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Malaria Surveillance — United States, 1997

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Abortion	NCCDPHP	2000; Vol. 49, No. SS-11
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Health Risks	NCCDPHP	1999; Vol. 48, No. SS-8
Health-Care Services	NCCDPHP/NIP	1999; Vol. 48, No. SS-8
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Injuries and Violence	NCIPC/NCCDPHP	1999; Vol. 48, No. SS-8
Morbidity and Mortality	NCHS/NCCDPHP	1999; Vol. 48, No. SS-8
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State- and Sex-Specific Prevalence of Selected Characteristics	NCCDPHP	2000; Vol. 49, No. SS-6
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Contribution of Birth Defects to Infant Mortality Among Minority Groups	NCEHIC	1990; Vol. 39, No. SS-3
Breast and Cervical Cancer	NCCDPHP	1999; Vol. 48, No. SS-6
Cardiovascular Disease	EPO/NCCDPHP	1998; Vol. 47, No. SS-5
Chancroid	NCPS	1992; Vol. 41, No. SS-3
Chlamydia	NCPS	1993; Vol. 42, No. SS-3
Cholera	NCID	1992; Vol. 41, No. SS-1
Chronic Fatigue Syndrome	NCID	1997; Vol. 46, No. SS-2
Contraception Practices	NCCDPHP	1992; Vol. 41, No. SS-4
Cytomegalovirus Disease, Congenital	NCID	1992; Vol. 41, No. SS-2
Dengue	NCID	1994; Vol. 43, No. SS-2
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Ectopic Pregnancy	NCCDPHP	1993; Vol. 42, No. SS-6
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Escherichia coli O157	NCID	1991; Vol. 40, No. SS-1
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Food Safety	NCID	1998; Vol. 47, No. SS-4
Foodborne-Disease Outbreaks	NCID	2000; Vol. 49, No. SS-1

***Abbreviations**

ATSDR	Agency for Toxic Substances and Disease Registry
CIO	Centers/Institute/Offices
EPO	Epidemiology Program Office
IHPO	International Health Program Office
NCCDPHP	National Center for Chronic Disease Prevention and Health Promotion
NCEH	National Center for Environmental Health
NCEHIC	National Center for Environmental Health and Injury Control
NCHSTP	National Center for HIV, STD, and TB Prevention
NCID	National Center for Infectious Diseases
NCIPC	National Center for Injury Prevention and Control
NCPS	National Center for Prevention Services
NIOSH	National Institute for Occupational Safety and Health
NIP	National Immunization Program

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Subject	Responsible CIO/Agency*	Most Recent Report
Giardiasis	NCID	2000; Vol. 49, No. SS-7
Gonorrhea and Syphilis, Teenagers	NCPS	1993; Vol. 42, No. SS-3
Hazardous Substances Emergency Events	ATSDR	1994; Vol. 43, No. SS-2
Health Surveillance Systems	IHPO	1992; Vol. 41, No. SS-4
Homicide	NCEHIC	1992; Vol. 41, No. SS-3
Hysterectomy	NCCDPHP	1997; Vol. 46, No. SS-4
Infant Mortality (see also National Infant Mortality; Birth Defects; Postneonatal Mortality)	NCEHIC	1990; Vol. 39, No. SS-3
Influenza	NCID	2000; Vol. 49, No. SS-3
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Lead Poisoning, Childhood	NCEHIC	1990; Vol. 39, No. SS-4
Low Birth Weight	NCCDPHP	1990; Vol. 39, No. SS-3
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Meningococcal Disease	NCID	1993; Vol. 42, No. SS-2
Mumps	NIP	1995; Vol. 44, No. SS-3
Neisseria gonorrhoeae, Antimicrobial Resistance in	NCPS	1993; Vol. 42, No. SS-3
Neural Tube Defects	NCEH	1995; Vol. 44, No. SS-4
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Pertussis	NCPS	1992; Vol. 41, No. SS-8
Poliomyelitis	NCPS	1992; Vol. 41, No. SS-1
Postneonatal Mortality	NCCDPHP	1998; Vol. 47, No. SS-2
Pregnancy		
Pregnancy Nutrition	NCCDPHP	1992; Vol. 41, No. SS-7
Pregnancy-Related Mortality	NCCDPHP	1997; Vol. 46, No. SS-4
Pregnancy Risk Assessment Monitoring System (PRAMS)	NCCDPHP	1999; Vol. 48, No. SS-5
Pregnancy, Teenage	NCCDPHP	1993; Vol. 42, No. SS-6
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School Health Education Profiles	NCCDPHP	2000; Vol. 49, No. SS-8
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Tobacco-Control Laws, State	NCCDPHP	1999; Vol. 48, No. SS-3
Tobacco-Use Behaviors	NCCDPHP	1994; Vol. 43, No. SS-3
Youth Tobacco Surveillance	NCCDPHP	2000; Vol. 49, No. SS-10
Spina Bifida	NCEH	1996; Vol. 45, No. SS-2
Streptococcal Disease (Group B)	NCID	1992; Vol. 41, No. SS-6
Syphilis, Congenital	NCPS	1993; Vol. 42, No. SS-6
Syphilis, Primary and Secondary	NCPS	1993; Vol. 42, No. SS-3
Tetanus	NIP	1998; Vol. 47, No. SS-2

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Subject	Responsible CIO/Agency*	Most Recent Report
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Tuberculosis	NCPS	1991; Vol. 40, No. SS-3
Vaccination Coverage		
Among Children Enrolled in Head Start Programs or Day Care Facilities or Entering School	NIP	2000; Vol. 49, No. SS-9
Influenza, Pneumococcal, and Tetanus Toxoid Vaccination (Among Adults)	NIP	2000; Vol. 49, No. SS-9
National, State, and Urban Areas (Among Children Aged 19–35 Months)	NIP	2000; Vol. 49, No. SS-9
Waterborne-Disease Outbreaks	NCID	2000; Vol. 49, No. SS-4
Years of Potential Life Lost	EPO	1992; Vol. 41, No. SS-6
Youth Risk Behaviors	NCCDPHP	2000; Vol. 49, No. SS-5
College Students	NCCDPHP	1997; Vol. 46, No. SS-6
National Alternative High Schools	NCCDPHP	1999; Vol. 48, No. SS-7

Malaria Surveillance — United States, 1996

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Abstract

Problem/Condition: Malaria is caused by four species of intraerythrocytic protozoa of the genus *Plasmodium* (i.e., *P. falciparum*, *P. vivax*, *P. ovale*, or *P. malariae*), which are transmitted by the bite of an infected female *Anopheles* sp. mosquito. Most malaria infections in the United States occur in persons who have traveled to areas with ongoing transmission. Occasionally, cases occur in the United States through exposure to infected blood products, by congenital transmission, or by local mosquitoborne transmission. National public health surveillance for malaria is conducted to identify episodes of local transmission and to guide prevention recommendations for travelers.
Reporting Period Covered: Cases with onset of illness during 1996.
Description of System: Malaria cases confirmed by blood smears are reported to local and/or state health departments by health-care providers and/or laboratory staff. Case investigations are conducted by local and/or state health departments, and reports are transmitted to CDC through the National Malaria Surveillance System (NMSS). Data from NMSS serve as the basis for this report.
Results: CDC received reports of 1,392 cases of malaria with onset of symptoms during 1996 among persons in the United States or one of its territories. This number represents an increase of 19.3% from the 1,167 cases reported for 1995. *P. vivax*, *P. falciparum*, *P. malariae*, and *P. ovale* were identified in 47.4% 37.4%, 5.4%, and 2.0% of cases, respectively. More than one species was present in four patients (0.3% of total). The infecting species was not determined in 104 (7.5%) cases.

The number of reported malaria cases acquired in Africa (n=585)increased by 12.7% compared with 1995; cases acquired in Asia increased by 31.9% (n=442); and cases acquired in the Americas increased by 13.0% (n=278). Of 614 U.S. civilians who acquired malaria abroad, 97 (15.8%) had followed a chemoprophylactic drug regimen recommended by CDC for the area where they had traveled. Eleven patients became infected in the United States. Of these 11 cases, three were congenitally acquired; one was acquired by organ transplantation; one was acquired by a blood transfusion; two were acquired through infusion using a heparin lock; and one was acquired by a mosquito bite in a laboratory setting. In three cases, the source of infection was unknown. Five deaths were attributed to malaria.

Interpretation: The 19.3% increase in malaria cases in 1996 compared with 1995 resulted primarily from increases in cases acquired in Africa and Asia. This increase could have resulted from local changes in disease transmission, increased travel to these regions, improved reporting from state and local health departments, or a decreased use of effective antimalarial chemoprophylaxis. In most reported cases, U.S. civilians who acquired infection abroad were not on an appropriate chemoprophylaxis regimen for the country where they acquired malaria.

Public Health Actions: Additional information was obtained concerning the five fatal cases and the 11 infections acquired in the United States. In 1996, malaria prevention guidelines were updated and distributed to health-care providers.

Persons traveling to a malarious area should take the recommended chemoprophylaxis regimen and use personal protection measures to prevent mosquito bites. Any person who has been to a malarious area and who subsequently develops a fever or influenza-like symptoms should seek medical care immediately; investigation should include a blood smear for malaria. Malaria infections can be fatal if not diagnosed and treated promptly. Recommendations concerning prevention of malaria can be obtained from CDC's *Health Information for International Travel*.*

INTRODUCTION

Malaria is caused by infection with any of four *species of Plasmodium* (i.e., *P. falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*) that can infect humans. The infection is transmitted by the bite of an infective female *Anopheles* sp. mosquito. Malaria infection remains a devastating global problem, with an estimated 300–500 million cases occurring annually. Forty-one percent of the world's population lives in areas where malaria is transmitted (e.g., parts of Africa, Asia, Central America and South America, Hispaniola, the Middle East, and Oceania), and approximately 1.5–2.7 million persons die of malaria each year (*1*). In previous years, malaria was also endemic throughout much of the continental United States; an estimated 600,000 cases occurred during 1914 (*2*). During the late 1940s, a combination of improved socioeconomic conditions, water management, vector-control efforts, and case management was successful at interrupting malaria transmission in the United States. Since then, malaria case surveillance has been maintained to detect locally acquired cases that could indicate the reintroduction of transmission and to monitor patterns of antimalarial drug resistance seen among U.S. travelers.

Through 1996, most cases of malaria diagnosed in the United States have been imported from regions of the world where malaria transmission is known to occur. Each year, several congenital infections and infections resulting from exposure to blood or blood products are reported in the United States. In addition, a few cases are reported that might have been acquired through local mosquitoborne transmission (*3*).

State and/or local health departments and CDC thoroughly investigate all malaria cases acquired in the United States, and CDC conducts an analysis of all imported cases

*To obtain confirmation diagnosis of blood smears from questionable cases and to obtain appropriate treatment recommendations, contact either your state or local health department or CDC's National Center for Infectious Diseases, Division of Parasitic Diseases, Malaria Epidemiology Branch; telephone (770) 488-7788.

to detect trends in acquisition. This information has been used to guide malaria prevention recommendations for travelers abroad. For example, an increase in *P. falciparum* malaria among U.S. travelers to Africa, an area with increasing chloroquine-resistance, prompted CDC in 1990 to change the recommended chemoprophylaxis from chloroquine to mefloquine (*4*).

The signs and symptoms of malaria illness are variable, but most patients have fever. Other common symptoms include headache, back pain, chills, increased sweating, myalgia, nausea, vomiting, diarrhea, and cough. The diagnosis of malaria should be considered for any person who has these symptoms and has traveled to an area with known malaria transmission. Malaria should also be considered in the differential diagnosis of persons who have a fever of unknown origin, regardless of their travel history. Untreated *P. falciparum* infections can progress to coma, renal failure, pulmonary edema, and death. Asymptomatic parasitemia can occur among persons who have been long-term residents of malarious areas. This report summarizes malaria cases reported to CDC with onset of symptoms in 1996.

METHODS

Sources of Data

Data regarding malaria cases are reported to both the National Malaria Surveillance System (NMSS) and the National Notifiable Diseases Surveillance System (NNDSS) (*5*). All nationally notifiable diseases, which includes malaria, are reported to CDC through NNDSS. The numbers of reported cases might differ because of differences in the collection and transmission of data. A comparison was made of cases in 10 states* that reported to NMSS and NNDSS. To determine the completeness of reporting to the two systems and to obtain an estimate of the total number of cases in these 10 states, cases were matched using variables that included state, age (±5 years), sex, race, and date of onset of illness (±1 month). The capture-recapture methodology (*6*) was used to compare NMSS and NNDSS.

NMSS receives more detailed clinical and epidemiologic data regarding each case (e.g., information concerning the area where the infected person has traveled) than NNDSS. This information is needed for programmatic decision making (e.g., CDC takes this information into account when making recommendations for malaria chemoprophylaxis). Cases of blood-smear–confirmed malaria are identified by health-care providers and/or laboratories. Each slide-confirmed case is reported to local and/or state health departments and to CDC on a uniform case report form that contains clinical, laboratory, and epidemiologic information. CDC staff review all report forms at the time of receipt and request additional information if necessary (e.g., when no recent travel to a malarious country is reported). Reports of other cases are telephoned directly by health-care providers to CDC, usually when assistance with diagnosis or treatment is requested. All cases that have been acquired in the United States are investigated, including all induced and congenital cases and possible introduced or cryptic cases. Information derived from uniform case report forms is entered into a database and analyzed annually.

* Florida, Hawaii, Illinois, Maine, Massachusetts, Missouri, New Jersey, Tennessee, Texas, and Washington.

Definition of Terms

The following definitions are used in this report:

- ***Laboratory criteria for diagnosis:*** Demonstration of malaria parasites in blood films.
- ***Confirmed case:*** Symptomatic or asymptomatic infection that occurs in the United States in a person who has microscopically confirmed malaria parasitemia, regardless of whether the person had previous attacks of malaria while in other countries. A subsequent attack of malaria is counted as an additional case if the demonstrated *Plasmodium* species differs from the initially identified species. A subsequent attack of malaria occurring in a person while in the United States could indicate a relapsing infection or treatment failure resulting from drug resistance if the demonstrated *Plasmodium* species is the same species identified previously.

This report also uses terminology derived from the recommendations of the World Health Organization (*7*). Definitions of the following terms are included for reference.

- **Autochthonous malaria:**
  - —**Indigenous.** Mosquitoborne transmission of malaria in an area where malaria occurs regularly.
  - —**Introduced.** Mosquitoborne transmission of malaria from an imported case in an area where malaria does not occur regularly.
- **Imported malaria:** Malaria acquired outside a specific area. In this report, imported cases are those acquired outside of the United States and its territories (Puerto Rico, Guam, and the U.S. Virgin Islands).
- **Induced malaria:** Malaria acquired through artificial means (e.g., blood transfusion or use of shared syringes).
- **Relapsing malaria:** Renewed manifestations (i.e., clinical symptoms and/or parasitemia) of malarial infection that are separated from previous manifestations of the same infection by an interval greater than the usual periodicity of the paroxysms.
- **Cryptic malaria:** An isolated malaria case that cannot be linked epidemiologically to additional cases.

Microscopic Diagnosis of Malaria

The early diagnosis of malaria requires that physicians consider malaria in the differential diagnosis of every patient who has fever; the evaluation of such a patient should include taking a comprehensive travel history. If malaria is suspected, a Giemsa-stained smear of the patient's peripheral blood should be examined for parasites. Thick and thin blood smears must be prepared properly because the accuracy of diagnosis depends on the quality of the blood film and the experience of the laboratory personnel.* (See Appendix for proper procedures for accurately diagnosing malaria).

*To obtain confirmation diagnosis of blood smears from questionable cases and to obtain appropriate treatment recommendations, contact either your state or local health department or CDC's National Center for Infectious Diseases, Division of Parasitic Diseases, Malaria Epidemiology Branch; telephone (770) 488-7788.

RESULTS

General Surveillance

During 1996, CDC received reports of 1,392 malaria cases through NMSS that had onset of symptoms among persons in the United States and its territories, representing a 19.3% increase from the 1,167 cases reported for 1995 (*8*). This incidence is the largest number of reported cases since 1980 and represents the largest number of U.S. civilian cases reported since 1966 (Table 1). Since 1988, with the exception of 1992, malaria among U.S civilians has accounted for most of the cases reported to CDC. In 1996, 618 cases occurred in U.S. civilians compared with 599 cases reported for 1995, whereas the number of cases in foreign civilians increased from 461 cases to 636 (Figure 1). Cases among U.S. military personnel increased from 12 in 1995 to 32 in 1996. In 106 cases, information was not sufficient to determine whether the person was a civilian or in the military.

In the comparison of NMSS and NNDSS, 294 cases were reported to NMSS from the 10 selected states, and 505 were reported to NNDSS. Two hundred thirteen cases were reported to both systems. Using both the Chandra Sekar-Deming and Lincoln-Peterson Capture-Recapture methods, the total estimated number of cases in these states was 697 (660, 734, 95% confidence interval), and an estimated 111 cases were missed by both systems. The completeness of reporting to NMSS and NNDSS was 42% and 72%, respectively.

Plasmodium Species

The infecting species of *Plasmodium* was identified in 1,288 (92.5%) of the cases reported in 1996. *P. vivax* and *P. falciparum* were identified in blood smears from 47.4% and 37.4% of infected persons, respectively (Table 2). The 660 *P. vivax* cases reported for 1996 represented a 17.4% increase from the 562 cases in 1995, whereas the number of *P. falciparum* infections increased by 15.8% (from 450 in 1995 to 521 in 1996). Among 1,244 cases in which both the region of acquisition and the infecting species were known, 80.3% of infections acquired in Africa were attributed to *P. falciparum*, whereas 7.6% were attributed to *P. vivax*. The converse was true of malaria infections acquired in Asia and the Americas: 83.6% and 81.5% were attributed to *P. vivax*, and only 10.7% and 13.7% were attributed to *P. falciparum*, respectively.

Region of Acquisition and of Diagnosis

Of all reported cases, 99% (n=1,381) were imported. Of 1,337 imported cases in which the region of acquisition was known, most (n=585; 43.7%) were acquired in Africa, whereas 33.1% (n=442) and 20.0% (n=267) were acquired in Asia and the Americas, respectively (Table 3). The highest concentration of cases acquired in Africa (n=406; 69.4%) came from countries in West Africa, whereas most (n=381; 86.2%) of the cases acquired in Asia came from the Indian subcontinent. The other regions where imported cases of malaria were acquired were Central America and Caribbean (17.1%), South America (2.2%) and Oceania (3.1%). Information regarding region of acquisition was missing for 44 (3.2%) of the 1,381 imported cases. In Africa, the number of reported malaria cases acquired (n=585) in 1996 increased by 12.3% compared with 1995; in Asia, the number of cases increased by 31.5% (n=442) in 1996 compared with 1995. Cases from the Americas increased by 8.5% (n=267) in 1996 compared with 1995.

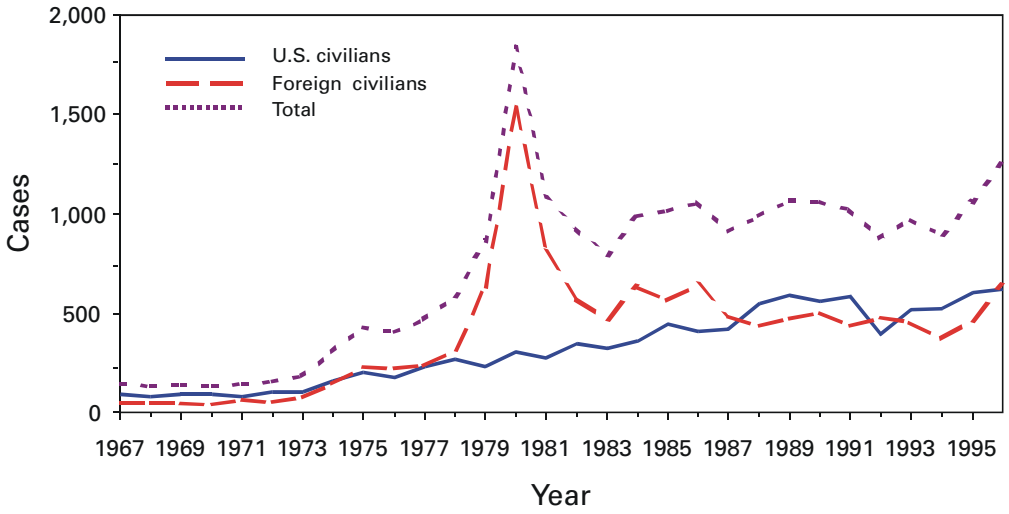
TABLE 1. Number of malaria cases* in U.S. and foreign civilians and U.S. military personnel — United States, 1966–1996

Year	U.S. military personnel	U.S. civilians	Foreign civilians	Unknown	Total
1966	621	89	32	22	**764**
1967	2,699	92	51	15	**2,857**
1968	2,567	82	49	0	**2,698**
1969	3,914	90	47	11	**4,062**
1970	4,096	90	44	17	**4,247**
1971	2,975	79	69	57	**3,180**
1972	454	106	54	0	**614**
1973	41	103	78	0	**222**
1974	21	158	144	0	**323**
1975	17	199	232	0	**448**
1976	5	178	227	5	**415**
1977	11	233	237	0	**481**
1978	31	270	315	0	**616**
1979	11	229	634	3	**877**
1980	26	303	1,534	1	**1,864**
1981	21	273	809	0	**1,103**
1982	8	348	574	0	**930**
1983	10	325	468	0	**803**
1984	24	360	632	0	**1,016**
1985	31	446	568	0	**1,045**
1986	35	410	646	0	**1,091**
1987	23	421	488	0	**932**
1988	33	550	440	0	**1,023**
1989	35	591	476	0	**1,102**
1990	36	558	504	0	**1,098**
1991	22	585	439	0	**1,046**
1992	29	394	481	6	**910**
1993	278	519	453	25	**1,275**
1994	38	524	370	82	**1,014**
1995	12	599	461	95	**1,167**
1996	32	618	636	106	**1,392**

* A case was defined as symptomatic or asymptomatic illness that occurs in the United States in a person who has microscopically confirmed malaria parasitemia, regardless of whether the person had previous attacks of malaria while in other countries. A subsequent attack of malaria occurring in a person is counted as an additional case if the demonstrated *Plasmodium* species differs from the initially identified species. A subsequent attack of malaria occurring in a person while in the United States could indicate a relapsing infection or treatment failure resulting from drug resistance if the demonstrated *Plasmodium* species is the same species identified previously.

In the United States, the five areas reporting the highest number of malaria cases were California (n=350), New York City (n=292), Florida (n=113), New York (n=92), and Virginia (n=53) (Figure 2). Florida, which ranked fifth in number of cases in 1995, ranked third in 1996, an increase of 73.8% (from 65 cases in 1995 to 113 cases in 1996). New York City, which began reporting cases to CDC in 1993, reported a 23% increase in cases in 1996 compared with 1995. This increase in the reported number of cases might be a result of increased international travel, improved access to health care, or more sensitive surveillance for both Florida and New York City.

FIGURE 1. Number of malaria cases among U.S. and foreign civilians — United States,* 1967–1996†



* Includes Puerto Rico, Guam, and the U.S. Virgin Islands.

† The substantial increase in the number of cases reported for 1980 primarily reflects cases diagnosed in immigrants from Southeast Asia after the Vietnam conflict.

TABLE 2. Number of malaria cases, by *Plasmodium* species — United States, 1995 and 1996

Plasmodium species	1995		1996	
	No.	(%)	No.	(%)
P. vivax	562	(48.2)	660	(47.4)
P. falciparum	450	(38.6)	521	(37.4)
P. malariae	46	(3.9)	75	(5.4)
P. ovale	26	(2.2)	28	(2.0)
Undetermined	80	(6.9)	104	(7.5)
Mixed	3	(0.3)	4	(0.3)
Total	**1,167**	**(100.0)**	**1,392**	**(100.0)**

Interval Between Arrival and Illness

Both the interval between the date of arrival in the United States and onset of illness, and the identification of the infecting *Plasmodium* species were known for 1,033 (74.8%) of the imported cases of malaria (Table 4). Symptoms began after arrival in the United States for 968 (93.7%) of these cases. Clinical malaria developed within 1 month after arrival in 349 (80.0%) of the 436 *P. falciparum* cases and in 144 (27.8%) of the 518 *P. vivax* cases (Table 4). Only 39 (3.8%) of the 1,033 persons became ill >1 year after returning to the United States. An additional 65 persons reported becoming ill before arriving in the United States.

TABLE 3. Number of malaria cases, by *Plasmodium* species and area of acquisition — United States, 1996

Area of acquisition	*Plasmodium* species						
	P. vivax	*P. falciparum*	*P. malariae*	*P. ovale*	Unknown	Mixed	Total
AFRICA	41	431	37	26	48	2	**585**
Angola	0	3	0	0	0	0	**3**
Benin	0	2	0	0	0	0	**2**
Cameroon	2	6	1	0	3	0	**12**
Chad	0	1	0	0	1	0	**2**
Central African Republic	0	1	0	0	0	0	**1**
Comoros	1	0	0	0	0	0	**1**
Congo	0	1	0	0	0	0	**1**
Côte d'Ivoire	0	21	1	2	3	0	**27**
Democratic Republic of the Congo (Zaire)	2	7	1	1	0	0	**11**
Equatorial Guinea	1	1	0	0	0	0	**2**
Ethiopia	7	2	1	1	0	0	**11**
Gabon	0	1	0	0	0	0	**1**
Gambia	0	1	0	0	0	0	**1**
Ghana	3	70	3	0	5	0	**81**
Guinea	0	13	0	2	0	0	**15**
Kenya	5	19	3	4	3	0	**34**
Liberia	0	22	3	1	3	0	**29**
Madagascar	1	0	0	0	0	0	**1**
Malawi	0	1	0	0	0	0	**1**
Mali	0	4	0	1	0	0	**5**
Mauritania	1	0	0	0	0	0	**1**
Morocco	0	0	0	0	1	0	**1**
Mozambique	0	1	0	0	0	1	**2**
Niger	0	1	0	0	0	0	**1**
Nigeria	9	143	13	3	15	1	**184**
São Tomé	0	0	0	0	1	0	**1**
Senegal	0	9	0	0	1	0	**10**
Sierra Leone	0	11	1	1	1	0	**14**
Somali Republic	1	4	0	0	0	0	**5**
South Africa	0	6	0	0	0	0	**6**
Sudan	1	2	1	0	1	0	**5**
Swaziland	0	0	1	0	0	0	**1**
Tanzania	0	4	0	1	0	0	**5**
Togo	0	2	0	0	0	0	**2**
Uganda	0	3	0	0	1	0	**4**
Zambia	0	2	0	0	0	0	**2**
Zimbabwe	0	3	0	0	0	0	**3**
East Africa, Unspecified	2	10	2	0	0	0	**14**
West Africa, Unspecified	0	26	2	2	4	0	**34**
South Africa, Unspecified	0	3	1	0	0	0	**4**
Africa, Unspecified	5	25	3	7	5	0	**45**
ASIA	353	45	22	1	20	1	**442**
Afghanistan	1	0	0	0	0	0	**1**
Bangladesh	1	0	0	0	0	0	**1**
Cambodia	0	0	0	0	1	0	**1**
China	0	1	0	0	0	0	**1**
India	282	21	18	0	14	0	**335**

TABLE 3. (*Continued*) Number of malaria cases, by *Plasmodium* species and area of acquisition — United States, 1996

Area of acquisition	*Plasmodium* species						Total
	P. vivax	*P. falciparum*	*P. malariae*	*P. ovale*	Unknown	Mixed	
Indonesia	12	8	0	0	1	0	**21**
Iran	1	0	0	0	0	0	**1**
Iraq	1	0	0	0	0	0	**1**
Korea	1	0	0	0	0	0	**1**
Laos	1	3	0	0	0	0	**4**
Middle East	1	0	0	0	0	0	**1**
Myanmar	0	1	0	0	0	0	**1**
Nepal	1	0	0	0	0	0	**1**
Pakistan	33	4	3	0	3	0	**43**
Philippines	2	2	0	1	0	0	**5**
Thailand	0	2	0	0	0	0	**2**
Viet Nam	0	1	1	0	1	1	**4**
Yemen	2	1	0	0	0	0	**3**
Asia, Unspecified	11	1	0	0	0	0	**12**
Southeast Asia, Unspecified	3	0	0	0	0	0	**3**
CENTRAL AMERICA AND CARIBBEAN	112	30	9	0	16	0	**217**
Belize	8	0	0	0	1	0	**9**
Costa Rica	5	2	0	0	0	0	**7**
Dominican Republic	1	0	0	0	0	0	**1**
El Salvador	5	0	0	0	0	0	**5**
Guatemala	16	1	2	0	1	0	**20**
Haiti	4	17	1	0	4	0	**26**
Honduras	77	4	5	0	6	0	**92**
Nicaragua	24	4	1	0	2	0	**31**
Panama	0	0	0	0	1	0	**1**
Central America, Unspecified	21	2	0	0	1	0	**24**
Caribbean, Unspecified	1	0	0	0	0	0	**1**
NORTH AMERICA	26	2	1	1	0	0	**30**
United States	8	2	0	1	0	0	**11**
Mexico	18	0	1	0	0	0	**19**
SOUTH AMERICA	22	4	1	0	2	1	**30**
Bolivia	1	0	0	0	0	0	**1**
Brazil	0	1	0	0	0	0	**1**
Colombia	0	0	0	0	1	0	**1**
Ecuador	3	0	0	0	1	0	**4**
French Guiana	0	1	0	0	0	0	**1**
Guyana	5	1	0	0	0	1	**7**
Peru	10	0	1	0	0	0	**11**
Surinam	1	1	0	0	0	0	**2**
South America, Unspecified	2	0	0	0	0	0	**2**
America, Unspecified	1	0	0	0	0	0	1
OCEANIA	31	2	3	0	7	0	**43**
Papua New Guinea	27	2	3	0	7	0	**39**
Solomon Islands	2	0	0	0	0	0	**2**
Oceania, Unspecified	2	0	0	0	0	0	**2**
Unknown	24	7	2	0	11	0	**44**
Total	**660**	**521**	**75**	**28**	**104**	**4**	**1,392**

FIGURE 2. Number of malaria cases,* by state in which the disease was diagnosed — United States, 1996

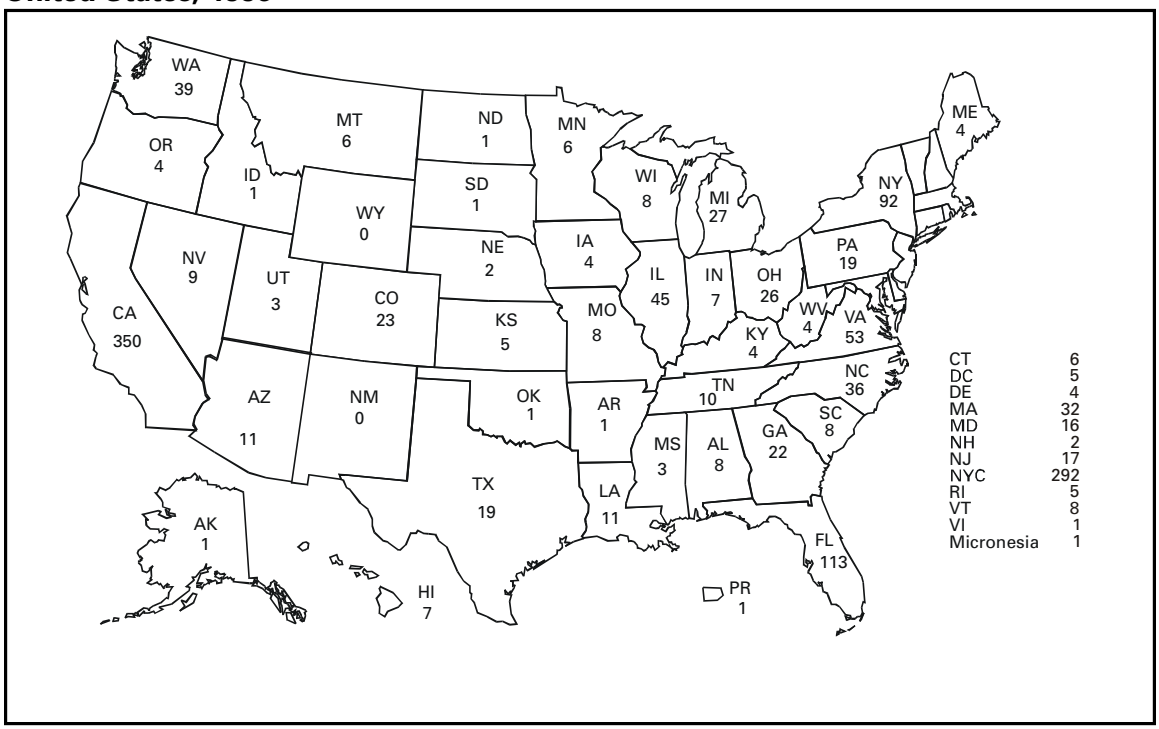


TABLE 4. Number of imported malaria cases, by *Plasmodium* species and by interval between date of arrival in the country and onset of illness — United States, 1996

Interval	*Plasmodium* species										Total	
	P. vivax		*P. falciparum*		*P. malariae*		*P. ovale*		Mixed			
(days)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
<0*	21	(4.0)	40	(9.2)	3	(5.2)	1	(5.5)	0	(0.0)	**65**	**(6.3)**
0–29	144	(27.8)	349	(80.0)	19	(32.8)	1	(5.5)	1	(33.3)	**514**	**(49.8)**
30–89	90	(17.4)	32	(7.3)	9	(15.5)	2	(11.1)	2	(66.7)	**135**	**(13.1)**
90–179	101	(19.5)	9	(2.1)	11	(18.9)	5	(27.8)	0	(0.0)	**126**	**(12.2)**
180–364	128	(24.7)	5	(1.2)	14	(24.1)	7	(39.0)	0	(0.0)	**154**	**(14.9)**
≥365	34	(6.6)	1	(0.2)	2	(3.5)	2	(11.1)	0	(0.0)	**39**	**(3.7)**
Total	**518**	**(100.0)**	**436**	**(100.0)**	**58**	**(100.0)**	**18**	**(100.0)**	**3**	**(100.0)**	**1,033**	**(100.0)**

* Case-patients had onset of illness before arriving in the United States.

Imported Malaria Cases

Imported Malaria in Military Personnel

Thirty-two cases of imported malaria in U.S. military personnel were reported for 1996. Eight of these cases occurred in personnel of the U.S. Army; seven cases, U.S. Air Force; three cases, U.S. Marine Corps; and three cases, U.S. Navy. In 11 cases, the branch of the military was unknown. Of the 28 case-patients for whom information on use of chemoprophylaxis was available, eight persons did not use any chemoprophylaxis.

Imported Malaria in Civilians

A total of 1,249 imported malaria cases were reported among civilians. Of these, 614 (49.2%) cases occurred among U.S. residents, and 635 (50.8%) occurred among residents of other countries (Table 5). Of the 614 imported malaria cases in U.S. civilians, 282 (45.9%) had been acquired in Africa, approximately the same number reported in 1995. The Central American and Caribbean region accounted for 109 (17.8%) cases of imported malaria in U.S. civilians, whereas travel to the Indian subcontinent accounted for an additional 97 (15.8%) cases. Of the 635 imported cases among foreign civilians, most cases were acquired in either Africa (n=257; 40.5%) or the Indian subcontinent (n=255; 40.2%).

Use of Antimalarial Chemoprophylaxis

Use of Chemoprophylaxis Among U.S. Civilians. Information concerning the use of chemoprophylaxis was known for 559 (91.0%) of the 614 U.S. civilians who had imported malaria. Of these 559 persons, 313 (56.0%) had not taken any chemoprophylaxis, and 149 (26.7%) had not taken a drug recommended by CDC for the area visited. Only 97 (17.3%) U.S. civilians had taken a medication recommended by CDC (*9*). Seventy-five of these patients had taken mefloquine weekly; 10 had taken doxycycline daily; and 12 who had traveled only in areas where chloroquine-resistant malaria has not been documented had taken chloroquine weekly. Of the 149 patients taking a nonrecommended drug, information on the type of chemoprophylaxis used was known for 112. Of these 112 persons, 63 (56.3%) reported taking chloroquine during travel to an area where chloroquine resistance had been documented.

Malaria Infection After Use of Recommended Prophylaxis. A total of 111 patients (97 U.S. civilians, five persons in the U.S. military, four foreigners, and five persons with missing information) developed malaria after taking a recommended antimalarial drug. Although the length of time before symptom onset for all 111 cases was determined, the infecting species could not be determined for nine cases.

TABLE 5. Number of imported malaria cases in U.S. and foreign civilians, by region of acquisition — United States, 1996

Region of acquisition	U.S. civilians		Foreign civilians		Total	
	No.	(%)	No.	(%)	No.	(%)
Africa	282	(45.9)	257	(40.5)	**539**	**(43.2)**
America, Unknown*	1	(0.2)	—	—	**1**	**(0.1)**
Asia, Unknown*	9	(1.5)	2	(0.3)	**11**	**(0.8)**
Central America/ Caribbean	109	(17.8)	98	(15.4)	**207**	**(16.6)**
China	1	(0.2)	0	(0.0)	**1**	**(0.1)**
Middle East	2	(0.3)	3	(0.5)	**5**	**(0.4)**
Oceania	37	(6.0)	2	(0.3)	**39**	**(3.1)**
South East Asia	33	(5.4)	6	(0.9)	**39**	**(3.1)**
South America	21	(3.4)	8	(1.3)	**29**	**(2.3)**
Indian subcontinent	97	(15.8)	255	(40.2)	**352**	**(28.2)**
Unknown†	22	(3.5)	4	(0.6)	**26**	**(2.1)**
Total	**614**	**(100.0)**	**635**	**(100.0)**	**1,249**	**(100.0)**

* Country unknown.
† Region of acquisition unknown.

***Cases of* P. vivax *or* P. ovale.** Of the 111 patients who developed malaria after using recommended chemoprophylaxis, 72 cases (64.9%) were caused by *P. vivax* (n=66) or *P. ovale* (n=6). Malaria case surveillance reports indicated that 10 (13.9%) of these patients were noncompliant with their antimalarials. Fifty-three (73.6%) cases of *P. vivax or P. ovale* occurred >45 days after the case-patients arrived in the United States. These cases were consistent with relapsing infections and, thus, do not indicate prophylaxis failures.

Because of insufficient information regarding 12 cases of *P. vivax* malaria, it could not be determined whether these cases were relapsing infections. Onset of symptoms in these cases began before the persons returned to the United States.

Seven cases of *P. vivax* occurred within 45 days after the patient returned to the United States. Of these case-patients, none was among the 10 who were known to be noncompliant with the antimalarial chemoprophylaxis. Region of acquisition varied widely for these seven cases (one from Central America, one from South America, one from India, two from Oceania, one from Southeast Asia, and one from Africa), and serum drug levels could not be checked for any of these patients because blood samples were not available. The most likely explanations for these cases are either inappropriate dosing or noncompliance. No evidence existed that would indicate the emergence of a new area of chloroquine-resistant *P. vivax*.

The remaining 39 cases of malaria reported among persons who had taken a recommended antimalarial drug for chemoprophylaxis included 26 cases of *P. falciparum*, 4 cases of *P. malariae,* and 9 cases in which the infecting species was not identified.

***Cases of* P. falciparum.** Twenty-three of the 26 *P. falciparum* cases were acquired in Africa, whereas the other three cases were acquired in Asia. In 13 (50.0%) of the case-patients, noncompliance with recommended antimalarials was reported.

The remaining 13 cases of *P. falciparum* that were acquired while the patient was reported to have used appropriate chemoprophylaxis varied in region of acquisition. Ten were acquired in Africa (seven in West Africa, two in East Africa, and one in southern Africa), whereas the other three were acquired in Asia (one each in Thailand, India, and Indonesia). Serum drug levels of the antimalarials were unavailable for these patients. The most likely explanations for these cases are either inappropriate dosing or noncompliance.

Purpose of Travel. The purpose of travel to malarious areas was reported for 325 (52.9%) of the 614 U.S. civilians with imported malaria (Table 6). Of the cases among U.S. civilians, the largest percentage (13.8%) traveled to teach or study, and the second and third largest (11.7% and 9.6%) traveled to visit a friend or relative or to do missionary work.

Malaria Acquired in the United States

Congenital Malaria

Three cases of congenital malaria were reported in 1996.

Case 1. On November 30, 1996, a full-term male infant was delivered by spontaneous vaginal delivery in Washington, D.C. His mother had immigrated to the United States from Nicaragua 2 months before delivery. She reported beginning malaria chemoprophylaxis in Nicaragua when she was 5 months pregnant but had stopped taking the medication after arriving in the United States. When she was 8 months pregnant, she had

TABLE 6. Number of imported malaria cases in U.S. civilians, by purpose of travel at the time of acquisition — United States, 1996

Category	Imported cases	
	No.	(%)
Unknown	280	(45.6)
Teacher/Student	85	(13.8)
Visitor of a friend or relative	72	(11.7)
Tourist	50	(8.1)
Missionary	59	(9.6)
Business representative	39	(6.4)
Peace Corps worker	12	(1.9)
Sailor/Air crew	4	(0.7)
Refugee	4	(0.7)
Other	9	(1.5)
Total	**614**	**(100.0)**

been hospitalized with fever and was diagnosed and treated for malaria. The species was reported as "most likely *P. vivax"*; the therapy she received was not known. On the day before delivery, she was diagnosed with *P. falciparum* malaria and was treated with chloroquine after delivery.

On December 8, 1996, the infant was hospitalized because of a 1-day history of fever, vomiting, lethargy, and refusal to feed. His physical examination and laboratory tests (cerebrospinal fluid analysis, white blood cell count, hemoglobin, and blood and urine cultures) were normal. The infant received no antimicrobial therapy and was discharged after 24 hours with a diagnosis of viral gastroenteritis.

On December 16, the infant was readmitted with a persistent fever of 101 F (38 C) and splenomegaly. His peripheral blood smears demonstrated the presence of *P. falciparum* rings (parasitemia <0.5%). He rapidly defervescenced after chloroquine therapy was initiated.

Case 2. A female infant was born in October 1996 in California. Her mother had traveled to Mexico for 2 weeks when she was 8 months pregnant and had not used malaria chemoprophylaxis during her travel. While in Mexico, she had been diagnosed and treated for malaria, but the species and therapy received were not known nor was it known if she received further evaluation or treatment after her return to the United States.

On December 5, 1996, the infant, aged 7 weeks, was hospitalized with a 1-week history of fever. Her blood smears demonstrated *P. vivax* malaria; evaluation of the mother's blood smears revealed *Plasmodium* parasites of an undetermined species, although she was asymptomatic. The baby was treated successfully with mefloquine; the therapy received by the mother was not known.

Case 3. In December 1995, a full-term female infant was delivered by spontaneous vaginal delivery in New York City. The mother had immigrated to the United States from India when she was 7 months pregnant. She had not had a malaria-like illness during her pregnancy and reported that her last episode of malaria-like symptoms, which remitted without treatment, had been 2 years earlier.

On January 24, 1996, the infant, aged 1 month, was hospitalized with a 1-day history of fever and chills. Examination of her blood smears indicated *P. vivax*. She responded well to chloroquine therapy. The mother's blood smears did not demonstrate malaria parasites, and she was discharged without treatment. Upon receiving the surveillance report of this case, CDC contacted the hospital to advise that the mother should receive treatment, but she could not be contacted.

Cryptic Malaria

Four cases of cryptic malaria were reported in 1996.

Case 1. On July 22, 1996, a man aged 40 years who was homeless and unemployed was admitted to a hospital with a 1-week history of fever, vomiting, and headache. The patient lived in Florida. CDC confirmed the presence of *P. vivax* (parasitemia <1%) in his blood smears. He recovered after treatment with quinine and sulfadoxine-pyrimethamine.

The patient had never traveled outside of the United States; in the previous 3 years, his only travel had been to New York and Georgia. Although he had a history of intravenous heroin use 20 years earlier, he had no recent history of parenteral drug use nor did the examining physician find any evidence of drug abuse. The patient had never received blood or blood products.

Case 2. On July 30, 1996, a man aged 45 years who lived in Florida was admitted to a hospital with a 4-day history of fever. CDC confirmed the diagnosis of *P. vivax* parasitemia. The patient was treated successfully with chloroquine and primaquine.

The patient, who was homeless, was employed as a house painter. He lived approximately 1 mile away from Case 1. He had never traveled outside of Florida and had no other known risk factors for malaria.

The local and state health departments, with assistance from CDC, conducted an investigation to determine a potential source of infection for both cases. An entomologic assessment of the areas where both patients lived was conducted. Breeding sites and adult *Anopheles* mosquitoes were found near the first patient's shelter. Epidemiologic investigation did not reveal other cases of malaria in the vicinity of the two cases. Although both cases were presumed to have been locally acquired mosquitoborne infections, they were classified as cryptic cases because a source of infection could not be identified.

Case 3. On May 22, 1996, a man aged 53 years was hospitalized in Georgia with a 12-day history of fever, chills, fatigue, and myalgias. CDC confirmed the diagnosis of *P. vivax* parasites in his blood smears. He was treated successfully with chloroquine and primaquine.

The patient was born on the Texas-Mexico border, more than 500 miles from the nearest malarious area in Mexico. He was a farmworker in southwest Georgia and had lived in the United States for more than 10 years. He had returned to Mexico once (in August 1993) since emigration, where he traveled no further than 70 miles from the Texas border, which is more than 400 miles away from the malarious areas in Mexico. The patient reported never having had a blood transfusion or having used parenteral drugs. He said that during May and June 1996, he had spent nights at a mobile-home park and at a small encampment of trailers contiguous to the farm.

The state health department conducted an investigation to determine a potential source of the patient's infection. *Anopheles quadrimaculatus* larvae and adults were found in the vicinity of the two sites where the patient had spent nights around the time

of his illness. The epidemiologic investigation indicated that large populations of migrant laborers from malarious areas of Mexico and Central America worked in the area where the patient acquired his infection. However, because a source of infection could not be identified, the case was classified as cryptic.

Case 4. On April 28, 1996, a man aged 65 years was evaluated at a hospital in Georgia; he had a 6-day history of fever. CDC confirmed the diagnosis of *P. vivax* parasitemia in his blood smears. He responded well to treatment with chloroquine and primaquine.

The patient had no history of recent travel outside of the United States, transfusion with blood or blood products, or parenteral drug use. However, he did work as an entomologist in a laboratory where he routinely handled infected *anopheline* mosquitoes, and before his infection, he had been working with *A. stephensi* that were infected with a strain of *P. vivax* from Thailand. He reported having been bitten by several mosquitos in the laboratory. He had no previous history of malaria. Although this infection was believed to have been acquired through mosquitoborne transmission in the laboratory, it was classified as cryptic because it could not be linked epidemiologically to other cases.

Induced Malaria

Four cases of induced malaria were reported in 1996: one acquired by organ transplantation; one by blood transfusion; and two nosocomial infections acquired through infusions using a heparin lock.

Case 1. A woman aged 33 years who had immigrated to New York City from Nigeria in 1991 developed end-stage renal disease of unknown etiology. On November 29, 1996, she underwent a renal transplant; the patient did not receive blood or blood products at the time of the transplant. On December 14, she developed fever. Intraerythrocytic organisms, initially identified as *P. falciparum,* were identified on blood smears. Microscopic examination at CDC identified the species as *P. ovale*. She responded well to treatment with chloroquine and primaquine.

The patient reported having had malaria during her childhood in Nigeria but had not traveled out of the United States since emigrating. She had never had a blood transfusion or used intravenous drugs.

The kidney donor was the patient's brother, who had come directly from Nigeria. At the time of his arrival in the United States, he reportedly was not feeling well, but the nature of his illness was unknown. He had not been evaluated for malaria before the kidney donation, and it was not known whether he was tested after his sister was diagnosed.

Case 2. A man aged 70 years who had Waldenström macroglobulinemia was hospitalized in Missouri on November 27, 1996; he had a 2-day history of fever. Peripheral blood smears showed intraerythrocytic parasites suspected to be either *Plasmodium* or *Babesia*. Despite treatment with oral quinine and clindamycin, the patient developed respiratory and renal failure and died on November 30. The patient had not traveled outside of the United States since the 1940s but had been transfused with seven units of packed red blood cells in 1996 (two in May, two in June, and three in November).

The presence of *P. falciparum* parasites in the patient's blood smears (6% parasitemia) was confirmed at CDC. Stored sera from all seven donors were tested for antimalarial antibodies at CDC using the indirect fluorescent antibody (IFA) test. One of the November donors, an Army reservist (at a basic training installation) whose blood was collected by a civilian blood center, had elevated titers of 1:16,384 to *P. falciparum*; 1:256 to both

P. malariae and *P. ovale;* and 1:64 to *P. vivax*. Blood smears obtained from this donor in March 1997 revealed rare *P. falciparum* rings, and DNA of the same species was detected by polymerase chain reaction of the whole blood. The donor reported no febrile illness around the time of the blood donation. He had immigrated to the United States from Nigeria in April 1996. He was treated with oral quinine and doxycycline.

Case 3. On February 11, 1996, a man aged 84 years who had multiple medical problems, including congestive heart failure, syncope, and bradycardia was admitted to a hospital in Florida with a 12-day history of fever and chills. *P. vivax* parasites were identified on blood films that had been obtained for a complete blood count (CBC) on admission. Microscopic diagnosis was confirmed at CDC. He responded well to treatment with chloroquine.

The patient's most recent travel outside of the United States was approximately 15 years previously on a cruise ship to the Bahamas. He had no other risk factors for malaria. However, during January 22–24, he had been hospitalized for bradycardia and had been placed in a room adjacent to a patient with imported *P. vivax* malaria acquired in Bolivia. During his hospitalization, he had four venipunctures, and intravenous medications were administered through a heparin lock.

Case 4. On January 20, 1996, a woman with chronic obstructive pulmonary disease was admitted to the same hospital in Florida as Case 3. The patient, aged 60 years, was admitted with respiratory congestion and shortness of breath. She had a fever of 101 F (38 C) on admission but was subsequently afebrile throughout her hospitalization. In addition, during her hospitalization, she had multiple venipunctures and was administered intravenous drugs through a heparin lock. The patient improved and was discharged on January 26.

On February 12, she was readmitted with a 2-day history of fever and chills. CDC confirmed the diagnosis of *P. vivax* parasites on blood films that had been obtained for CBC on admission. She was treated successfully with chloroquine.

The patient had no risk factors for malaria, but during her initial hospitalization during January 20–26, she had also stayed in a room adjacent to the patient with imported *P. vivax* malaria from Bolivia (as had the patient in Case 3).

The local health department, assisted by the state, conducted an epidemiologic investigation of Cases 3 and 4 to determine the source of the infections. None of the health-care workers at the hospital had been ill with malaria-like symptoms. The room of the patient with imported malaria was between the rooms where the other two patients stayed. The windows in these rooms had screens, and the windows were never opened. Intravenous drugs were administered by the same health-care worker to all three patients via an intravenous line for the index case-patient and via heparin locks for the other two case-patients. Hospital workers routinely used 10 cc vials of heparinized solution to flush heparin locks and occasionally used the same vial for two or more patients. Although this practice could not be directly linked to the three cases, it seemed the most plausible explanation for their infections. After the investigation, the hospital routinely began using single-dose vials for flushing intravenous devices.

Deaths Attributed to Malaria

Five deaths attributed to malaria were reported in 1996.

Case 1. On January 26, 1996, a woman aged 53 years who had emigrated from Somalia on January 25 was evaluated at a hospital emergency room in California because of fever. She was discharged with a diagnosis of a viral syndrome; information

regarding whether she received any treatment was unknown. When she returned to the hospital 4 days later, she was semicomatose, had acute renal failure, and respiratory distress. Blood smears taken on the day of her emergency room visit 4 days earlier were examined; *P. falciparum* ring forms (15% parasitemia) were found. Intravenous quinidine and exchange transfusion were initiated. Although parasitemia cleared and her renal function improved, she never regained consciousness and died on February 8.

Case 2. On March 31, 1996, a male pilot aged 57 years was admitted to a hospital in Florida 1 week after having returned from a trip to several countries in sub-Saharan Africa (Kenya, South Africa, and Nigeria). The patient had used no malaria chemoprophylaxis during his travels. His family reported that he had a 5-day history of fever, lethargy, and jaundice. On admission, he was comatose, had generalized seizures, hemolytic anemia, metabolic acidosis, acute renal failure, hypotension, and hypoglycemia. CDC confirmed the diagnosis of *P. falciparum* parasites in his blood smears. Therapy was initiated with intravenous quinidine; preparations were being made for exchange blood transfusion when he died 1 day after admission.

Case 3. On August 25, 1996, a boy aged 10 years who had emigrated from Guinea, West Africa, 8 days previously was evaluated in an emergency room of a hospital in New York City because of a 2-day history of fever, chills, headache, and generalized seizures. On examination, he was found to have hemolytic anemia and altered mental status. CDC confirmed the diagnosis of *P. falciparum* rings in his blood smears. He died in the emergency room before therapy could be initiated.

Case 4. On October 21, 1996, a woman aged 32 years was admitted to a hospital in New York City. Her complaints and the findings of her physical examination on admission were unknown. Her blood smears revealed *P. falciparum* parasites. Attempts to obtain information related to her therapy and the succession of events leading to her death were unsuccessful because her hospital record remains closed because of litigation.

Case 5. Case 2, an induced case described previously, was a fatal case that was induced through blood transfusion at a hospital in Missouri.

DISCUSSION

A total of 1,392 cases of malaria were reported to CDC for 1996, representing a 19.3% increase from the 1,167 cases reported for 1995. This increase primarily resulted from an increase in cases acquired in Africa and Asia that might have resulted from improved reporting, increased international travel, changing patterns of travel (i.e., emigration from malarious areas or "adventure tourism"), or a decreased use of effective antimalarial chemoprophylaxis.

Some limitations of the matching process used for the comparison of NMSS and NNDSS included

- differences in completeness and accuracy of disease reporting across the systems because of different disease reporting mechanisms and data collection schemes;
- inconsistencies in the way demographic data and the date associated with the case were reported by the two systems;
- existence of a substantial amount of missing data on demographic variables that limited the accuracy of the matching process; and
- limited number of variables available for the matching process.

Despite these limitations, the comparison demonstrated that substantial numbers of cases are not being captured by one or both systems. More cases are being reported to NNDSS; one contributing factor appears to be that some state health departments only report to NNDSS and not to NMSS. The NNDSS and NMSS surveillance systems are currently assessing the feasibility of developing an integrated approach for electronically reporting malaria case data from the states and territories to CDC. The objectives of this effort are to decrease reporting burden in the states, streamline reporting of data to CDC, and achieve more consistency in the format of data reported to CDC.

One reason for conducting malaria surveillance is to monitor the emergence of drug resistance and the consequent failure of chemoprophylaxis; however, more than 80% of imported malaria cases among U.S. civilians occurred in persons who were either not taking or taking nonrecommended prophylaxis for the region to which they were traveling. Of the 111 persons who reported taking adequate prophylaxis, for 24 cases (i.e., seven *P. vivax,* 13 *P. falciparum*, and four *P. malariae)* sufficient information was not available to determine whether they represented problems with compliance while using proper antimalarial chemoprophylaxis, reporting errors, or emerging drug resistance. However, no conclusive evidence existed to suggest a single national or regional source of infection among this group of patients. Health-care providers are encouraged to contact CDC if they suspect chemoprophylaxis failure, thus enabling measurement of serum drug levels of the antimalarial drug in question.

The importance of taking proper precautions and chemoprophylaxis is underscored by the five fatal cases of malaria that occurred in the United States in 1996, including one case in a U.S. civilian who was not on prophylaxis during his exposure in malarious areas. An earlier review of deaths attributed to malaria in the United States identified several risk factors for fatal malaria, including a) failure to take recommended antimalarial chemoprophylaxis, b) refusal to or delay in seeking medical care, and c) misdiagnosis (*10*).

Signs and symptoms of malaria might be vague, but fever is generally present. Other symptoms include headache, chills, increased sweating, back pain, myalgia, diarrhea, nausea, vomiting, and cough. Prompt diagnosis requires that malaria be included in the differential diagnosis of illness in a febrile person with a recent history of travel to a malarious area. Clinicians should ask febrile patients for a travel history, particularly when evaluating febrile illnesses in international visitors, immigrants, refugees, migrant laborers, and international travelers.

Treatment for malaria should be initiated immediately after the diagnosis has been confirmed by a positive blood smear. Treatment should be determined on the basis of the infecting *Plasmodium* species, the probable geographic origin of the parasite, the parasite density, and the patient's clinical status (*11*). Although non-*falciparum* malaria rarely causes severe complications, *P. falciparum* malaria can cause severe, life-threatening complications.

Health-care workers are encouraged to consult appropriate sources for malaria treatment recommendations or to contact CDC's National Center for Infectious Diseases, Division of Parasitic Diseases, Malaria Epidemiology Branch (Box).

BOX. CDC sources for malaria prophylaxis and treatment recommendations

Type of information	Source	Time available	Phone number
Prophylaxis	CDC Travelers' Health Hotline	24 hours per day, 7 days per week	(877) 394-8747
Prophylaxis	CDC Travelers' Health Fax	24 hours per day, 7 days per week	(888) 232-3299
Prophylaxis	*Health Information for International Travel*	Mail to Superintendent of Documents U.S. Government Printing Office Washington, DC 20402-9235	(202) 512-1800
Treatment	CDC Malaria Epidemiology Branch	8:00 am to 4:30 pm Monday through Friday	(770) 488-7788*
Treatment†	CDC Malaria Epidemiology Branch	4:30 pm to 8:00 am Monday through Friday 24 hours per day, after hours, weekends, and federal holidays	(404) 639-2888* (Ask operator to page person on call for malaria section.)

* Phone number is intended for use by health-care professionals only.

† To obtain confirmation diagnosis of blood smears from questionable cases and to obtain appropriate treatment recommendations, contact either your state or local health department or CDC's National Center for Infectious Diseases, Division of Parasitic Diseases, Malaria Epidemiology Branch; telephone (770) 488-7788.

Acknowledgment

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APPENDIX

Microscopic Procedures for Diagnosing Malaria

To establish the diagnosis of malaria, a blood smear must be prepared from fresh blood obtained by pricking the finger (Figures A-1 and A-2).* The thin smear is fixed in methanol before staining; the thick smear is stained unfixed. Many hospitals have a Wright-Giemsa stain available, which is acceptable; however, Wright stain alone will not reliably stain *Plasmodium* parasites. For best results, the smear should be stained with a 3% Giemsa solution (pH of 7.2) for 30–45 minutes. In *P. falciparum* infections, the parasite density should be estimated by counting the percentage of red blood cells infected — not the number of parasites — under an oil immersion lens on a thin film.

Thick blood smears are more sensitive in detecting malaria parasites because the blood is concentrated, allowing a greater volume of blood to be examined. However,

*In Figures A-1 and A-2, the hands are shown ungloved to better illustrate their placement during the procedures. However, wearing gloves while processing blood specimens is recommended to prevent transmission of bloodborne pathogens (*MMWR* 1988;37:377–82, 387–8 and *MMWR* 1987;36[No. S2]).

FIGURE A-1. Blood collection for thin or thick blood film

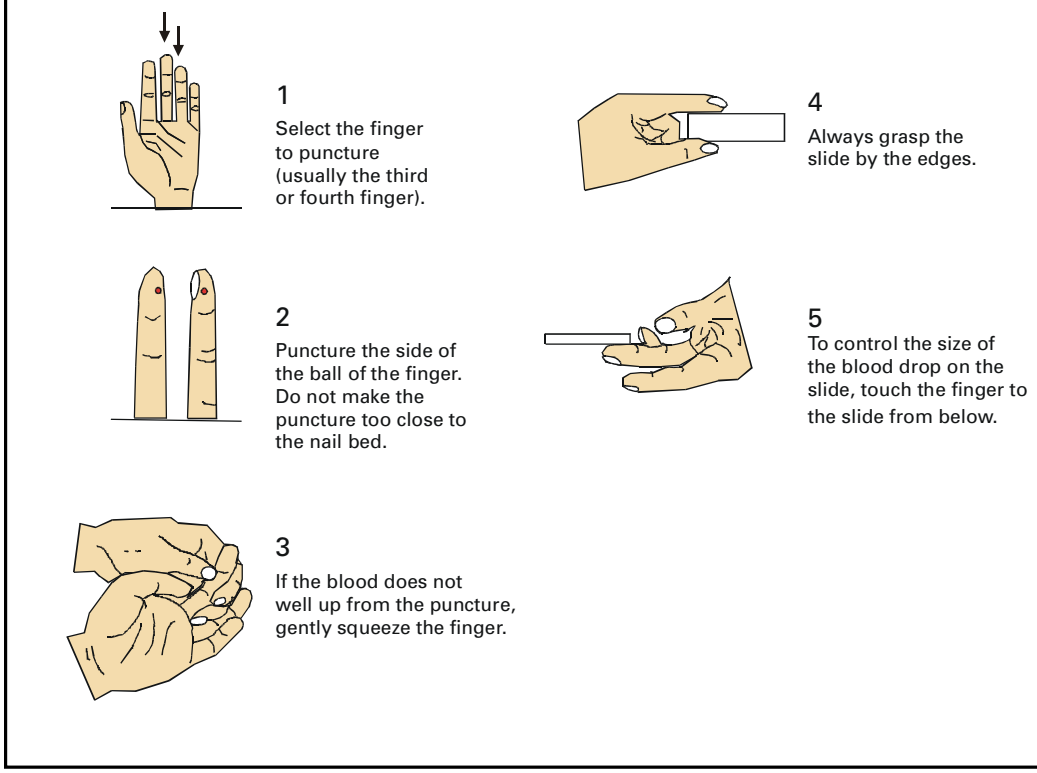
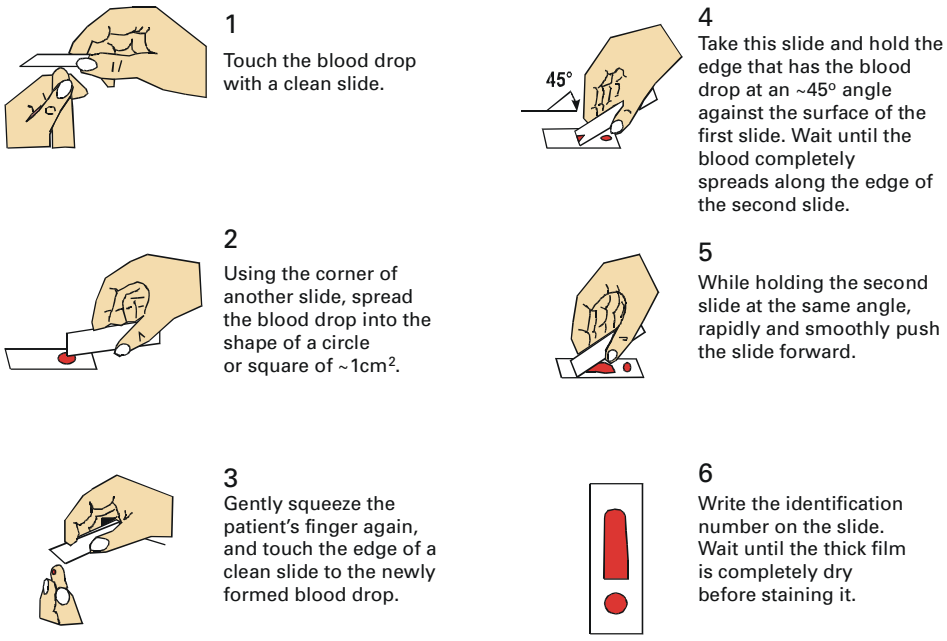


FIGURE A-2. Preparation of a thin and thick blood film on the same slide



thick smears are more difficult to read, and thin smears might be preferred by laboratories that have limited experience. *Plasmodium* parasites are always intracellular, and they demonstrate, if stained correctly, blue cytoplasm with a red chromatin dot. Common errors in reading malaria smears are caused by platelets overlying a red blood cell, concern about missing a positive slide, and misreading artifacts as parasites. Persons suspected of having malaria but whose blood smears do not show the presence of parasites should have blood smears repeated approximately every 12–24 hours for 3 consecutive days. If smears remain negative, then the diagnosis of malaria is unlikely.

For rapid diagnosis, make the thick and thin smears on separate slides. Air dry the thin film, fix it with methyl alcohol, and immediately stain it. If no parasites are found on the thin film, wait until the thick film is dry, and examine it for organisms that might not have been detected on the thin preparation.

Malaria Surveillance — United States, 1997

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Abstract

Problem/Condition: Malaria is caused by four species of intraerythrocytic protozoa of the genus *Plasmodium* (i.e., *P. falciparum*, *P. vivax*, *P. ovale*, or *P. malariae*), which are transmitted by the bite of an infective female *Anopheles* sp. mosquito. Most malaria infections in the United States occur in persons who have traveled to areas with ongoing transmission. Occasionally, cases occur in the United States through exposure to infected blood products, by congenital transmission, or by local mosquitoborne transmission. Malaria surveillance is conducted to identify episodes of local transmission and to guide prevention recommendations for travelers.

Reporting Period Covered: Cases with onset of illness during 1997.

Description of System: Malaria cases confirmed by blood smears are reported to local and/or state health departments by health-care providers and/or laboratory staff. Case investigations are conducted by local and/or state health departments, and reports are transmitted to CDC through the National Malaria Surveillance System (NMSS). Data from NMSS serve as the basis for this report.

Results: CDC received reports of 1,544 cases of malaria with onset of symptoms during 1997 among persons in the United States or one of its territories. This number represents an increase of 10.9% from the 1,392 cases reported for 1996. *P. vivax*, *P. falciparum*, *P. malariae*, and *P. ovale* were identified in 48.9%, 36.7%, 3.1%, and 2.0% of cases, respectively. More than one species was present in nine patients (0.6% of total). The infecting species was not determined in 134 (8.7%) cases.

The number of reported malaria cases acquired in Africa increased by 38.0% (n=697) compared with 1996, and cases acquired in Asia increased by 12.9% (n=499) compared with 1996. Cases acquired in the Americas decreased by 9.3% (n=245) compared with 1996. Of 695 U.S. civilians who acquired malaria abroad, 144 (20.7%) reported that they had followed a chemoprophylactic drug regimen recommended by CDC for the area where they had traveled.

Five patients became infected in the United States. Three of these cases were congenitally acquired; one was acquired by a blood transfusion; and one was acquired by a needle stick. Six deaths were attributed to malaria.

Interpretation: The 10.9% increase in malaria cases in 1997 compared with 1996 resulted from increases in cases acquired in Africa and Asia. This increase could have

resulted from local changes in disease transmission, increased travel to these regions, improved reporting from state and local health departments, or a decreased use of effective antimalarial chemoprophylaxis. In most reported cases, U.S. civilians who acquired infection abroad were not on an appropriate chemoprophylaxis regimen for the country where they acquired malaria.

Public Health Actions: Additional information was obtained concerning the six fatal cases and the five infections acquired in the United States.

Persons traveling to a malarious area should take the recommended chemoprophylaxis regimen and use personal protection measures to prevent mosquito bites. Any person who has been to a malarious area and who subsequently develops a fever or influenza-like symptoms should seek medical care immediately; investigation should include a blood smear for malaria. Malaria infections can be fatal if not diagnosed and treated promptly. Recommendations concerning prevention and treatment of malaria can be obtained from CDC.

INTRODUCTION

Malaria is caused by infection with one or more of four species of *Plasmodium* (i.e., *P. falciparum*, *P. vivax*, *P. ovale*, and *P. malariae*) that infect humans. The infection is transmitted by the bite of an infective female *Anopheles* sp. mosquito. Malaria infection remains a devastating global problem, with an estimated 300–500 million cases occurring annually. Forty-one percent of the world's population lives in areas where malaria is transmitted (i.e., parts of Africa, Asia, Central America and South America, Hispaniola, the Middle East, and Oceania), and approximately 1.5–2.7 million persons die of malaria each year (*1*). In previous years, malaria was endemic throughout much of the continental United States; an estimated 600,000 cases occurred during 1914 (*2*). During the late 1940s, a combination of improved socioeconomic conditions, water management, vector-control efforts, and case management was successful at interrupting malaria transmission in the United States. Since then, malaria case surveillance has been maintained to detect locally acquired cases that could indicate the reintroduction of transmission and to monitor patterns of antimalarial drug resistance seen among U.S. travelers.

Through 1997, most cases of malaria diagnosed in the United States have been imported from regions of the world where malaria transmission is known to occur. Each year, several congenital infections and infections resulting from exposure to blood or blood products are reported in the United States. In addition, a few cases are reported that might have been acquired through local mosquitoborne transmission (*3*).

State and/or local health departments and CDC thoroughly investigate all malaria cases acquired in the United States, and CDC conducts an analysis of all imported cases to detect trends in acquisition. This information has been used to guide malaria prevention recommendations for travelers abroad. For example, an increase in *P. falciparum* malaria among U.S. travelers to Africa, an area with increasing chloroquine-resistance, prompted CDC to change the recommended chemoprophylaxis from chloroquine to mefloquine in 1990 (*4*).

The signs and symptoms of malaria illness are variable, but most patients have fever. Other common symptoms include headache, back pain, chills, increased sweating, myalgia, nausea, vomiting, diarrhea, and cough. The diagnosis of malaria should be considered for any person who has any of these symptoms and has traveled to an area with

known malaria transmission. Malaria should also be considered in the differential diagnosis when persons have a fever of unknown origin, regardless of their travel history. Untreated *P. falciparum* infections can rapidly progress to coma, renal failure, pulmonary edema, and death. Asymptomatic parasitemia can occur among persons who have been long-term residents of malarious areas. This report summarizes malaria cases reported to CDC with onset of symptoms in 1997.

METHODS

Sources of Data

Data regarding malaria cases are reported to both the National Malaria Surveillance System (NMSS) and the National Notifiable Diseases Surveillance System (NNDSS) (*5*). Although both systems rely on passive reporting, the numbers of reported cases might differ because of differences in the collection and transmission of data. A major difference in the data collected in these two systems is that NMSS receives more detailed clinical and epidemiologic data regarding each case (e.g., information concerning the area where the infected person has traveled). Cases of blood-smear–confirmed malaria are identified by health-care providers and/or laboratories. Each slide-confirmed case is reported to local and/or state health departments and to CDC on a uniform case report form that contains clinical, laboratory, and epidemiologic information. CDC staff review all report forms at the time of receipt and request additional information if necessary (e.g., when no recent travel to a malarious country is reported). Reports of other cases are telephoned directly by health-care providers to CDC, usually when assistance with diagnosis or treatment is requested. All cases that have been acquired in the United States are investigated, including all induced and congenital cases and possible introduced or cryptic cases. Information derived from uniform case report forms is entered into a database and analyzed annually.

Definition of Terms

The following definitions are used in this report:

- ***Laboratory criteria for diagnosis:*** Demonstration of malaria parasites in blood films.
- ***Confirmed case:*** Symptomatic or asymptomatic infection that occurs in the United States in a person who has microscopically confirmed malaria parasitemia, regardless of whether the person had previous attacks of malaria while in other countries. A subsequent attack of malaria is counted as an additional case if the demonstrated *Plasmodium* species differs from the initially identified species. A subsequent attack of malaria occurring in a person while in the United States could indicate a relapsing infection or treatment failure resulting from drug resistance if the demonstrated *Plasmodium* species is the same species identified previously.

This report also uses terminology derived from the recommendations of the World Health Organization (*6*). Definitions of the following terms are included for reference.

- **Autochthonous malaria:**
  - **Indigenous.** Mosquitoborne transmission of malaria in an area where malaria occurs regularly.
  - **Introduced.** Mosquitoborne transmission of malaria from an imported case in an area where malaria does not occur regularly.
- **Imported malaria:** Malaria acquired outside a specific area. In this report, imported cases are those acquired outside of the United States and its territories (Puerto Rico, Guam, and the U.S. Virgin Islands).
- **Induced malaria:** Malaria acquired through artificial means (e.g., blood transfusion or use of shared syringes).
- **Relapsing malaria:** Renewed manifestations (i.e., clinical symptoms and/or parasitemia) of malarial infection that are separated from previous manifestations of the same infection by an interval greater than the usual periodicity of the paroxysms.
- **Cryptic malaria:** An isolated malaria case that cannot be linked epidemiologically to additional cases.

Microscopic Diagnosis of Malaria

The early diagnosis of malaria requires that physicians consider malaria in the differential diagnosis of every patient who has fever; the evaluation of such a patient should include taking a comprehensive travel history. If malaria is suspected, a Giemsa-stained smear of the patient's peripheral blood should be examined for parasites. Thick and thin blood smears must be prepared properly because the accuracy of diagnosis depends on the quality of the blood film and the experience of the laboratory personnel.* (See Appendix A for proper procedures necessary for accurately diagnosing malaria).

RESULTS

General Surveillance

During 1997, CDC received reports of 1,544 malaria cases that had onset of symptoms among persons in the United States and its territories, representing a 10.9% increase from the 1,392 cases reported for 1996 (*7*). This incidence is the largest number of reported cases since 1980. In 1997, a total of 698 cases occurred in U.S. civilians compared with 618 cases reported for 1996. This incidence represents the largest number of U.S. civilian cases reported since 1968 (Table 1). The number of cases in foreign civilians decreased from 636 in 1996 to 592 in 1997 (Figure 1). Cases among U.S. military personnel also decreased from 32 in 1996 to 28 in 1997. In 226 cases, civilian or military status was not reported.

*To obtain confirmation diagnosis of blood smears from questionable cases and to obtain appropriate treatment recommendations, contact either your state or local health department or CDC's National Center for Infectious Diseases, Division of Parasitic Diseases, Malaria Epidemiology Branch; telephone (770) 488-7788.

TABLE 1. Number of malaria cases* in U.S. and foreign civilians and U.S. military personnel — United States, 1968–1997

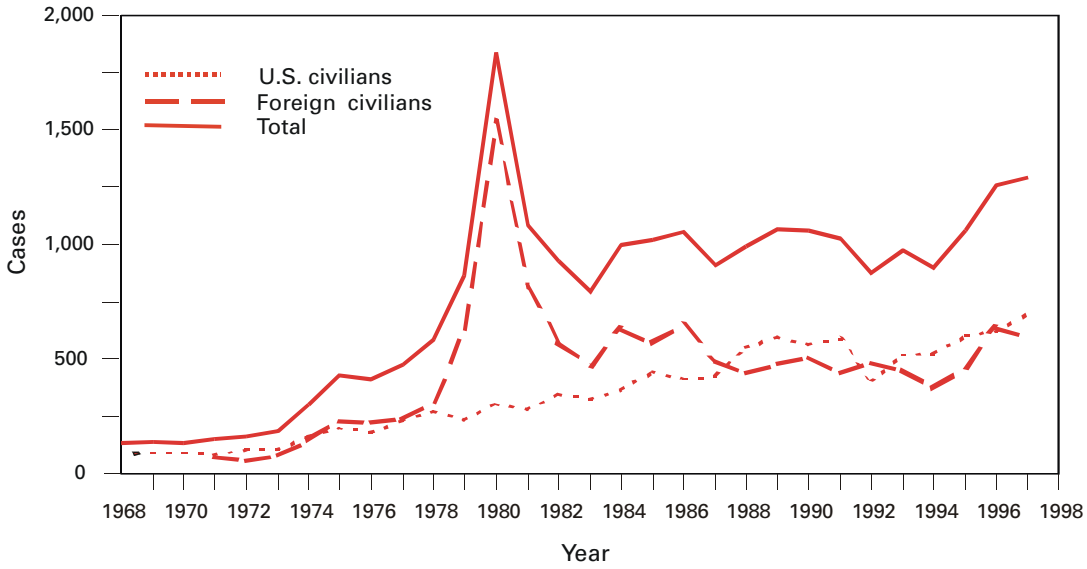
Year	U.S. military personnel	U.S. civilians	Foreign civilians	Unknown	Total
1968	2,567	82	49	0	**2,698**
1969	3,914	90	47	11	**4,062**
1970	4,096	90	44	17	**4,247**
1971	2,975	79	69	57	**3,180**
1972	454	106	54	0	**614**
1973	41	103	78	0	**222**
1974	21	158	144	0	**323**
1975	17	199	232	0	**448**
1976	5	178	227	5	**415**
1977	11	233	237	0	**481**
1978	31	270	315	0	**616**
1979	11	229	634	3	**877**
1980	26	303	1,534	1	**1,864**
1981	21	273	809	0	**1,103**
1982	8	348	574	0	**930**
1983	10	325	468	0	**803**
1984	24	360	632	0	**1,016**
1985	31	446	568	0	**1,045**
1986	35	410	646	0	**1,091**
1987	23	421	488	0	**932**
1988	33	550	440	0	**1,023**
1989	35	591	476	0	**1,102**
1990	36	558	504	0	**1,098**
1991	22	585	439	0	**1,046**
1992	29	394	481	6	**910**
1993	278	519	453	25	**1,275**
1994	38	524	370	82	**1,014**
1995	12	599	461	95	**1,167**
1996	32	618	636	106	**1,392**
1997	28	698	592	226	**1,544**

* A case was defined as symptomatic or asymptomatic illness that occurs in the United States in a person who has microscopically confirmed malaria parasitemia, regardless of whether the person had previous attacks of malaria while in other countries. A subsequent attack of malaria occurring in a person is counted as an additional case if the demonstrated *Plasmodium* species differs from the initially identified species. A subsequent attack of malaria occurring in a person while in the United States could indicate a relapsing infection or treatment failure resulting from drug resistance if the demonstrated *Plasmodium* species is the same species identified previously.

Plasmodium Species

The infecting species of *Plasmodium* was identified in 1,410 (91.3%) of the cases reported in 1997. *P. vivax* and *P. falciparum* were identified in blood smears from 48.9% and 36.7% of infected persons, respectively (Table 2). The 755 *P. vivax* cases reported for 1997 represented a 14.4% increase from the 660 cases in 1996, whereas the number of *P. falciparum* infections increased by 8.8% (from 521 in 1996 to 567 in 1997). Among 1,410 cases in which both the region of acquisition and the infecting species were known,

FIGURE 1. Number of malaria cases in U.S. and foreign civilians — United States,* 1968–1997†



* Includes Puerto Rico, Guam, and the U.S. Virgin Islands.

† The substantial increase in the number of cases reported for 1980 primarily reflects cases diagnosed in immigrants from Southeast Asia after the Vietnam conflict.

TABLE 2. Number of malaria cases, by *Plasmodium* species — United States, 1996 and 1997

Plasmodium species	1996 No.	1996 (%)	1997 No.	1997 (%)
P. vivax	660	(47.4)	755	(48.9)
P. falciparum	521	(37.4)	567	(36.7)
P. malariae	75	(5.4)	48	(3.1)
P. ovale	28	(2.0)	31	(2.0)
Undetermined	104	(7.5)	134	(8.7)
Mixed	4	(0.3)	9	(0.6)
Total	**1,392**	**(100.0)**	**1,544**	**(100.0)**

76.6% of infections acquired in Africa were attributed to *P. falciparum*; 12.4% were attributed to *P. vivax*. The converse was true of infections acquired in Asia and the Americas: 89.6% and 69.7% were attributed to *P. vivax,* and only 8.1% and 19.9% were attributed to *P. falciparum*, respectively.

Region of Acquisition and of Diagnosis

Approximately 98% (n=1,522) of all cases were classified as imported. Of 1,507 imported cases in which the region of acquisition was known, most 46.2% (n=697) were acquired in Africa, whereas 33.1% (n=499) and 16.2% (n=245) were acquired in Asia and the Americas, respectively (Table 3). The largest concentration of cases acquired in Africa (n=457; 65.6%) came from countries in West Africa, whereas most (n=410; 82.2%)

TABLE 3. Number of malaria cases, by *Plasmodium* species and area of acquisition — United States, 1997

Area of acquisition	*Plasmodium* species						
	P. vivax	*P. falciparum*	*P. malariae*	*P. ovale*	Unknown	Mixed	Total
AFRICA	75	465	34	30	90	3	**697**
Angola	0	2	0	1	0	0	**3**
Benin	1	1	0	1	0	0	**3**
Cameroon	0	15	1	1	5	1	**23**
Central African Republic	1	0	0	0	1	0	**2**
Congo	1	0	0	0	1	0	**3**
Côte d'Ivoire	0	15	1	1	7	0	**24**
Democratic Republic of the Congo (Zaire)	1	4	0	0	1	0	**6**
Ethiopia	9	1	0	0	0	0	**10**
Gabon	0	0	0	0	1	0	**1**
Gambia	1	4	0	0	0	0	**5**
Ghana	4	88	8	1	8	0	**109**
Guinea	0	9	0	0	0	0	**9**
Kenya	12	21	2	2	9	0	**46**
Liberia	3	25	2	0	3	0	**33**
Madagascar	8	1	0	1	1	0	**11**
Malawi	2	3	0	0	1	0	**6**
Mali	0	9	0	0	3	0	**12**
Mauritania	0	0	0	0	1	0	**1**
Mozambique	1	2	0	0	2	0	**5**
Nigeria	7	152	7	10	23	1	**200**
Rwanda	0	3	0	0	0	0	**3**
Senegal	0	7	1	1	1	0	**10**
Sierra Leone	0	13	2	1	1	0	**17**
Somali Republic	2	0	0	1	1	0	**4**
South Africa	1	3	1	0	1	0	**6**
Sudan	3	5	0	0	0	0	**8**
Tanzania	2	3	3	2	3	0	**13**
Togo	0	1	0	1	0	0	**2**
Uganda	1	8	0	1	3	0	**13**
Zambia	0	2	1	0	1	0	**4**
Zimbabwe	0	7	0	1	2	0	**10**
East Africa, Unspecified	5	6	0	0	0	0	**11**
West Africa, Unspecified	3	26	0	2	1	0	**32**
Central Africa, Unspecified	0	0	1	0	0	0	**1**
South Africa, Unspecified	0	1	0	1	0	0	**2**
Africa, Unspecified	7	27	4	1	9	1	**49**
ASIA	432	39	8	1	17	2	**499**
Afghanistan	3	0	0	0	0	0	**3**
Burma	1	0	0	0	1	0	**2**
Cambodia	1	0	0	0	0	0	**1**
China	1	0	0	0	0	0	**1**
India	371	18	7	1	11	2	**410**
Indonesia	11	6	1	0	1	0	**19**
Iraq	3	1	0	0	0	0	**4**
Korea	3	0	0	0	0	0	**3**

TABLE 3. (*Continued*) Number of malaria cases, by *Plasmodium* species and area of acquisition — United States, 1996

Area of acquisition	*Plasmodium* species						Total
	P. vivax	*P. falciparum*	*P. malariae*	*P. ovale*	Unknown	Mixed	
Laos	0	2	0	0	0	0	**2**
Middle East	4	0	0	0	0	0	**4**
Pakistan	11	1	0	0	1	0	**13**
Philippines	4	0	0	0	1	0	**5**
Sri Lanka	3	1	0	0	0	0	**4**
Thailand	1	3	0	0	0	0	**4**
Viet Nam	1	0	0	0	0	0	**1**
Yemen	1	2	0	0	0	0	**3**
Asia,Unspecified	6	3	0	0	0	0	**9**
Southeast Asia, Unspecified	7	2	0	0	2	0	**11**
CENTRAL AMERICA AND CARIBBEAN	143	41	4	0	16	2	**206**
Belize	8	1	0	0	0	0	**9**
Costa Rica	2	1	0	0	0	0	**3**
El Salvador	10	1	0	0	0	0	**11**
Guatemala	16	0	0	0	2	0	**18**
Haiti	1	27	1	0	5	0	**34**
Honduras	69	6	2	0	7	2	**86**
Nicaragua	23	3	1	0	1	0	**28**
Panama	1	0	0	0	1	0	**2**
Trinidad-Tobago	1	0	0	0	0	0	**1**
Central America, Unspecified	12	2	0	0	0	0	**14**
NORTH AMERICA	13	1	1	0	0	0	**15**
United States	4	1	0	0	0	0	**5**
Mexico	9	0	1	0	0	0	**10**
SOUTH AMERICA	19	8	0	0	2	1	**30**
Brazil	4	0	0	0	0	0	**4**
Colombia	1	1	0	0	0	0	**2**
Ecuador	1	1	0	0	0	0	**2**
Guyana	6	4	0	0	2	0	**12**
Peru	4	1	0	0	0	1	**6**
Surinam	1	0	0	0	0	0	**1**
Venezuela	1	0	0	0	0	0	**1**
South America, Unspecified	1	1	0	0	0	0	**2**
OCEANIA	37	4	0	0	4	1	**46**
Papua New Guinea	34	4	0	0	4	1	**43**
Solomon Islands	3	0	0	0	0	0	**3**
EUROPE/NEWLY INDEPENDENT STATES	1	0	0	0	0	0	**1**
Armenia	1	0	0	0	0	0	**1**
Unknown	28	7	1	0	0	0	**36**
Total	**754**	**567**	**48**	**31**	**134**	**9**	**1,544**

of the cases acquired in Asia came from the Indian subcontinent. The other regions where imported cases of malaria were acquired were Central America and Caribbean (n=206; 13.7%), South America (n=30; 2.0%), and Oceania (n=46; 3.0%). Information regarding region of acquisition was missing for 32 (2.1%) of the imported cases. The number of reported malaria cases acquired in Africa increased by 19.1% (n=697) compared with 1996, and cases acquired in Asia increased by 12.9% (n=499) compared with 1996. Cases from the Americas decreased by 6.0% (n=251) in 1997 compared with 1996.

In the United States, the six areas reporting the largest number of malaria cases were California (n=374), New York City (n=303), Florida (n=120), New York (n=84), Virginia (n=68), and Illinois (n=68) (Figure 2). Of these areas, only New York reported a decrease in cases in 1997 compared with 1996. This overall increase in reported number of cases might be a result of an increased rate of international travel, improved access to health care, or more sensitive surveillance.

Interval Between Arrival and Illness

Of those persons who became ill with malaria after arriving in the United States, both a) the interval between the date of arrival in the United States and onset of illness and b) the identification of the infecting *Plasmodium* species were known for 1,091 (71.7%) of the imported cases of malaria (Table 4). Symptoms began after arrival in the United States for 1,022 (93.7%) of these cases. Clinical malaria developed within 1 month after arrival in 344 (77.6%) of the 443 *P. falciparum* cases and in 124 (21.3%) of the 582 *P. vivax* cases (Table 4). Only 27 (2.6%) of the 1,022 persons became ill >1 year after returning to the United States. An additional 69 (6.3%) persons reported becoming ill before arriving in the United States.

FIGURE 2. Number of malaria cases, by state in which the disease was diagnosed — United States, 1997

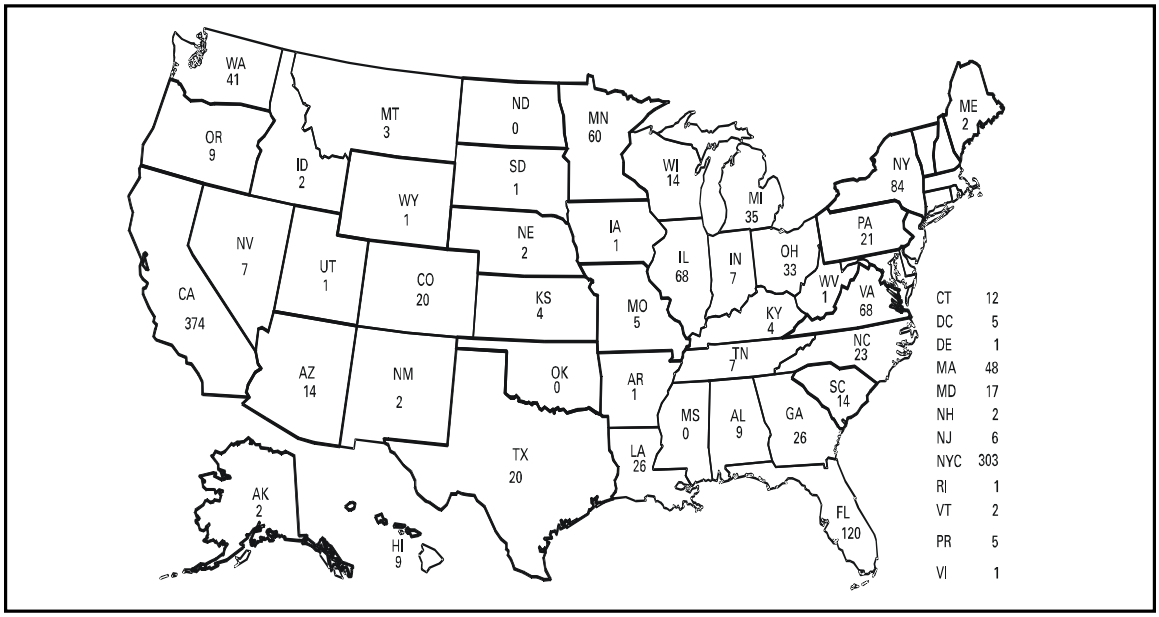


TABLE 4. Number of imported malaria cases, by *Plasmodium* species and by interval between date of arrival in the country and onset of illness — United States, 1997

Interval	*Plasmodium* species										Total	
	P. vivax		*P. falciparum*		*P. malariae*		*P. ovale*		Mixed			
(days)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
<0*	20	(3.4)	46	(10.4)	1	(2.6)	1	(4.3)	1	(20.0)	**69**	**(6.3)**
0–29	124	(21.3)	344	(77.7)	18	(47.4)	6	(26.1)	2	(40.0)	**494**	**(45.3)**
30–89	134	(23.0)	35	(7.9)	8	(21.0)	6	(26.1)	2	(40.0)	**185**	**(16.9)**
90–179	132	(22.7)	10	(2.2)	9	(23.7)	6	(26.1)	0	(0.0)	**157**	**(14.4)**
180–364	146	(25.1)	7	(1.6)	2	(5.3)	4	(17.4)	0	(0.0)	**159**	**(14.6)**
≥365	26	(4.5)	1	(0.2)	0	(0.0)	0	(0.0)	0	(0.0)	**27**	**(2.5)**
Total	**582**	**(100.0)**	**443**	**(100.0)**	**38**	**(100.0)**	**23**	**(100.0)**	**5**	**(100.0)**	**1,091**	**(100.0)**

* Case-patients had onset of illness before arriving in the United States.

Imported Malaria Cases

Imported Malaria in Military Personnel

Twenty-eight cases of imported malaria in U.S. military personnel were reported for 1997. Of the 26 case-patients for whom information on use of chemoprophylaxis was available, 10 were not using any prophylaxis.

Imported Malaria in Civilians

A total of 1,287 imported malaria cases were reported among civilians. Of these, 695 (54.0%) occurred in U.S. residents, and 592 (46.0%) occurred in residents of other countries (Table 5). Of the 695 imported malaria cases in U.S. civilians, 353 (50.8%) had been acquired in Africa, an increase of 78.4% from cases reported in 1996. The Central American and Caribbean region accounted for 109 (15.7%) cases of imported malaria in U.S. civilians, whereas travel to Asia accounted for an additional 148 (21.3%) cases. Of the 592 imported cases among foreign civilians, most cases were acquired in either Africa (n=209; 35.3%) or Asia (n=295; 49.8%).

Use of Antimalarial Chemoprophylaxis

Use of Chemoprophylaxis Among U.S. Civilians. Information concerning use of chemoprophylaxis and area of travel was known for 620 (89.2%) of the 695 U.S. civilians who had imported malaria. Of these 620 persons, 356 (57.4%) had not taken any chemoprophylaxis, and 82 (13.2%) had not taken a drug recommended by CDC for the area visited. Only 144 (23.2%) U.S. civilians had taken a medication recommended by CDC (*8*). Data for the actual drug taken were missing for the remaining 38 (6.1%) travelers. Of the civilian patients on prophylaxis recommended by CDC, 118 had taken mefloquine weekly; nine had taken doxycycline daily; and 17 who had traveled only in areas where chloroquine-resistant malaria has not been documented had taken chloroquine weekly. Of the 82 patients taking a nonrecommended drug, information on the type of chemoprophylaxis used was known for 59. Of these 59 persons, 56 (94.9%) reported taking chloroquine during travel to an area where chloroquine resistance had been documented.

Malaria Infection After Use of Recommended Prophylaxis. After taking a recommended antimalarial drug, 182 patients (144 U.S. civilians, 10 persons in the U.S. military,

TABLE 5. Number of imported malaria cases in U.S. and foreign civilians, by region of acquisition — United States, 1997

Region of acquisition	U.S. civilians No.	(%)	Foreign civilians No.	(%)	Total No.	(%)
Africa	353	(50.8)	209	(35.3)	**562**	**(43.7)**
Asia, Unknown*	148	(21.3)	295	(49.8)	**443**	**(34.4)**
Central America and Caribbean	109	(15.7)	69	(11.7)	**178**	**(13.8)**
Europe/Newly Independent States	1	(0.1)	0	(0.0)	**1**	**(0.1)**
North America	1	(0.1)	5	(0.8)	**6**	**(0.5)**
Oceania	41	(5.9)	4	(0.7)	**45**	**(3.5)**
South America	22	(3.2)	6	(1.0)	**28**	**(2.2)**
Unknown†	20	(2.9)	4	(0.7)	**24**	**(1.9)**
Total	**695**	**(100.0)**	**592**	**(100.0)**	**1,287**	**(100.1)**

* Country unknown.
† Region of acquisition unknown.

10 foreign civilians, and 18 persons whose information regarding their status was missing) developed malaria. The infecting species was undetermined for 29 cases.

***Cases of* P. vivax *or* P. ovale.** Of the 182 patients who developed malaria after taking recommended chemoprophylaxis, 98 cases (53.8%) were caused by *P. vivax* (n=94) or *P. ovale* (n=4). Malaria case surveillance reports indicated that 16 (16.3%) of these patients were noncompliant with antimalarial prophylaxis.

Fifty (51.0%) cases of *P. vivax* or *P. ovale* occurred >45 days after the case-patients arrived in the United States. These cases were consistent with relapsing infections and, thus, do not necessarily indicate prophylaxis failures. Because of insufficient information regarding 37 cases, it could not be determined whether these cases were relapsing infections. Eleven cases (11.2%) caused by *P. vivax* occurred within 45 days after the patient returned to the United States. Of these case-patients, seven were noncompliant with the recommended antimalarial chemoprophylaxis. The region of acquisition varied for the four case-patients reported to have complied (two from Central America, one from South America, one from Papua New Guinea). Serum drug levels could not be checked for any of these patients because blood samples were not available. The most likely explanations for these prophylaxis failures are either inappropriate dosing or unreported noncompliance. No evidence indicates the emergence of a new area of chloroquine-resistant *P. vivax*.

The remaining 84 cases of malaria reported among persons who had taken a recommended antimalarial drug for chemoprophylaxis include 43 cases of *P. falciparum*, 8 cases of *P. malariae,* 4 cases of mixed infection, and 29 cases in which the infecting species was not identified.

***Cases of* P. falciparum.** Thirty-six of the 43 *P. falciparum* cases were acquired in Africa, two in Asia, two in Central America and Carribean, and three in South America. In 22 (51.2%) of the case-patients, noncompliance with antimalarials was reported; one of the case-patients died as a result of noncompliance. Twenty-one (48.8%) persons who reported taking the recommended prophylaxis regimen acquired *P. falciparum* infections; however, serum drug levels were not available for these patients. The most likely explanations for these failures are either inappropriate dosing or noncompliance.

Purpose of Travel. The purpose of travel to malarious areas was reported for 469 (67.5%) of the 695 U.S. civilians with imported malaria (Table 6). Of the cases in U.S. civilians, the largest percentage (22.6%) of case-patients traveled to visit friends or relatives in malarious areas; the second and third largest percentages, 11.5% and 10.9%, traveled to tour and to do missionary work, respectively.

Malaria Acquired in the United States

Congenital Malaria

Three cases of congenital malaria were reported in 1997.

Case 1. In May 1997, a male neonate of 30 weeks' gestational age was delivered in New York City. Two days after delivery, he developed hyperbilirubinemia; fever was first noted two days after delivery, but no cause was identified. Fourteen days after delivery, his hemoglobin level had dropped to 9.0 g/dL with a platelet count of 65,000/mm^3. The neonate received a blood transfusion; he was discharged and sent home.

On May 20, 1997, the neonate was readmitted to the hospital. A malaria smear revealed *P. vivax* parasites. He was treated with chloroquine and recovered uneventfully.

The neonate's mother, a native of India, was aged 38 years. She had returned from visiting India approximately 1 month before the birth of her son. During that trip, she was not taking antimalarial prophylaxis. A malaria smear of her peripheral blood was positive for *P. vivax* parasites. The mother responded well to chloroquine and primaquine therapy.

Case 2. After an uneventful prenatal course, a full-term male infant was born by normal spontaneous vaginal delivery in June 1997 in Oakland, California. The infant was admitted to the hospital with fever 3 weeks after birth. He was reported as feeding well. On examination, he was noted to have mild icterus and occasional petechiae and purpura. His platelet count was 37,000/mm^3. A peripheral blood smear revealed intraerythrocytic parasites consistent with *P. vivax*. The infant was treated with a 3-day course of chloroquine and recovered without complications.

TABLE 6. Number of imported malaria cases in U.S. civilians, by purpose of travel at the time of acquisition — United States, 1997

	Imported cases	
Category	**No.**	**(%)**
Other	226	(32.5)
Teacher/Student	63	(9.1)
Visit of a friend or relative	157	(22.6)
Tourist	80	(11.5)
Missionary or dependent	76	(10.9)
Business representative	65	(9.4)
Peace Corps volunteer	14	(2.0)
Sailor/Air crew	4	(0.6)
Refugee/Immigrant	10	(1.4)
Total	**695**	**(100.0)**

The mother was born in the Punjab Province of India. She had immigrated to the United States in July 1996 and had not traveled outside of California since. She did not report any malaria symptoms during her pregnancy; however, she recalled having episodes of febrile illness while she was in India. The most recent febrile episode had been 3 years before delivery.

The diagnosis of *P. vivax* was confirmed by CDC. The mother's thick and thin blood smears were negative, and immunofluorescent assay titers were 1:64 to *P. vivax*, <1:16 to *P. falciparum*, <1:16 to *P. malariae*, and <1:16 to *P. ovale*. The mother was treated with a course of chloroquine followed by 14 daily doses of primaquine.

Case 3. In September 1997, a male infant was born in New York City, the son of a native of India who had immigrated to New York 14 months before she delivered. The mother had no episodes of febrile illness after arriving in the United States.

The infant developed fever 45 days after birth, and *P. vivax* malaria was diagnosed. He was successfully treated with chloroquine. The mother's peripheral blood smear was examined; however, no parasites were found. Serum samples from both the infant and mother tested positive by immunofluorescent assay.

Cryptic Malaria

No cases of cryptic malaria were reported in 1997.

Induced Malaria

Two cases of induced malaria were reported in 1997, one acquired by a needle stick and one by blood transfusion.

Case 1. On February 24, 1997, a Filipino nurse, aged 56 years, was working in a hospital in California and sustained a needle-stick injury while starting an intravenous line. The patient was being treated for a *P. vivax* infection acquired in Honduras.

The nurse had immigrated to the United States in 1970, and her last visit to the Philippines was more than 4 years before her illness. Although she had traveled internationally to other areas in the previous 4 years, she had not been to any malarious areas.

The nurse developed fever and chills on March 10, and a blood smear demonstrated *P. vivax* parasites. She was successfully treated with a 3-day course of chloroquine and a 14-day course of primaquine.

Case 2. In Missouri, a male resident of an extended care facility, aged 85 years, was hospitalized for acute gastrointestinal hemorrhage in October 1997. While he was hospitalized, he received five units of packed red blood cells and was then discharged.

The patient was readmitted on November 1, 1997, with another episode of acute gastrointestinal hemorrhage and fever to 104 F (40.0 C). Peripheral blood smears were positive for intraerythrocytic parasites identified as *P. falciparum* rings and trophozoites. He was treated with oral quinine and doxycycline; this regimen was changed to intravenous quinidine gluconate and doxycycline the next day when his mental status deteriorated. A computed tomography scan indicated evidence of a cerebral vascular accident. He died on November 18, 1997.

The patient had been a World War II veteran but had no recent history of international travel. All five units of packed red blood cells that he received were obtained from the same community blood center; four of the units were donated by U.S. military personnel and one by a long-time civilian donor. Sera from the donors were tested by immunofluorescent assay; one donor tested positive for *P. falciparum* $\geq$16,384.

Deaths Attributed to Malaria

Six deaths attributed to malaria were reported in 1997.

Case 1. On February 21, 1997, a male in North Carolina, aged 20 years, reported to an infirmary approximately 2 weeks after returning from a 2-month holiday trip to his native Zimbabwe. The man was in Zimbabwe for approximately 2 months; he reported having taken mefloquine prophylaxis sporadically during the trip. Upon reporting to the infirmary, he had fever, chills, cough, and headache. He was referred to an urgent care center; an upper respiratory infection was diagnosed. The patient was sent home with a prescription for amoxicillin.

Within 1 week, he returned to the infirmary with fevers to 103 F (39.4 C), chills, vomiting, diarrhea, and jaundice. He was referred to the hospital emergency department for evaluation; his platelet count was 10,000/mm^3. The patient was started on broad spectrum antibiotics. Arrangements were made to transfer him to the university hospital; however, the transfer was delayed for 24 hours because no vacant bed was available at the hospital.

A peripheral blood smear revealed intraerythrocytic parasites, which were thought to be either *P. falciparum* or *Babesia microti*. A decision to delay treatment for possible malaria was made, pending a reevaluation at the university hospital.

Upon arriving at the referral hospital, the patient was alert. However, approximately 1 hour after arriving, his neurologic status began to deteriorate; he subsequently experienced respiratory and cardiac arrest. He was resuscitated, placed on a respirator, and transferred to the coronary care unit. Repeat blood smears were positive for *P. falciparum* with a parasitemia of 23%. Exchange blood transfusions were started that evening as well as an intravenous therapy of quinidine gluconate and doxycycline. The patient's neurologic status did not improve, and he died in early March.

Case 2. On June 12, 1997, a man aged 57 years went to a hospital in Ohio 12 days after leaving The Gambia where he had spent 2 months performing missionary work. He reported having taken a prophylactic medication, but neither the name of the drug nor the regimen were known.

On admission, his hemoglobin level was 11 g/dL; total bilirubin, 5.0 g/dL; and platelet count, 13,000/mm^3. Peripheral blood smears revealed that 25% of the erythrocytes were parasitized with *P. falciparum*.

The patient was started on intravenous quinidine gluconate and doxycycline and was being prepared for exchange transfusion when he experienced severe bradycardia followed by cardiac arrest. The initial resuscitation was successful; however, he then suffered a second cardiac arrest, and resuscitation was not successful.

Case 3. In June 1997, a man from Wisconsin, aged 59 years, traveled to Kenya for a safari. He was given chloroquine for prophylaxis. On June 15, he became ill with gastroenteritis. On June 23, 3 days after leaving Kenya, he became ill again and sought medical care the following day. He was started on antibiotic treatment, pending results of blood and stool cultures. The antibiotic was changed to ciprofloxacin on June 27 because his symptoms had continued.

The patient was admitted to a hospital in Wisconsin on June 28. Blood smears taken on admission revealed *P. falciparum*, and he was started on quinine sulfate, doxycycline, and clindamycin. The patient developed oliguria and metabolic acidosis 1 day after admission. He died of multiple organ failure on June 30.

Case 4. On September 6, 1997, a man who is a native of Nigeria, went to a New York City emergency department with altered mental status. The man, aged 58 years, was known to have insulin-dependent diabetes. He had recently returned from Nigeria. Information regarding whether he had used chemoprophylaxis was not known.

Four days before admission, the patient had gone to his primary physician because he was not feeling well. An upper respiratory infection was diagnosed, and he was started on doxycycline. On the day before admission, he began having diarrhea; his mental status also began deteriorating.

On physical examination, the patient was unconscious, had a temperature of 98.2 F (36.8 C), blood pressure of 120/90, and a pulse of 90 beats per minute. No significant findings were revealed from the remainder of the physical examination. Laboratory tests indicated a hemoglobin level of 11.3 g/dL; white blood cell count, 6,300/mm^3; platelet count, 49,000/mm^3; total bilirubin, 3.4 g/dL; glucose, 444 mg/dL; blood urea nitrogen, 112 mg/dL; creatinine, 2.8 mg/dL; and potassium, 5.6 meq/L. Malaria blood smear was positive for *P. falciparum* parasites.

The patient was started on intravenous normal saline, an insulin drip, and intravenous cefuroxime. He was subsequently intubated and placed on mechanical ventilation. Intravenous quinidine gluconate was ordered after obtaining the results of the malaria smear; however, before it could be started, the patient suffered a cardiac arrest in the emergency department. Resuscitation attempts were not successful. Cause of death was listed as diabetic ketoacidosis and malaria.

Case 5. See Case 2 of the "Induced Malaria" section.

Case 6. On December 14, 1997, an infant, aged 9 months, began to have fever and lethargy and was taken to a hospital in Florida. Two days before the symptoms began, he had immigrated from Nigeria. He had been recently treated for malaria with an unknown injectable medicine while he was in Nigeria.

On examination, the infant had pallor, hepatosplenomegaly, lethargy, and a temperature of 104 F (40.0 C). Laboratory tests revealed a hemoglobin level of 5.3 g/dL and a white blood cell count of 63,000/mm^3. Malaria blood smears initially tested positive for *P. vivax*; however, CDC was consulted by telephone and suggested that the infection was *P. falciparum*.

The infant was intubated, started on intravenous quinidine gluconate, and administered a blood transfusion. A computed tomography scan indicated cerebral hemorrhage and herniation. The infant died on December 17.

DISCUSSION

A total of 1,544 cases of malaria was reported to CDC for 1997, representing a 10.9% increase from the 1,392 cases reported for 1996. This change primarily resulted from an increase in cases acquired in Africa and Asia that might have resulted from improved reporting, increased international travel, changing patterns of travel (i.e., immigration from malarious areas or "adventure tourism"), or a decreased use of effective antimalarial chemoprophylaxis. Since 1992, the number of malaria case-patients who were not classified as U.S. military, U.S. civilian, or foreign civilian have been increasing (Table 1). The Malaria Case Surveillance Report was changed in 1996, possibly contributing to the increase from 1996 to 1997; however, this change does not account for the earlier increases. Unknown cases were classified as such because data were missing from the surveillance forms.

One reason for conducting malaria surveillance is to monitor the emergence of drug resistance and the consequent failure of chemoprophylaxis; however, approximately 70% of imported malaria in U.S. civilians occurred in persons who were either not taking or taking nonrecommended prophylaxis for the region where they were traveling. Of the 144 persons who reported taking adequate prophylaxis, for 24 cases (i.e. 7 *P. vivax,* 13 *P. falciparum*, and 4 *P. malariae*), sufficient information was not available to determine whether they represented problems with compliance while using proper antimalarial chemoprophylaxis, reporting errors, or emerging drug resistance. However, no conclusive evidence existed to suggest a single national or regional source of infection among this group of patients. Health-care providers are encouraged to contact CDC at (770) 488-7788 whenever they suspect chemoprophylaxis failure, thus enabling measurement of serum drug levels of the antimalarial drug in question.

The importance of taking proper precautions and chemoprophylaxis is underscored by five of the six fatal cases of malaria in the United States in 1997. An earlier review of deaths attributed to malaria in the United States identified several risk factors for fatal malaria, including failure to take recommended antimalarial chemoprophylaxis, refusal of or delay in seeking medical care, and misdiagnosis (*9*).

Signs and symptoms of malaria often are vague, but fever is generally present. Other typical symptoms include headache, chills, increased sweating, back pain, myalgia, diarrhea, nausea, vomiting, and cough. Prompt diagnosis requires that malaria be included in the differential diagnosis of illness in a febrile person with a recent history of travel to a malarious area. Clinicians should ask febrile patients for a travel history, particularly when evaluating febrile illnesses in international visitors, immigrants, refugees, migrant laborers, and international travelers.

Treatment for malaria should be initiated immediately after the diagnosis has been confirmed by a positive blood smear. Treatment should be determined on the basis of the infecting *Plasmodium* species, the probable geographic origin of the parasite, the parasite density, and the patient's clinical status (*10*). Although non-*falciparum* malaria rarely causes complications, persons with *P. falciparum* infection are at risk for developing severe, life-threatening complications.

Health-care workers are encouraged to consult appropriate sources for malaria treatment recommendations or to contact CDC's National Center for Infectious Diseases, Division of Parasitic Diseases, Malaria Epidemiology Branch (Box).

BOX. CDC sources for malaria prophylaxis and treatment recommendations

Type of information	Source	Time available	Phone number
Prophylaxis	CDC Travelers' Health Hotline	24 hours per day, 7 days per week	(877) 394-8747
Prophylaxis	CDC Travelers' Health Fax	24 hours per day, 7 days per week	(888) 232-3299
Prophylaxis	*Health Information for International Travel*	Mail to Superintendent of Documents U.S. Government Printing Office Washington, DC 20402-9235	(202) 512-1800
Treatment	CDC Malaria Epidemiology Branch	8:00 am to 4:30 pm Monday through Friday	(770) 488-7788*
Treatment†	CDC Malaria Epidemiology Branch	4:30 pm to 8:00 am Monday through Friday 24 hours per day, after hours, weekends, and federal holidays	(404) 639-2888* (Ask operator to page person on call for malaria section.)

* Phone number is intended for use by health-care professionals only.

† To obtain confirmation diagnosis of blood smears from questionable cases and to obtain appropriate treatment recommendations, contact either your state or local health department or CDC's National Center for Infectious Diseases, Division of Parasitic Diseases, Malaria Epidemiology Branch; telephone (770) 488-7788.

Acknowledgment

The authors acknowledge the state health departments, health-care providers, and public health laboratories for reporting this information to CDC.

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APPENDIX

Microscopic Procedures for Diagnosing Malaria

To establish the diagnosis of malaria, a blood smear must be prepared from fresh blood obtained by pricking the finger (Figures A-1 and A-2).* The thin smear is fixed in methanol before staining; the thick smear is stained unfixed. Many hospitals have a Wright-Giemsa stain available, which is acceptable; however, Wright stain alone will not reliably stain *Plasmodium* parasites. For best results, the smear should be stained with a 3% Giemsa solution (pH of 7.2) for 30–45 minutes. In *P. falciparum* infections, the parasite density should be estimated by counting the percentage of red blood cells infected — not the number of parasites — under an oil immersion lens on a thin film.

Thick blood smears are more sensitive in detecting malaria parasites because the blood is concentrated, allowing a greater volume of blood to be examined. However, thick smears are more difficult to read, and thin smears might be preferred by laboratories that have limited experience. *Plasmodium* parasites are always intracellular, and

*In Figures A-1 and A-2, the hands are shown ungloved to better illustrate their placement during the procedures. However, wearing gloves while processing blood specimens is recommended to prevent transmission of bloodborne pathogens (*MMWR* 1988;37:377–82, 387–8 and *MMWR* 1987;36[No. S2]).

FIGURE A-1. Blood collection for thin or thick blood film

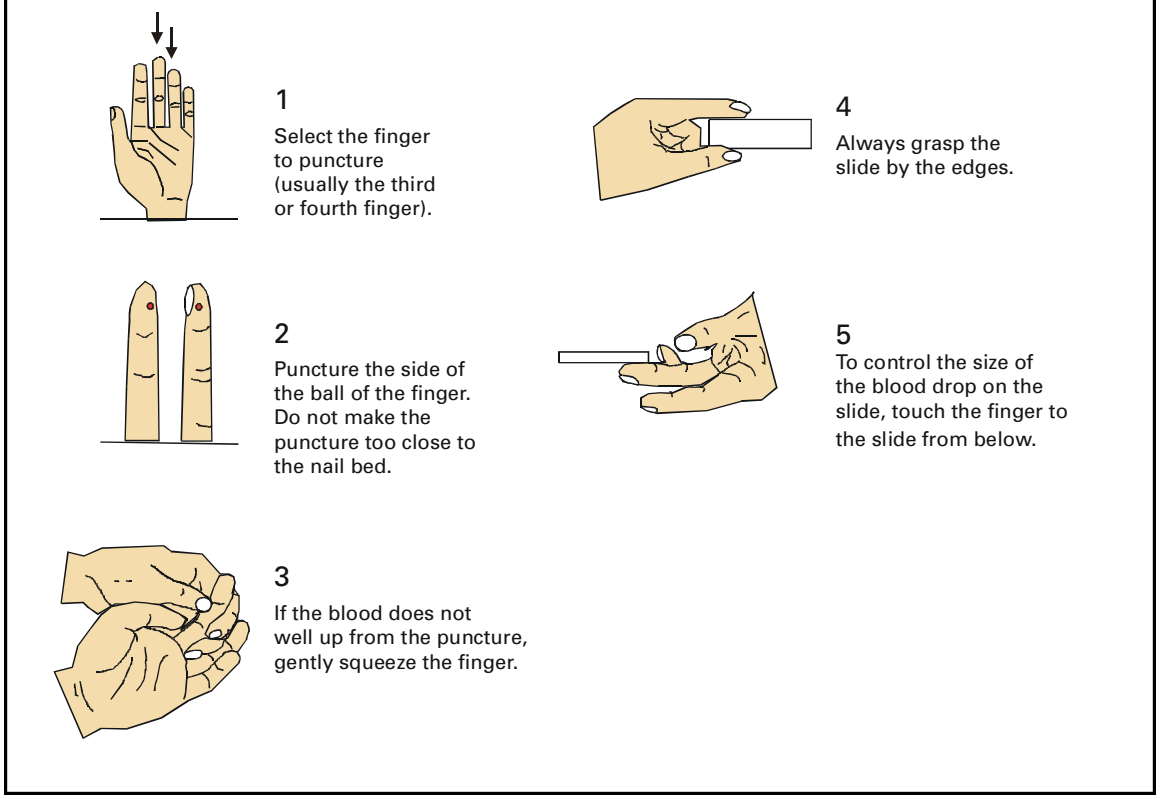
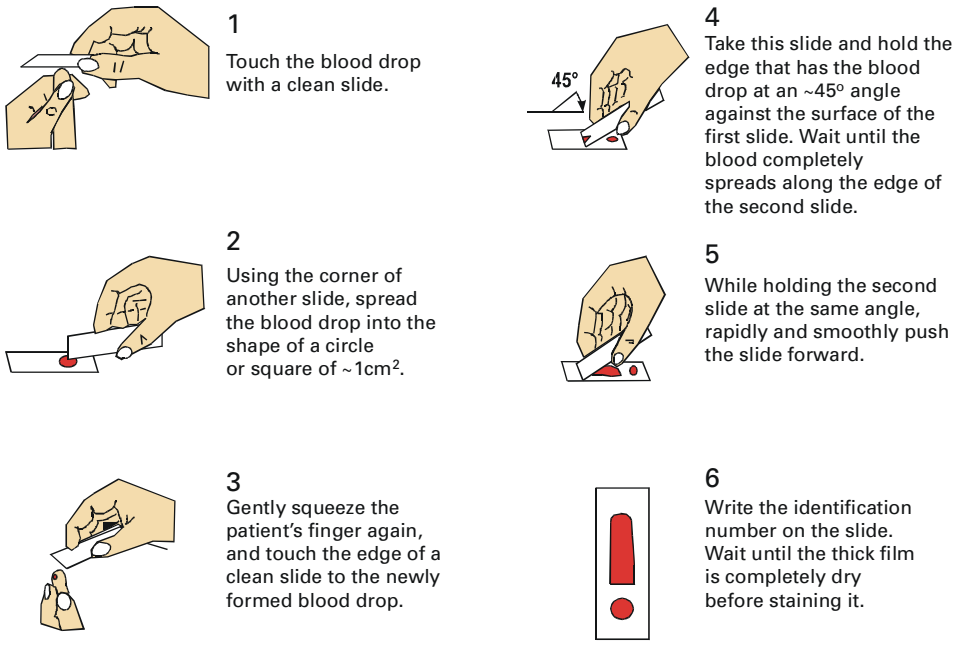


FIGURE A-2. Preparation of a thin and thick blood film on the same slide



they demonstrate, if stained correctly, blue cytoplasm with a red chromatin dot. Common errors in reading malaria smears are caused by platelets overlying a red blood cell, concern about missing a positive slide, and misreading artifacts as parasites. Persons suspected of having malaria but whose blood smears do not demonstrate the presence of parasites should have blood smears repeated approximately every 12–24 hours for 3 consecutive days. If smears remain negative, then the diagnosis of malaria is unlikely.

For rapid diagnosis, make the thick and thin smears on separate slides. Air dry the thin film, fix it with methyl alcohol, and immediately stain it. If no parasites are found on the thin film, wait until the thick film is dry and examine it for organisms that might not have been detected on the thin preparation.

State and Territorial Epidemiologists and Laboratory Directors

State and Territorial Epidemiologists and Laboratory Directors are acknowledged for their contributions to *CDC Surveillance Summaries*. The epidemiologists and the laboratory directors listed below were in the positions shown as of February 2001.

State/Territory	Epidemiologist	Laboratory Director
Alabama	John P. Lofgren, MD	William J. Callan, PhD
Alaska	John P. Middaugh, MD	Bernard Jilly, PhD
Arizona	Norman Peterson, MD, MPH	Wes B. Press, MS
Arkansas	Thomas C. McChesney, DVM	Michael G. Foreman
California	Duc Vugia, MD, MPH	Paul Kimsey, PhD
Colorado	Richard E. Hoffman, MD, MPH	Ronald L. Cada, DrPH
Connecticut	James L. Hadler, MD, MPH	Katherine Kelley, DrPH
Delaware	A. LeRoy Hathcock, PhD	Jane Getchall, DrPH
District of Columbia	Martin E. Levy, MD, MPH	Maurice Knuckles, PhD (Acting)
Florida	Richard S. Hopkins, MD, MSPH	Ming S. Chan, PhD
Georgia	Paul Blake, MD, MPH	Elizabeth A. Franko, DrPH
Hawaii	Paul V. Effler, MD, MPH	Vernon K. Miyamoto, PhD
Idaho	Christine G. Hahn, MD	Richard H. Hudson, PhD
Illinois	Mark Dworkin, MD, MPH	David L. Maserang, PhD
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