania receive presumptive treatment with 6-dose artemether-lumefantrine within 3 days before departure for the United States. Instead, they all received sulfadoxine-pyrimethamine before departure; high rates of resistance to sulfadoxine-pyrimethamine have been reported,<sup>5</sup> but the artemether-lumefantrine regimen has been effective in field settings in Africa.<sup>6</sup>

Two of the patients in this report who were infected with *P. falciparum*, the patients in cases 4 and 5, were resettled to the United States after July 7, 2007, the date when IOM instituted the change to artemether-lumefantrine treatment. These two patients received a complete artemether-lumefantrine presumptive treatment course before departure from Tanzania, yet both were diagnosed with *P. falciparum* after arrival in the United States. Possible explanations include incomplete treatment or nonadherence to the medication regimen (only 3 of 6 doses were directly observed in these two patients, and in the patients in cases 2 and 3), poor medication absorption, reinfection after treatment, or treatment during a time in the parasite's lifecycle when it would be unaffected by this regimen. In response to such continuing cases, IOM now directly observes all 6 doses of artemether-lumefantrine treatment and provides milk with each dose to improve absorption.

Current IOM policy targets infection with *P. falciparum* only. However, cases 2 and 3 in this series involved relapses of *P. ovale* after arrival in the United States. Infection with *P. ovale* (or *Plasmodium vivax*) generally results in less severe disease than infection with *P. falciparum*. Hypnozoites of *P. ovale* or *P. vivax* can re-

main dormant in the liver for months or years before causing relapse, and primaquine is the only agent available that can eliminate malaria parasites at this stage of their life cycle.<sup>7,8</sup> However, predeparture presumptive treatment with primaquine to prevent relapse of *P. ovale* or *P. vivax* currently is not recommended because the cost, logistics of implementing a 14-day medication course, and risk for severe hemolytic anemia in glucose-6-phosphate dehydrogenase (G6PD)-deficient patients outweigh the potential benefit of avoiding a small number of non-*P. falciparum* malaria cases.

Up to 10,000 Burundian refugees from Tanzania will have been resettled in the United States during 2007–2008.<sup>9</sup> Health-care providers in the United States caring for refugee populations resettling from malarial regions should remain aware of the possibility of malaria in these groups, regardless of prior treatment.

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