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Surveillance for Emergency Events Involving Hazardous Substances — United States, 1990–1992

Dengue Surveillance — United States, 1986–1992

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*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 Preventionand Health Promotion
NCEH	National Center for Environmental Health
NCEHIC	National Center for Environmental Health and Injury Control
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

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Surveillance for Emergency Events Involving Hazardous Substances — United States, 1990–1992

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Abstract

Problem/Condition: A review of existing reporting systems indicated that not enough information was being collected to determine the public health consequences of emergency events involving hazardous substances.

Reporting Period Covered: January 1990 through December 1992.

Description of System: State health departments in selected states collect and each quarter transmit information about the events, substances released, and the public health consequences of hazardous substance releases (i.e., morbidity, mortality, and evacuations) to the Agency for Toxic Substances and Disease Registry (ATSDR). Five state health departments (Colorado, Iowa, Michigan, New Hampshire, and Wisconsin) began data collection on January 1, 1990. On January 1, 1992, the reporting state health departments included those from Colorado, Iowa, New Hampshire, New York, North Carolina, Oregon, Rhode Island, Washington, and Wisconsin.

Results and Interpretation: During 1990–1992, 3,125 events were reported from participating states to ATSDR's Hazardous Substances Emergency Events Surveillance (HSEES) system. Of these events, 2,391 (77%) were fixed-facility events (i.e., occurred at stationary facilities), and 723 (23%) were transportation related. In 88% of events, a single chemical was released. The most frequently released hazardous substances were volatile organic compounds (18% of the total 4,034 substances released), herbicides (15%), acids (14%), and ammonias (11%). In 467 events (15% of all events), 1,446 persons were injured; 11 persons died as a result of these injuries. Respiratory irritation (37%) and eye irritation (23%) were the most frequently reported health effects. A total of 457 (15%) events resulted in evacuations; of these, 400 (88%) were ordered by an official (e.g., a police officer or firefighter). The median number of persons evacuated was 25 (range: from 12 to >9,999 persons). Evacuations lasted an average of 9.4 hours (median: 3 hours; range: 1–240 hours).

Actions Taken: Information from HSEES is being used for preparedness planning, such as the relocation of hazardous materials (HazMat) teams to areas with higher incidence and the training of first responders and employees. The information is also used to conduct follow-up epidemiologic studies and to determine risk factors associated with events resulting in injury.

INTRODUCTION

Since World War II, the number of chemicals that have been developed, produced, and used in the United States has increased rapidly. More than 65,000 substances are

available on the market, and approximately 600 new substances are produced each year (*1*). However, the potential health effects of many of the substances in common use are unknown. Furthermore, comprehensive information regarding the public health consequences of hazardous substance releases (i.e., the morbidity, mortality, and evacuations of the general public, first responders, and employees*) was not available.

In 1988, the Agency for Toxic Substances and Disease Registry (ATSDR) initiated a study of the information about hazardous substance releases available in three national databases: the National Response Center Database, the Hazardous Materials Information System (HMIS), and the Acute Hazardous Events Database (*2*). These databases were found to have limitations for assessing the public health consequences of hazardous substance releases (*2–4*). Not all events were included in these databases (e.g., HMIS does not include events involving intrastate carriers and fixed [stationary] facilities), and many events were not reported. Moreover, the accuracy of the collected information could not be confirmed. Other types of data not included in these systems were information concerning the persons injured by hazardous substance releases, the types of injuries received, and evacuations.

Because of these limitations in data collection, in October 1989 ATSDR implemented an active, state-based Hazardous Substances Emergency Events Surveillance (HSEES) system in selected states to enable assessment of the public health consequences associated with hazardous substance releases. This report describes the public health consequences of events reported to the HSEES system from January 1990 through December 1992.

METHODS

Five state health departments (Colorado, Iowa, Michigan, New Hampshire, and Wisconsin) began data collection on January 1, 1990. On January 1, 1992, the reporting state health departments included those from Colorado, Iowa, New Hampshire, New York, North Carolina, Oregon, Rhode Island, Washington, and Wisconsin. Information regarding the event, chemicals released, affected persons, injuries,† and evacuations was recorded on standardized data collection forms designed by ATSDR. Personnel from state health departments used different sources (e.g., records or verbal reports by personnel of state environmental protection agencies, police and fire departments, and hospitals) to obtain information for the data collection form. The data were computerized, using a data entry system provided by ATSDR, and were reported quarterly to ATSDR.

Hazardous substance emergency events were defined as uncontrolled or illegal releases or threatened releases of chemicals or their hazardous by-products. The reportable chemicals included the 200 substances identified by ATSDR as the most hazardous substances found at Superfund sites (*5*), all other insecticides and herbicides in addition to those found at Superfund sites, chlorine, hydrochloric acid,

*The term "first responders" refers to those persons whose occupations require that they respond immediately to emergency events (e.g., firefighters, law enforcement officers, emergency medical service personnel, and hazardous materials [HazMat] team members). "Employees" refers to persons employed by the company responsible for the hazardous event. "General public" refers to all other persons at the scene of the event.

†In this report, "injuries" includes all injuries and any other adverse health effects.

sodium hydroxide, nitric acid, phosphoric acid, acrylic acid, and hydrofluoric acid. Events were reported if the amount of substance released needed to be removed, cleaned up, or neutralized according to federal, state, or local law. In addition, events were reported if they resulted in a potential for a release of a designated hazardous substance and if this potential led to an action (e.g., an evacuation) to protect the health of employees, first responders, or the general public.

RESULTS

A total of 3,125 events were reported from participating states to the HSEES system during 1990–1992. Of these events, 2,391 (77%) were fixed-facility events, and 723 (23%) were transportation related. Type of event was unknown for 11 of the reported events. Location of event was known for 3,092 events. Most (1,890 [61%]) events occurred in areas with industrial or commercial land use; 547 (18%), in areas classified as rural; and 329 (11%), in residential areas.

The frequency distribution by day of week for Monday through Friday did not vary substantially. However, the daily average number of 538 emergency events on a Monday through Friday was more than twice the daily average number on a Saturday or Sunday (i.e., 219 events). Time of day that the emergency event occurred was known for 2,957 events. Of these, 2,230 (75%) events occurred from 6 a.m. to 6 p.m.; 467 (16%), from 6 p.m. to 12 a.m.; and 260 (9%), from 12 a.m. to 6 a.m.

The hazardous substances released during the events were grouped into 11 categories (Table 1). The most frequently released hazardous substances were volatile organic compounds (18% of the total 4,034 substances released), herbicides (15%), acids (14%), and ammonias (11%). The substances released during the two types of events were similar; however, a greater number of transportation-related incidents involved the release of herbicides.

For the four categories of substances that were released most frequently, 13%–27% of the releases resulted in injury. The substances released most often, however, were not necessarily those most likely to result in injury. For example, although insecticides were released in only 5% of all events, 80 (37%) of the 217 events with releases of insecticides resulted in injuries.

A single substance was released in 2,747 (88%) of all events, and two substances were released in 199 (6%). The distribution of the number of substances released during events that resulted in injury (Table 2) was comparable to the distribution of the number of substances released during all events.

In 467 events (15% of all events), 1,446 persons were injured. In 252 (54%) events resulting in injury, only one person was injured. In an additional 88 (19%) events resulting in injury, two persons were injured. Information about age was available for 883 (61%) injured persons (mean age: 33 years; range: 1–79 years). Seventy-six percent of injured persons were male. Overall, 968 (67%) injured persons were employees, 200 (14%) were first responders, and 276 (19%) were from the general public. In transportation-related events, 46 (34%) injured persons were first responders.

For both fixed-facility and transportation-related events, respiratory irritation and eye irritation were the most frequently reported health effects (Table 3). In transportation-related events, injured persons also commonly had traumatic injuries (i.e., 28 [13%] of transportation-related injuries were traumatic).

TABLE 1. Substances released during all hazardous substances emergency events and during all such events resulting in personal injury,* by chemical category — selected states,† Hazardous Substances Emergency Events Surveillance, 1990–1992

	Substances released				
	During all events		During events resulting in personal injury		
Substance category	No.	(%)§	No.	(%)¶	(%)**
Volatile organic compounds	727	(18)	93	(12)	(13)
Herbicides	588	(15)	126	(16)	(21)
Acids	553	(14)	148	(19)	(27)
Ammonias	448	(11)	103	(13)	(23)
Metals	261	(7)	21	(3)	(8)
Insecticides	217	(5)	80	(10)	(37)
Polychlorinated biphenyls	212	(5)	6	(1)	(3)
Bases	152	(4)	40	(5)	(26)
Chlorine	157	(4)	43	(6)	(27)
Cyanides	21	(1)	9	(1)	(43)
Unclassified	698	(17)	108	(14)	(15)
Total	**4,034**	**(100)**	**777**	**(100)**	

*Refers to injuries and all other adverse health effects.
†During 1990–1991, participating states included Colorado, Iowa, Michigan, New Hampshire, and Wisconsin. During 1992, participating states included Colorado, Iowa, New Hampshire, New York, North Carolina, Oregon, Rhode Island, Washington, and Wisconsin.
§Percentage of all substances released.
¶Percentage of all substances released during events that resulted in personal injury.
**Within the substance category, the percentage of substances released during events that resulted in personal injury.

TABLE 2. Distribution of number of chemicals released per hazardous substances emergency event with injured* persons — selected states,† Hazardous Substances Emergency Events Surveillance, 1990–1992

	Type of event								
	Fixed-facility			Transportation-related			All events§		
No. of chemicals released	Events		Total no. of chemicals	Events		Total no. of chemicals	Events		Total no. of chemicals
	No.	(%)		No.	(%)		No.	(%)	
1	338	(85.1)	338	53	(76.8)	53	391	(83.9)	391
2	27	(6.8)	54	11	(15.9)	22	38	(8.2)	76
3	12	(3.0)	36	3	(4.3)	9	15	(3.2)	45
4	5	(1.3)	20	1	(1.4)	4	6	(1.3)	24
5	4	(1.0)	20	1	(1.4)	5	5	(1.1)	25
≥6	11	(2.8)	216	—	—	—	11	(2.4)	216
Total	**397**	**(100.0)**	**684**	**69**	**(100.0)**	**93**	**466**	**(100.0)**	**777**

*Refers to injuries and all other adverse health effects.
†During 1990–1991, participating states included Colorado, Iowa, Michigan, New Hampshire, and Wisconsin. During 1992, participating states included Colorado, Iowa, New Hampshire, New York, North Carolina, Oregon, Rhode Island, Washington, and Wisconsin.
§Location of one event was not known. A total of 467 events resulted in personal injury.

Eleven deaths were reported, two of which occurred during one event. Nine deaths occurred at fixed facilities, and two during transportation-related events. Eight persons who died were employees, one was a first responder, and two were from the general public. Demographic information was known for 10 persons who died; all were male (mean age: 43.5 years). Eight persons who died had not worn personal protective equipment, and nine had not worn eye protection. The conditions associated with these deaths were trauma, chemical burns, thermal burns, heat stress, cardiac arrest, and asphyxiation.

Most (869 [60%]) of the injured persons were treated at a hospital but did not require inpatient admission. Others were admitted to a hospital for treatment (220 [15%] injured persons), treated at the scene of the event (167 [12%]), or transported to a hospital for observation but required no treatment (88 [6%]). Sixty-seven (5%) injured persons were treated for their injuries by private physicians within 24 hours of the event.

Of the 1,353 injured persons for whom information concerning use of protective equipment was available, 984 (73%) were not using any type of personal protective equipment at the scene of the event. Of the injured employees, 676 (75%) were not using personal protective equipment. Hard hats and steel-toed shoes were worn by 136 (15%). Of the injured first responders, 40 (22%) used no personal protective equipment, 77 (43%) used firefighter protective gear, 34 (19%) used Level B protection, and 22 (12%) used Level A protection.*

Approximately 457 (15%) of events resulted in evacuations, of which 400 (88%) were ordered by an official (e.g., a police officer or firefighter). In 40 (1%) events, per-

*_Level A_ protective equipment provides the highest level of protection for skin, eyes, and the respiratory system and includes a respirator and chemical-resistant suit, gloves, and boots. _Level B_ protective equipment provides a high level of respiratory protection, but less skin protection than Level A.

TABLE 3. Types of injuries* sustained during emergency events involving hazardous substances — selected states,† Hazardous Substances Emergency Events Surveillance, 1990–1992

Type of injury	No. of injuries	Percentage
Respiratory irritation	933	37.3
Eye irritation	571	22.8
Nausea	222	8.9
Chemical burns	153	6.1
Dizziness or other central nervous system symptoms	126	5.0
Skin irritation	96	3.8
Physical trauma	82	3.3
Headache	80	3.2
Heat stress	49	2.0
Thermal burns	26	1.0
Vomiting	8	0.3
Other	155	6.2
Total	**2,501**	**100.0**

*Refers to injuries and all other adverse health effects.

†During 1990–1991, participating states included Colorado, Iowa, Michigan, New Hampshire, and Wisconsin. During 1992, participating states included Colorado, Iowa, New Hampshire, New York, North Carolina, Oregon, Rhode Island, Washington, and Wisconsin.

sons in the affected areas were instructed to stay indoors. The median number of persons evacuated was 25 (range: from 12 to >9,999), and evacuations lasted an average of 9.4 hours (median: 3 hours; range: 1–240 hours). For 116 (29%) of the evacuations ordered by an official, the evacuation zone was defined as a circle or radius around the site of the event. For 33 (8%) evacuations, no criteria were used for defining the evacuation zone. For 52 (13%), the evacuation zone was downwind from the location of the hazardous substance release; for 192 (49%), the affected building or part of the building was evacuated. Evacuation criteria were not known for seven events.

DISCUSSION

The information from the events reported to the HSEES system during 1990–1992 indicates that public health consequences (i.e., the morbidity, mortality, and evacuations) may be associated with approximately 15% of hazardous substance releases. These estimates, combined with other information, such as the number and types of substances most likely to be released (e.g., volatile organic compounds, acids, ammonias, and herbicides) and the substances most likely to be associated with injuries (e.g., insecticides), may be used to help develop prevention strategies. For example, knowledge regarding the characteristics of hazardous substance releases and the associated public health consequences may allow formulation of guidelines for primary prevention (i.e., prevention of hazardous substance releases) and secondary prevention (prevention of morbidity and mortality as a result of hazardous substance releases).

The information provided by the HSEES system is used to train first responders, to plan for emergency preparedness, and to conduct follow-up epidemiologic studies. Trends in the spatial distribution of events are used for relocating HazMat (first responder) teams to areas with higher frequency of events. Effective statewide interventions to prevent public health consequences from hazardous substance releases should reduce the number of injuries associated with such events.

Limitations of the HSEES system during the 1990–1992 reporting period included the nonrandom selection of participating states and the narrow definition of an emergency event. To improve the representativeness of these data for the United States, the system has been expanded to additional states and the number of reportable substances has been increased. The definition of an emergency event was expanded January 1, 1993, to include all hazardous substances except petroleum products. This new definition will increase the likelihood of detecting public health consequences from releases of newly developed and produced substances.

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Dengue Surveillance — United States, 1986–1992

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Abstract

Problem/Condition: Dengue is an acute, mosquito-transmitted viral disease characterized by fever, headache, arthralgia, myalgia, rash, nausea, and vomiting. The worldwide incidence of dengue hemorrhagic fever (DHF) and dengue shock syndrome (DSS) increased from the mid-1970s through 1992. Although dengue is not endemic to the 50 United States, it presents a risk to U.S. residents who visit dengue-endemic areas.

Reporting Period Covered: 1986–1992.

Description of System: Dengue surveillance in the 50 United States and the U.S. Virgin Islands relies on provider-initiated reports to state health departments. State health departments then submit clinical information and serum samples to CDC for diagnostic confirmation of disease among U.S. residents who become ill during or after travel to dengue-endemic areas and among residents of the U.S. Virgin Islands. In Puerto Rico, an active, laboratory-based surveillance program receives serum specimens from ambulatory and hospitalized patients throughout the island, clinical reports on hospitalized cases, and copies of death certificates that list dengue as a cause of death. Laboratory diagnosis relies on virus isolation or serologic diagnosis of disease (i.e., IgM or IgG antibodies against dengue viruses).

Results: In 1986, the first indigenous transmission of dengue in the United States in 6 years occurred in Texas; from the time of that incident through 1992, however, no further endemic transmission was reported. During 1986–1992, CDC processed serum samples from 788 residents of 47 states and the District of Columbia. Among these 788 residents, 157 (20%) cases of dengue were diagnosed serologically or virologically. Of the 157 patients, 71 (45%) had visited Latin America or the Caribbean; 63 (40%), Asia and the Pacific; seven (4%), Africa; and nine (6%), several continents. All four dengue virus serotypes (DEN-1, DEN-2, DEN-3, and DEN-4) were isolated from travelers to Asia and the Pacific; however, travelers to the Americas acquired infections with only DEN-1, DEN-2, or DEN-4. Even though the number of laboratory-diagnosed dengue infections among travelers was small, severe and fatal disease was documented. In the U.S. Virgin Islands and Puerto Rico, three serotypes (DEN-1, DEN-2, and DEN-4) circulated during 1986–1992. In Puerto Rico, disease transmission was characterized by a cyclical pattern, with peaks in incidence occurring during months with higher temperatures and humidity (usually from September through November). The highest incidence of laboratory-diagnosed disease (1.2 cases per 1,000 population) occurred among persons <30 years of age; rates were similar for

males and females. During 1986–1991, small numbers of laboratory-diagnosed DHF cases (range: 6–17 cases) were reported each year.

Interpretation: The increase in dengue incidence throughout the tropics presents a risk both to travelers and to residents in areas of the United States where *Aedes aegypti* mosquito infestations occur.

Actions: The emphasis for dengue prevention is on sustainable, community-based mosquito control, with limited reliance on chemical larvicides and adulticides. Travelers to tropical areas can reduce their risk for dengue infection by taking appropriate precautionary measures to avoid mosquito bites (e.g., use of mosquito repellents, protective clothing, and spray insecticides). Physicians should consider dengue in the differential diagnosis of all patients who have symptoms compatible with dengue and who reside in or have visited tropical areas. Suspected dengue cases should be reported to the respective state or territorial health department, and clinical summaries and serum samples obtained from persons with suspected dengue should be sent for confirmation through the state health department laboratory to the Dengue Branch of CDC's National Center for Infectious Diseases.

INTRODUCTION

Dengue fever is an acute, mosquito-transmitted viral disease characterized by fever, headache, arthralgia, myalgia, rash, nausea, and vomiting. Infections are caused by any of four virus serotypes (DEN-1, DEN-2, DEN-3, and DEN-4). Although dengue is not endemic in the 50 United States, it presents a risk to U.S. residents who visit dengue-endemic areas throughout the world. More than 400 cases of introduced dengue were reported for 1977 through 1992 (*1–8*). Two competent mosquito vectors (*Aedes aegypti* and *Aedes albopictus*) are found in the southeastern states, and both could possibly transmit an introduced virus (Figure 1) (*9–11*).

Most dengue infections result in relatively mild illness, but some can produce dengue hemorrhagic fever (DHF), which is characterized by fever, low platelet count, minimal to severe hemorrhagic manifestations, and excessive capillary permeability. If any sign of circulatory failure is evident, the condition is referred to as dengue shock syndrome (DSS). The fatality rate for patients with DSS may be high (12%–44%) (*12*). Dengue is endemic in most tropical areas throughout the world (Figure 2), but DHF and DSS are reported most commonly in Southeast Asia.

Ae. aegypti is the principal vector mosquito for epidemic dengue. Although this species was nearly eradicated from the Americas in the 1960s, it is now found in all countries of the region except Bermuda, Canada, the Cayman Islands, Chile, and Uruguay (Figure 3). Dengue epidemics were relatively infrequent in the Americas before 1977, but the disease is now endemic in the Caribbean and most countries of Central and South America. Three of the four serotypes (DEN-1, DEN-2, and DEN-4) have been circulating in the Americas since 1981, but DEN-3 transmission has not occurred in the region since 1977 (*13,14*).

The first case of DHF with laboratory-diagnosed dengue in the Americas was detected in Puerto Rico in 1975 (*15*). An epidemic of DHF (caused by DEN-2) in Cuba in 1981 resulted in >10,000 cases of severe hemorrhagic fever and 158 deaths. From the time of the 1981 epidemic through 1992, sporadic cases of DHF were reported in most countries in the Caribbean region and from Brazil, Colombia, Ecuador, Suriname, and Venezuela (Figure 4). During 1984–1992, dengue epidemics with associated cases of

DHF occurred in Aruba, Brazil, Colombia, El Salvador, French Guiana, Honduras, Mexico, Nicaragua, Puerto Rico, St. Lucia, and Venezuela. Cuba is the only country of the region that has eliminated dengue as a health problem, through the near eradication of *Ae. aegypti* on the island. In October 1993, a dengue fever epidemic occurred in Costa Rica, which had maintained an *Aedes-aegypti*–free territory for many years but was recently reinfested with the mosquito. Panama, which had maintained low levels of mosquito populations and had prevented the occurrence of endemic dengue, also reported locally acquired disease in late 1993.

The worldwide incidence of DHF/DSS has increased substantially since the mid-1970s, primarily because of larger epidemics and an expanding distribution of disease in Asia (*14*). In China, epidemic dengue fever occurred in 1978 for the first time in >35 years. In Taiwan, an epidemic occurred in 1981. All four serotypes were identified in both countries, and China experienced its first epidemic of DHF/DSS in 1985 (*16*). In western Asia, major epidemics of DHF/DSS occurred for the first time in India (1982), the Republic of Maldives (1985), and Sri Lanka (1989) (*14*). In most countries of Southeast Asia, dengue is hyperendemic (with all four serotypes circulating simultaneously) and has a stable transmission pattern with periodic DHF/DSS epidemics occurring every 3–5 years. In these countries, DHF/DSS has become a frequent cause of hospitalization and death, with more than a million cases reported from 1986 through 1990 (*17*). In 1990, a resurgence of dengue fever/DHF began in Singapore—despite a mosquito control program that had been successful since its initiation in 1968. During the 1980s, major epidemics occurred in both East and West Africa; and, although surveillance data for dengue and DHF in Africa are sparse, all four serotypes were documented on the continent. The increases in dengue activity in Africa, the Americas, and

FIGURE 1. Distribution of *Aedes aegypti* and *Aedes albopictus* mosquitoes — United States, 1992

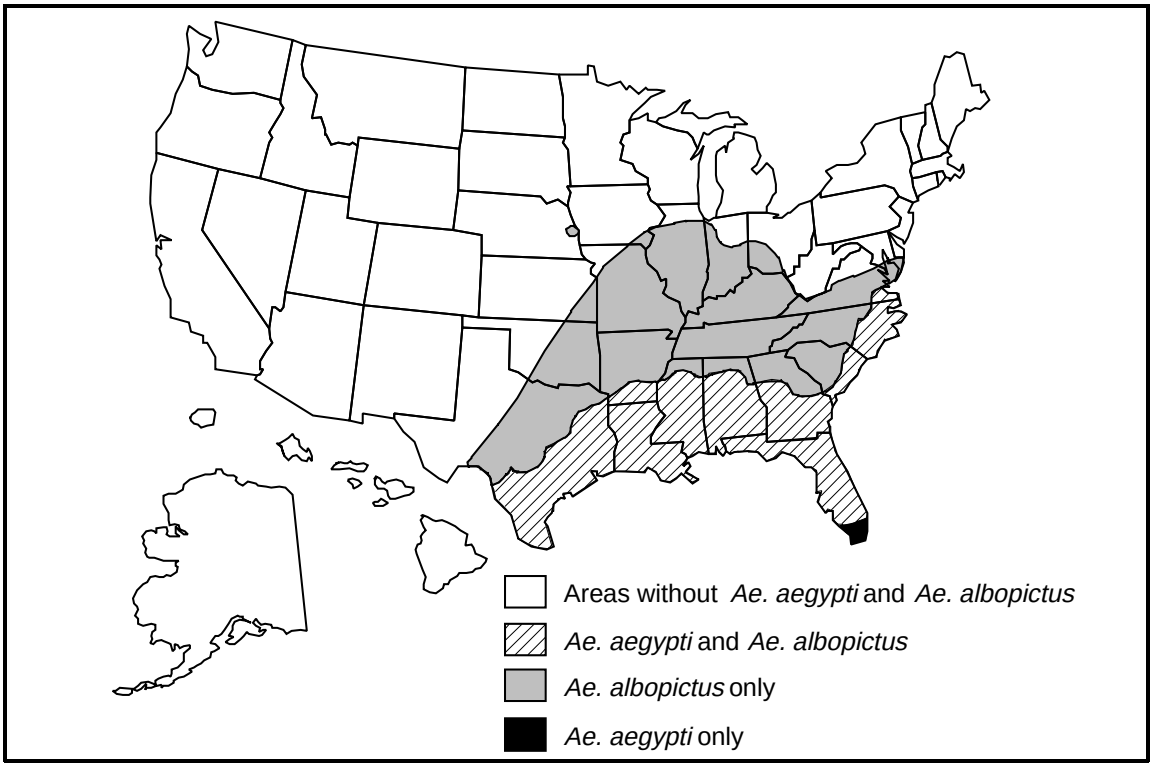


FIGURE 2. Distribution of dengue — worldwide, 1993

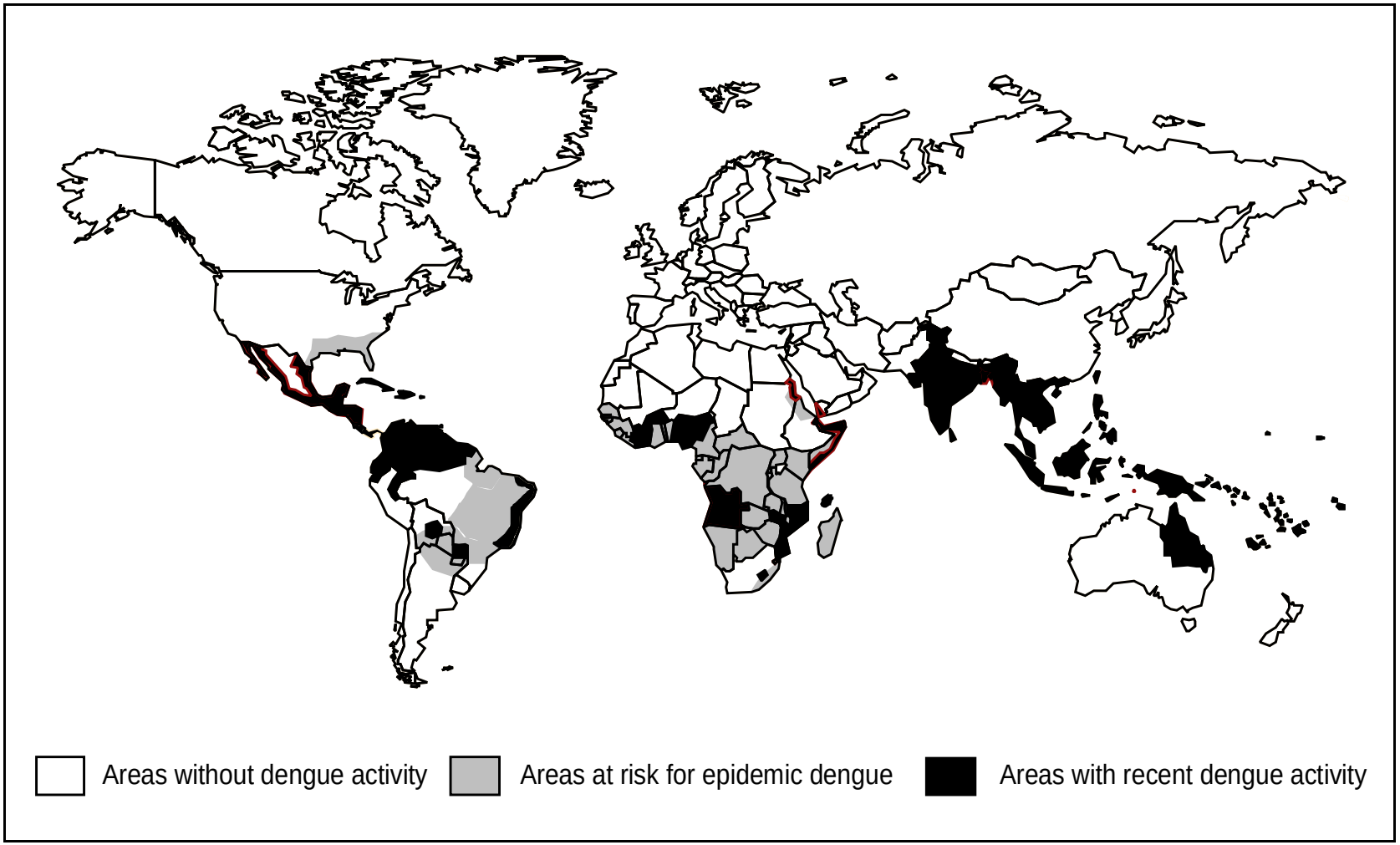


FIGURE 3. Distribution of *Aedes aegypti* mosquitoes — the Americas, 1970 and 1993

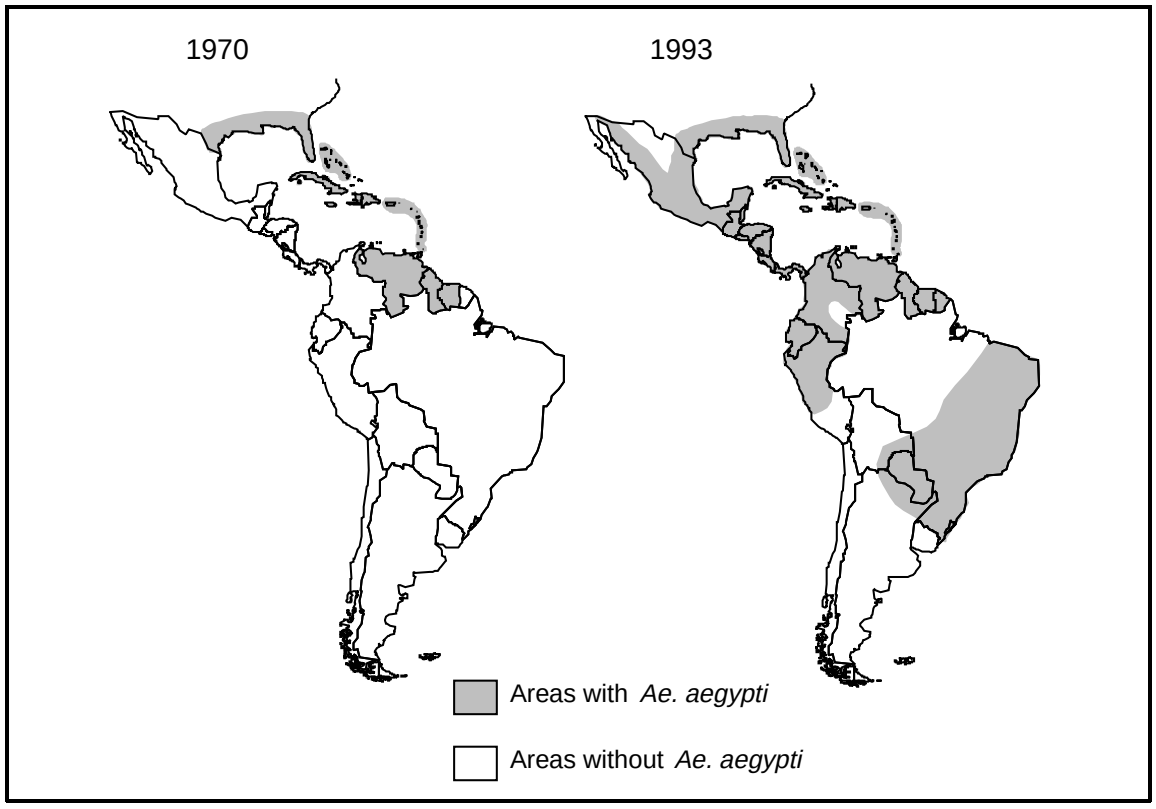


FIGURE 4. Distribution of dengue hemorrhagic fever (DHF) — the Americas, 1981–1992

Asia represent a pandemic that is being facilitated by increased air travel; global urbanization; population growth; greater abundance of disposable, nondegradable containers that can serve as *Aedes* breeding sites; and lack of effective mosquito control (*13,14*). This report summarizes information about cases of dengue virus infection in the 50 United States and in Puerto Rico and the U.S. Virgin Islands.

METHODS

Surveillance Procedures

To evaluate dengue activity at national and international levels, CDC maintains several overlapping surveillance systems. Dengue surveillance in the 50 United States and the U.S. Virgin Islands relies on provider-initiated reports to the appropriate state or territorial health department. These health departments then submit serum samples and clinical information obtained from persons who have suspected cases of dengue to CDC for diagnostic confirmation. Additionally, other countries submit samples to CDC for diagnostic analysis or confirmation. Serum samples from suspected dengue cases are accompanied usually by a clinical summary; dates of onset of illness and blood collection; and epidemiologic information, including a detailed travel history with dates and location of travel.

In Puerto Rico, CDC maintains an active laboratory-based surveillance program to provide early and precise information to public health officials regarding time and location of transmission, dengue virus serotype, and disease severity (*18*). CDC receives serum specimens from government clinics, public and private hospitals, and physicians' offices throughout Puerto Rico. These specimens are sent directly by physicians or collected locally and transported to CDC by staff of the Puerto Rico Department of Health. CDC also receives a copy of those death certificates filed in Puerto Rico that list dengue as a cause of death. A special system of surveillance for hospitalized dengue patients was started in 1984. As currently structured, this system relies on the assistance of hospital nurse epidemiologists (infection control practitioners), who provide detailed clinical information about hospitalized patients who have suspected cases of dengue. Community serosurveys are performed periodically at locations in Puerto Rico.

Laboratory Methods

Since 1984, serum specimens have been tested, using the IgM capture enzyme-linked immunosorbent assay (MAC-ELISA), for anti-dengue IgM antibody to a mixture of four dengue virus antigens (*19–21*). Specimens with positive virus isolation or borderline results by MAC-ELISA were evaluated further with hemagglutination-inhibition (HI) testing (adapted to microtiter) (*22*) or, after October 1992, with an IgG-ELISA (*23*). Dengue viruses were identified with serotype-specific monoclonal antibodies in an indirect fluorescent antibody (IFA) test on either virus-infected C6/36 mosquito cell cultures or tissues from inoculated *Toxorhynchites amboinensis* or *Ae. aegypti* mosquitoes (*24–26*).

Case Definitions

A *reported case* of dengue was defined as an illness diagnosed as dengue by a health-care professional who subsequently notified the state or territorial health

department. A *probable case* was defined as an illness that was clinically compatible with dengue in a person who had a positive IgM antibody test on a single late-acute– or convalescent-phase serum specimen, an HI titer ≥1,280, or an equivalent IgG-ELISA antibody titer ≥163,840. A *confirmed case* was defined as a probable case that met any of the following additional criteria for diagnosis: a) isolation of dengue virus from serum or autopsy tissue samples, b) a fourfold or greater change in IgG antibody titers in paired serum samples, or c) the demonstration of dengue virus antigen in autopsy tissue or serum samples by immunofluorescence or by viral nucleic acid detection (*27*). In this report, both probable and confirmed cases are considered *laboratory-diagnosed cases*.

According to the World Health Organization, a case of DHF must fulfill the following criteria: fever, minor or major hemorrhagic manifestations, thrombocytopenia (≤100,000/mm^3), and objective evidence of increased capillary permeability (e.g., hemoconcentration [hematocrit increased by ≥20%], pleural effusion [by chest radiography or other imaging method], or hypoalbuminemia). A case of DSS must meet all these criteria plus hypotension or narrow pulse pressure (≤20 mm Hg) (*28*).

RESULTS

Dengue in Texas, 1986

In 1986, after several years of intense dengue transmission in Mexico, the first indigenous transmission of dengue in the United States in 6 years occurred in Texas (*2,29*). The previous indigenous transmission, which occurred in 1980 after an absence of 35 years, had also occurred in Texas (*30*). Five of the 14 CDC-confirmed cases reported from Texas during 1986 were probably imported; the remainder of these patients had not traveled outside the state, suggesting that the infections were acquired locally. Four cases were reported from Brownsville; three cases, Corpus Christi; and two cases, Laredo. A DEN-1 virus was isolated from one of these nine patients. Three (1%) blood samples from a random sample of 315 patients at sexually transmitted diseases clinics in southern Texas were positive for dengue-specific IgM antibodies, indicating dengue infection had been acquired within the 2–3 months preceding the serosurvey (*2*). No further evidence of endemic dengue transmission in Texas was reported through 1992.

Imported Dengue in the United States, 1986–1992

From 1986 through 1992, CDC's Dengue Branch processed serum samples from 788 residents of 47 states (including Texas) and the District of Columbia to confirm clinical suspicion of dengue fever acquired during travel to tropical areas. Among the 788 residents, 157 (20%) dengue cases were diagnosed serologically or virologically (Table 1). Virus serotype was identified in 18 (11%) of these cases (seven cases of DEN-1; five, DEN-2; three, DEN-3; and three, DEN-4). Travel histories were available for 150 patients who had laboratory-diagnosed dengue. The majority (71 patients) had recently visited Latin America or the Caribbean, 63 had visited Asia and the Pacific, seven had visited Africa (including Madagascar), and nine had visited several continents. Travelers in the Americas acquired infections with DEN-1, DEN-2, or DEN-4, but all four serotypes were isolated from travelers to Asia and the Pacific. Persons with laboratory-diagnosed illness most commonly reported symptoms consistent with

TABLE 1. Suspected and laboratory-diagnosed cases of imported dengue, by state — United States, 1986–1992

State	No. cases		Dengue serotype* (no. isolates)
	Suspected	Laboratory-diagnosed	
Alabama	35	3	—
Alaska	1	0	—
Arizona	2	0	—
Arkansas	18	0	—
California	26	11	(1) DEN-1, (1) DEN-3
Colorado	27	6	(1) DEN-3
Connecticut	12	2	—
Delaware	2	0	—
District of Columbia	15	9	—
Florida	23	4	(1) DEN-3
Georgia	35	8	(1) DEN-1
Hawaii	21	8	(1) DEN-2
Idaho	2	1	—
Illinois	24	7	(1) DEN-1
Indiana	6	2	—
Iowa	10	2	—
Kansas	7	2	—
Kentucky	30	0	—
Louisiana	1	0	—
Maine	3	1	—
Maryland	12	3	—
Massachusetts	72	20	(2) DEN-1
Michigan	25	6	(1) DEN-4
Minnesota	20	4	(1) DEN-1
Mississippi	5	0	—
Missouri	9	2	—
Montana	2	0	—
Nebraska	1	0	—
Nevada	1	0	—
New Hampshire	1	1	(1) DEN-2
New Jersey	13	2	—
New Mexico	7	0	—
New York	103	15	(1) DEN-2
North Carolina	9	2	—
North Dakota	2	0	—
Ohio	25	7	(1) DEN-2, (1) DEN-4
Oklahoma	3	0	—
Oregon	10	3	(1) DEN-4
Pennsylvania	13	4	—
Rhode Island	1	0	—
South Carolina	0†	0	—
South Dakota	2	0	—
Tennessee	26	1	—
Texas	63	7	—
Utah	3	0	—
Vermont	5	2	—
Virginia	11	3	(1) DEN-2
Washington	26	7	(1) DEN-1
West Virginia	0†	0	—
Wisconsin	18	2	—
Wyoming	0†	0	—
TOTAL	**788**	**157**	

*If known.
†Case reports not received during this period.

classic dengue fever (e.g., fever, rash, headache, and myalgia). At least 12 patients were hospitalized, and one patient died.

U.S. Virgin Islands (St. Thomas, St. Croix, and St. John)

A small outbreak of DEN-2 was documented in the U.S. Virgin Islands in 1986, with most cases reported from the island of St. John. The outbreak began in the latter part of 1986 and continued into 1987, when DEN-4 virus was also isolated. No hemorrhagic disease was reported (*31*). From the end of the outbreak through January 1989, a small number of laboratory-diagnosed cases occurred almost every month. Disease activity increased during August 1989 and peaked in November of that same year. At that time, the only case of DHF with laboratory-diagnosed dengue during 1986–1992 occurred in a 23-month-old child.

During 1989, 275 serum samples were submitted for patients who had symptoms compatible with dengue. Dengue was diagnosed serologically or virologically in 124 (45%) of these patients. During 1990, 339 samples were submitted for patients who had symptoms compatible with dengue; of these, dengue was diagnosed serologically or virologically in 124 (37%). Confirmation rates were similar to this overall rate for all three islands (St. Thomas, 107 [38%] of 285 cases; St. Croix, 12 [30%] of 40 cases; and St. John, five [36%] of 14 cases). That same year, low-level dengue activity was observed from March through August; a substantial increase in activity occurred during September, with incidence peaking 2 months later in November.

During 1990, DEN-2 was the dominant serotype (i.e., 19 [86%] of the 22 isolates were DEN-2); in comparison, during the previous 2 years, 44 (76%) of the total 58 isolates were DEN-1. In 1989, DEN-1 activity was associated with the aftermath of Hurricane Hugo and transmission of the virus to disaster relief workers. In 1990, 21 isolates (DEN-2 and DEN-4 serotypes) were obtained from residents of St. Thomas; in 1989, only two isolates of DEN-2 were obtained from residents of this island. Only one isolate (DEN-1) was obtained in 1990 from St. Croix, compared with 18 DEN-1 viruses and one DEN-2 virus isolated in 1989. No isolates were obtained from St. John during 1989 and 1990.

Of the 124 patients for whom dengue was diagnosed serologically or virologically during 1990 (i.e., 1.2 cases per 1,000 population), two patients (from St. Thomas) were hospitalized, and 13 (10%) had at least one mild hemorrhagic manifestation. No cases of severe hemorrhagic disease were reported from the U.S. Virgin Islands during 1990. Only 62 and 44 samples were submitted for laboratory testing from the U.S. Virgin Islands for 1991 and 1992, respectively; in comparison, an average of 302 samples were submitted annually for 1987–1990.

Puerto Rico

After the DEN-1 epidemic in 1981 and DEN-4 epidemic in 1982, Puerto Rico had a 3-year period with low-level, sporadic dengue transmission, averaging approximately 2,300 reported cases annually. In 1986, reported dengue cases increased to 10,659, with peak transmission occurring during September and October. Cases were confirmed in 71 (91%) of the island's 78 municipalities, and DEN-1, DEN-2, and DEN-4 viruses were isolated. This epidemic differed quantitatively and qualitatively from previous epidemics because of the cocirculation of multiple dengue virus serotypes and the concomitant increase in severity of the illness. Although one case of DHF with laboratory-diagnosed dengue occurred in 1975, the first deaths associated with

laboratory-diagnosed dengue infection (n=3) and the first cluster of DHF cases (n=29) occurred in 1986 (*13,15*; CDC, unpublished data).

Although the number of reported dengue cases subsequently decreased during 1987–1991, the annual levels were higher than those reported during the first half of the 1980s. Disease transmission in Puerto Rico followed a cyclical pattern, with increased incidence during months with higher temperatures and humidity. In 1987, the peak reporting months were July and August; in 1988, April and November were both peak reporting months. From 1989 through 1992, peak reporting occurred from September through November.

During 1986–1992, laboratory-diagnosed dengue cases occurred every month, and cases occurred in most of the island's municipalities. During this period, three virus serotypes (DEN-1, DEN-2, and DEN-4) circulated with varying frequency (Figure 5). A small number of laboratory-diagnosed DHF cases were reported every year (i.e., 17 cases in 1987; eight in 1988; 13 in 1989; six in 1990; and 14 in 1991). In 1991, the overall incidence of laboratory-diagnosed disease was 1.0 cases per 1,000 population. The highest incidence (1.3 cases per 1,000 population) occurred among persons 15–29 years of age; rates were similar for males and females.

CONCLUSIONS

The worldwide distribution of *Ae. aegypti* mosquitoes and the spread of dengue have caused 1,263,321 cases of DHF and 15,940 deaths during the 5-year period 1986–1990; in comparison, 715,238 cases of DHF and 21,345 deaths were reported during the 25-year period 1956–1980 (*17*). The recent increase in dengue incidence presents a risk both to travelers and to residents in areas of the United States where *Ae. aegypti* mosquito infestations occur (as demonstrated by the indigenous transmission in Texas during 1986). In the United States, imported cases of dengue are reported less frequently than are imported cases of malaria (i.e., approximately 1,200 imported cases of malaria are reported every year) (*32*). However, most dengue infections are minimally symptomatic, and probably only a few symptomatic patients submit serum samples for laboratory confirmation of dengue. Therefore, official reports of dengue incidence are probably underestimates of true incidence. Even though the number of laboratory-diagnosed dengue infections among travelers was small, severe and fatal disease was documented.

The proliferation of mosquito breeding sites has surpassed the capacity of traditional mosquito control programs to inspect premises and apply insecticides. Because a vaccine is not currently available for dengue, CDC recommendations for dengue prevention emphasize sustainable, community-based mosquito control, with limited reliance on chemical larvicides and adulticides (*33*). The Pan American Health Organization (PAHO) has held regional meetings of member countries in Barbados, Brazil, Cuba, and Venezuela to discuss strategies for disease surveillance, vector control, emergency preparedness, and program evaluation. PAHO will soon publish the *Guidelines for the Prevention and Control of Dengue and Dengue Hemorrhagic Fever in the Americas* (*34*).

Travelers to tropical areas can reduce their risk for acquiring dengue infection by taking precautions to avoid mosquito bites (i.e., using mosquito repellents, protective clothing, and spray insecticides). *Ae. aegypti* mosquitoes can be found near or inside houses, and they often rest in dark corners (e.g., inside closets and bathrooms, behind

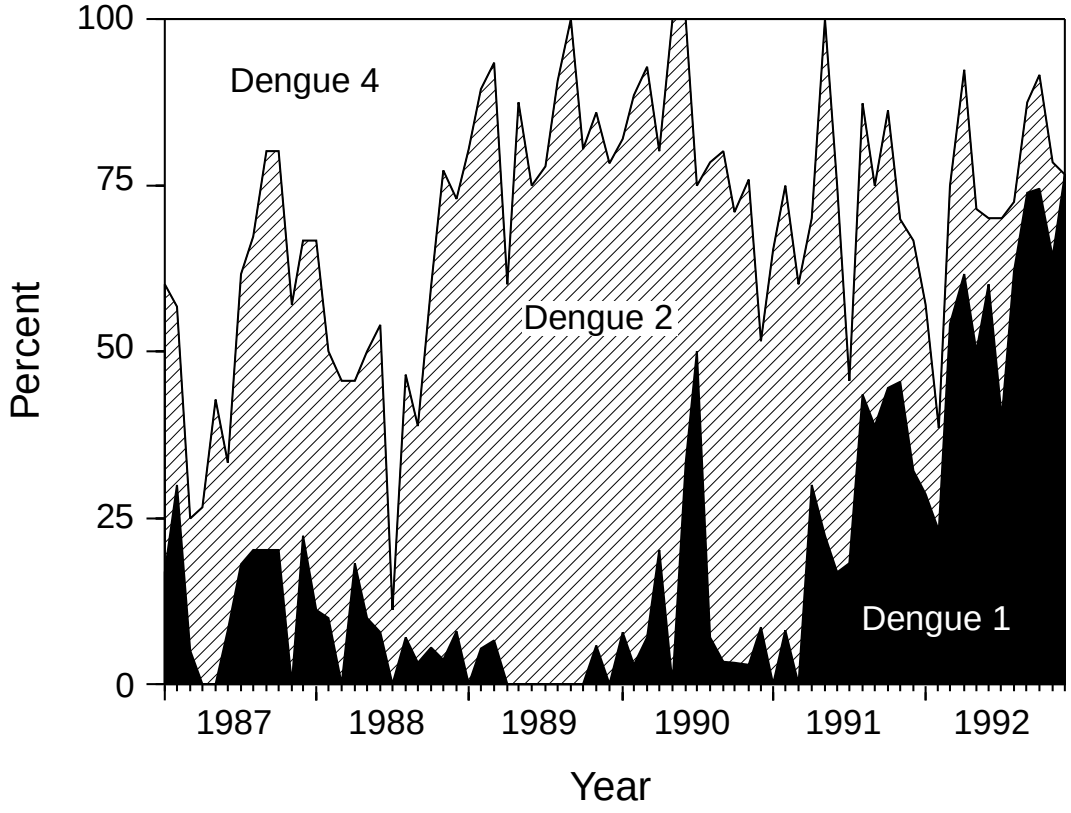
curtains, and under beds). The species bites preferentially (but not exclusively) in the early morning and the late afternoon (*35*). The risk for exposure may be lower for tourists in some settings, including beaches, hotels with well-kept grounds, and heavily forested areas and jungles.

Physicians should consider dengue in the differential diagnosis of all patients who have symptoms compatible with dengue and who reside in or have visited tropical areas. When dengue is suspected, the patient's blood pressure, hematocrit, and platelet count should be monitored for evidence of hypotension, hemoconcentration, and thrombocytopenia. Acetaminophen products are recommended for management of fever to avoid the anticoagulant properties of acetylsalicylic acid (i.e., aspirin). Acute- and convalescent-phase serum samples should be obtained for viral isolation and serodiagnosis.

Suspected dengue cases should be reported to the respective state or territorial health department; the report should include a clinical summary, dates of onset of illness and blood collection, and other epidemiologic information (e.g., a detailed travel history with dates and location of travel). Serum samples should be sent for confirmation through state health department laboratories to the Dengue Branch, Division of Vector-Borne Infectious Diseases, National Center for Infectious Diseases, CDC, 2 Calle Casia, San Juan, PR 00921-3200; telephone (809) 766-5181; FAX (809) 766-6596.

The Dengue Branch publishes the *Dengue Surveillance Summary* on a quarterly basis. This publication is available free of charge to health professionals who are

FIGURE 5. Month-to-month variations in dengue virus serotype isolations — Puerto Rico, 1987–1992



interested in the disease's distribution and manifestations and in community-based control programs. Copies can be obtained by contacting the Dengue Branch.

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State and Territorial Epidemiologists and Laboratory Directors

State and Territorial Epidemiologists and Laboratory Directors are gratefully acknowledged for their contributions to this report. The epidemiologists listed below were in the positions shown as of May 12, 1994, and the laboratory directors listed below were in the positions shown as of April 1994.

State/Territory	Epidemiologist	Laboratory Director
Alabama	Charles H. Woernle, MD, MPH	William J. Callan, PhD
Alaska	John P. Middaugh, MD	Katherine A. Kelley, DrPH
Arizona	Lawrence Sands, DO, MPH	Barbara J. Erickson, PhD
Arkansas	Thomas C. McChesney, DVM	Robert L. Horn
California	George W. Rutherford, MD	Michael G. Volz, PhD
Colorado	Richard E. Hoffman, MD, MPH	Ronald L. Cada, DrPH
Connecticut	James L. Hadler, MD, MPH	Sanders F. Hawkins, PhD (Acting)
Delaware	A. LeRoy Hathcock, Jr, PhD	Mahadeo P. Verma, PhD
District of Columbia	Martin E. Levy, MD, MPH	James B. Thomas, ScD
Florida	Richard S. Hopkins, MD, MSPH	E. Charles Hartwig, ScD
Georgia	Kathleen E. Toomey, MD, MPH	Elizabeth A. Franko, DrPH (Acting)
Hawaii	Richard L. Vogt, MD	Vernon K. Miyamoto, PhD
Idaho	Fritz R. Dixon, MD	Richard H. Hudson, PhD
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Nevada	Randall L. Todd, DrPH	Arthur F. DiSalvo, MD
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