DENED SEV VEL LANCE IN TExAS, 1995

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Abstract. Dengue epidemics have been occurring in the Caribbean and Central and South America, including Mexico. In 1995, the proximity of these epidemics increased the possibility of cases occurring in Texas. In response, medical and community educational materials were distributed and active surveillance for dengue cases was initiated. By the end of the year, sera from more than 360 patients were tested for anti-dengue antibody. Twenty-nine cases were detected statewide; seven cases in southern Texas were locally acquired.

Dengue (DEN) fever results from infection with one of four closely related dengue virus serotypes (DEN-1, DEN-2, DEN-3, and DEN-4). This mosquito-borne illness was once a significant source of morbidity in Texas. The last major outbreak occurred in 1922 when more than 40,000 cases were reported; three-fourths of these cases occurred in Galveston, Texas. In 1923 and 1924, 999 and 369 cases were reported, respectively. Over the next 26 years, excluding 1941 when there was an outbreak of 526 cases, an average of 78 cases (range = 7–257) were reported each year (Texas Department of Health [TDH], unpublished data). Dengue disappeared from Texas between 1950 and 1980, but during the 1980s, there were two outbreaks. In 1980, 63 cases of dengue were reported in Texas. Twenty-three of the patients had no international travel history. In 1986, 17 cases were reported; eight of them had no international travel history. During both the 1980 and 1986 outbreaks, DEN-1 was the only serotype isolated from patients with locally acquired infections. From 1987 through 1994 a total of seven travel-related cases were reported.

The emergence of dengue in the Americas in recent decades is a significant public health problem. Since 1980, both endemic and epidemic virus transmission has occurred throughout the Caribbean and Central and South America. In 1995, there were reports of more than 180,000 cases of dengue in South America, 68,000 in Central America, and 17,000 in Mexico (Pan American Health Organization, Communicable Disease Program, unpublished data). On August 25, 1995, the TDH was notified of an ongoing dengue fever outbreak in Reynosa, Tamaulipas, Mexico, approximately 10 miles south of McAllen, Texas in Hidalgo County. The proximity and timing of the Reynosa outbreak and the fact that the dengue virus vectors Aedes aegypti and Ae. albopictus are commonly found in much of the eastern two-thirds of Texas greatly increased the likelihood of cases in Texas. Educational and surveillance efforts were implemented and evaluated.

METHODS

Medical and community education. Because dengue was occurring at epidemic levels in many Central American countries and moving northward, the TDH published case reports of two travel-related dengue cases in Texas’ biweekly morbidity report in July 1995. When the TDH received notice of the outbreak in Reynosa, Mexico, information about dengue was sent to all infection control and infectious disease practitioners in southern Texas and to local health departments and primary care and emergency room physicians statewide. A second article providing current epidemiologic information was published in October in the state’s morbidity report. All medical education materials provided information about accessing laboratory services.

Since dengue vectors have a limited flight range, the TDH developed and distributed bilingual posters and pamphlets emphasizing the importance of basic preventive measures such as removal of mosquito breeding sites from around the household and work place, proper screening of doors and windows, and use of mosquito repellents. After the first autochthonous case was confirmed, the information was distributed via written and video news releases. Approximately seven weeks after the first press release, a telephone survey using random digit dialing was conducted to determine the knowledge level of Cameron and Hidalgo County residents, 21 years of age or older, regarding dengue.

Case ascertainment. In Texas, health care providers, hospitals, and laboratories are required to report suspect dengue cases (Communicable Disease Prevention and Control Act, Texas Health and Safety Code, Chapter 81). Dengue antibody test results for serum specimens obtained by physicians during the course of monitoring illness were obtained in three ways: 1) the TDH received copies of positive and negative results for specimens tested by the TDH Laboratory in Austin; the Houston Department of Health and Human Services (HDDHIS) Laboratory in Houston; the Dengue Branch, Centers for Disease Control and Prevention (CDC) Laboratory in San Juan, Puerto Rico; and the Center for Tropical Diseases Laboratory, University of Texas Medical Branch in Galveston; 2) hospital and clinical laboratories in Cameron, Hidalgo, and Webb Counties were contacted by telephone biweekly from October through December for dengue test results received from commercial reference laboratories; and 3) large commercial reference laboratories outside southern Texas were asked to forward test results performed on all Texas patients.

Case investigation. The TDH may investigate the incidence of communicable disease in Texas to determine the nature and extent of the disease and to formulate and evaluate control measures used to protect the public health (Texas Health and Safety Code, Chapter 81). When first specimens were reactive (antibody titer ≥ 1:20), follow-up specimens were verbally solicited from the patient’s physician. The TDH also solicited follow-up specimens for persons whose test results were initially negative. Those persons who
did not return to their doctor’s offices to have convalescent specimens drawn were visited at their home or work place. Each suspect dengue patient was interviewed using a standardized format.

**Case classification.** A case was confirmed if dengue virus was isolated from patient sera or if a four-fold or greater increase or decrease in anti-dengue antibody titer was demonstrated. A probable case had a clinical illness compatible with dengue and 1) an antibody titer $\geq 1:1,280$ by the hemagglutination inhibition assay or $\geq 1:512$ by immunofluorescent assay and/or a positive IgM test result on a convalescent phase serum sample or 2) a dengue-like illness and was epidemiologically linked to a travel-associated case.⁹

**RESULTS**

**Assessment of community education.** A total of 249 households in Cameron and Hidalgo Counties were contacted by telephone; the household response rate to the survey was 71.5%. The respondents were 71% Hispanic, 58% female, and ranged in age from 21 to 91 years. Eighty-nine percent said that they had heard about dengue fever; their principal sources of dengue information were television (73%), magazines or newspapers (34%), and radio (28%).

Of the people who had heard of dengue, 87% knew the disease was transmitted by mosquitoes. Fifty-eight percent said that they had taken steps to protect themselves, family members, and/or friends. Forty-two percent of respondents said their local health department had taken measures to protect the community from dengue.

**Case ascertainment (does not include two cases detected prior to August).** Public health laboratories (HDHHS, TDH, and CDC) tested sera from 199 Texas patients (Table 1); 41 were initially reactive and one yielded dengue virus. Investigation of the 42 patients resulted in the detection of two confirmed and nine probable cases. Two additional cases were confirmed upon receipt of convalescent sera for 21 of the remaining 31 patients whose sera were originally reactive. When letters requesting convalescent specimens were sent for patients whose sera were initially negative, 44 convalescent specimens were received. These efforts resulted in the detection of two confirmed cases.

Results were obtained for 53 acute/first sera tested through Cameron and Hidalgo County laboratories; 10 of these had reactive titers when first tested. Dengue virus was isolated from an eleventh, resulting in the confirmation of one case. Two probable cases were detected after convalescent sera were tested. Follow-up specimens were requested for patients whose sera were initially negative, 44 convalescent specimens were received. These efforts resulted in the detection of two confirmed cases.

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**Case investigation.** There were nine confirmed and 20 probable dengue cases from 10 Texas counties in 1995 (Figure 1). Six of the confirmed cases had a four-fold antibody titer increase between acute and convalescent phase serum samples; two had dengue virus isolated from acute serum specimens (DEN-2 from a patient in Hidalgo County and DEN-4 from a patient in Cameron County) coupled with a four-fold titer increase between acute and convalescent samples; and one had DEN-3 virus isolated from his acute serum sample. The confirmed/probable cases included nine males and 20 females 13–89 years of age. Signs and symptoms included fever (100%), joint/bone pain (90%), headache (83%), chills (72%), myalgias (62%), anorexia (62%), malaise (59%), rash (55%), lumbosacral pain (41%), nausea/vomiting (41%), dysgeusia (38%), retro-orbital pain (31%),

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**Table 1**

Dengue case ascertainment by reporting source*

<table>
<thead>
<tr>
<th>Initial reporting source</th>
<th>Result</th>
<th>Initial samples</th>
<th>Convalescent samples</th>
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<tr>
<td></td>
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<td>Number</td>
<td>Confirmed</td>
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<tr>
<td></td>
<td>Negative</td>
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<tr>
<td>Reference laboratories</td>
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</tr>
<tr>
<td></td>
<td>Negative</td>
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* Two cases detected prior to August are not included in this table.
Dengue fever is a mosquito-borne viral illness characterized by sudden onset, high fever, severe headaches, arthralgias, myalgias, nausea, vomiting, and rash following an incubation period of 3–14 days. The principal vector, *Ae. aegypti*, can be found all along the Gulf Coast of the United States and up to 200 miles inland. This mosquito’s larval habitats are almost exclusively water containers such as flower pots, bird baths, and old cans or tires. *Aedes albopictus* has been collected throughout the southeastern quadrant of the United States.¹⁰ Larvae of this species inhabit artificial containers, in addition to natural habitats such as tree-holes. Every year travelers to endemic and epidemic counties are infected with dengue virus.¹¹ The potential for secondary viral transmission exists in Texas, other Gulf Coast states, and beyond.

Dengue outbreaks often are not recognized until hundreds of people have been infected.¹² At this point emergency measures may be insufficient to alter the course of the epidemic. In the absence of a vaccine or other prophylactic measures, dengue prevention is promoted primarily through public education. People can eliminate breeding sites for *Aedes* mosquitoes at little or no cost by removing, emptying, or covering human-made or natural water receptacles in their neighborhoods. Almost two months after Texas’ public education campaign was initiated, the TDH surveyed residents of southern Texas to determine the extent of their knowledge of dengue. A similar survey, by Rosenbaum and others, was conducted in 1992 in Trinidad and Tobago.¹³ There, only rats and mice were considered more problematic than mosquitoes, especially in urban areas. Mosquitoes were considered a problem because they were annoying or disgusting; less than 20% of those surveyed mentioned that they were a health threat. When the results of both surveys are compared, participants in both studies were aware of dengue (93% versus 89% in Texas) and that it is caused by mosquitoes (73% versus 87% in Texas). In Texas, 58% of those questioned said they had taken steps to protect themselves. In the study of Rosenbaum and others, little relationship was found between knowledge of dengue prevention methods and actual implementation of these techniques. In fact, those who had experienced dengue were just as likely as others to have water-holding containers in their home environments. Since most interviewees in the study of Rosenbaum and others did not feel personally threatened by dengue, it was suggested that the public might better respond to messages about reducing breeding sites for nuisance mosquitoes.

It is possible that we have yet to identify all of the risk factors for dengue.¹⁴,¹⁵ Six of the seven persons with locally acquired infections lived in homes with intact screens and five lived in air-conditioned homes. Although screens and air conditioning are protective against other mosquito-borne diseases, they may not protect against dengue.¹⁶,¹⁷ One reason for this may be that dengue is transmitted by day-biting rather than night-biting mosquitoes. Daytime risk factors might include certain outdoor occupations or activities such as yard work, gardening, and walking. The TDH data suggest that in Texas, *Ae. aegypti* and *Ae. albopictus* frequently, and perhaps most often, bite out-of-doors (TDH, unpublished data).

In areas newly at risk of dengue, good case detection is only possible through timely physician education, the availability of a full complement of well-advertised laboratory tests, active surveillance, and the resources to collect follow-up specimens. Even with such efforts, cases are undoubtedly missed. As soon as the TDH learned of the Reynosa outbreak, medical educational efforts were increased. In all probability, failure to inform doctors of the problem would have had a negative impact on case ascertainment. After a nine-year hiatus, few physicians would be likely to recognize dengue’s nonspecific clinical manifestations. Since local information about disease prevalence would be expected to change the differential diagnosis for febrile patients, physician feedback was provided in mid-October.

### Table 2

<table>
<thead>
<tr>
<th>Clinical presentation</th>
<th>IgM result</th>
<th>IgG result</th>
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<td>Compatible</td>
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<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
<td>4*</td>
</tr>
<tr>
<td>Incompatible</td>
<td>Negative</td>
<td>Static</td>
<td>11</td>
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<tr>
<td>Lost to follow-up</td>
<td>Negative</td>
<td>Reactive</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>Negative</td>
<td>1†</td>
</tr>
</tbody>
</table>

*One patient had evidence of recent parvovirus infection and one had a significant rheumatologic component to his disease.

† This patient also had IgM antibody to hepatitis A virus.

**DISCUSSION**
Laboratory diagnosis of possible cases is essential in nonendemic settings because so many other illnesses cause fever and rash. It is important for laboratories to offer a full complement of test procedures with a quick turn-around. In contrast to previous years, TDH and CDC laboratory services were widely publicized in the last four months of 1995. As a result, specimens from nearly 200 people were submitted to the public health laboratories. During the same time period the previous year, only 10 specimens were submitted (TDH, unpublished data). Even so, many dengue specimens were tested at large reference laboratories. Despite their quick turn-around, multiple problems were associated with these laboratories. First, acute sera were not paired and tested with convalescent samples. Second, if a physician requested dengue IgG tests, then no dengue IgM or other flavivirus antibody tests were performed. Finally, physicians occasionally received misleading out-of-range values, leading to misinterpretation of results.

Active surveillance is of particular importance in nonendemic settings. To augment Texas’ usual passive system for case ascertainment, hospital and clinical laboratories in southern Texas and large reference laboratories were regularly contacted for dengue test results. Follow-up specimens from possible cases were solicited from the patients’ physician. Less vigorous pursuit of case reports would have significantly reduced case totals. Focusing exclusively on public health laboratories would have yielded 15 rather than 27 cases. Furthermore, failure to pursue convalescent specimens would have decreased the total number of cases by one-third. Collection of follow-up specimens from patients with initially negative titers was not as productive. Six cases were identified after analysis of 34 convalescent specimens from patients whose acute sera were reactive; only three cases were detected when follow-up specimens from 55 persons who were initially antibody negative were tested. Collection of follow-up specimens together with case investigation also allowed detection of false-positive IgM test results in five patients (Table 2).

Because dengue’s nonspecific clinical manifestations are often misdiagnosed, and for a variety of other reasons, significant underascertainment of cases is likely. For instance, half of the 16 travel-related cases diagnosed outside southern Texas were male. In contrast, 92% of the southern Texas patients were female. These data suggest that men living in border counties may be reluctant to seek health care. Moreover, infected persons living in southern Texas may not seek traditional medical care in the United States. The high rate of hospitalization during the 1986 and 1995 outbreaks also suggests that a sizeable proportion of cases may have gone undetected in these years. Only 8% of the patients in 1980 were hospitalized, whereas 29% and 34% were hospitalized in 1986 and 1995, respectively. Although this was not the first year of the Latin American epidemic, only two travel-related cases were reported during the first six months of 1995. One was reported in 1994. After the case reports were published in July, 20 travel-related cases were identified throughout the state (Figure 1). This suggests that many travel-related cases went undiagnosed and/or unreported over the previous few years.

Infection with one of the four dengue virus serotypes does not provide cross-protection, so persons living in an endemic area can have up to four infections in their lifetime. During the outbreaks in 1980 and 1986, only DEN-1 was isolated in Texas. In 1995, however, DEN-2 and DEN-4 were isolated from patients with locally acquired illnesses. Dengue 3 and the other serotypes were isolated from patients in nearby Mexico. Cocirculation of these viruses has induced a great deal of concern about dengue hemorrhagic fever (DHF) and dengue shock syndrome, serious forms of dengue fever. There has been a sharp increase in DHF cases in recent years. Although only 26 DHF cases were reported in Mexico from 1984 to 1993, 30 cases were reported in 1994, and 358 cases were reported in 1995. Since the cumulative number of reported cases during the three Texas outbreaks was only 109, the current risk for DHF in Texas is low. However, because increased trade and tourism, constant immigration, and the widespread presence of competent dengue vectors raises the potential for resurgence of endemic dengue, the threat of DHF in Texas may soon become less remote.

In summary, dengue has emerged in Central America and Mexico and stands poised at the border of the United States. In 1995, for the first time in nine years, autochthonous cases were reported in Texas. Although only seven locally acquired cases were documented, it is likely that other such cases went undiagnosed or unreported. Additional travel-associated cases may likewise have been undiagnosed or unreported. With steadily increasing tourism, business travel, and legal and illegal immigration, those regions of the southern United States with competent mosquito vectors remain at risk for local dengue transmission. The public health community can ameliorate the threat by educating the medical community and general public, making available a full complement of dengue diagnostic tests, and instituting active surveillance.

Addendum. Despite the fact that relatively few dengue cases were reported from the Mexican states that border Texas and there was a severe drought lasting well into the fall of 1996, active surveillance was once again conducted in 1996. Five cases were detected, including four males and one female 3–49 years of age. Signs and symptoms included fever (100%), headache (80%), chills (80%), nausea/vomiting (80%), myalgias (60%), respiratory symptoms (60%), rash (40%), joint/bone pain (20%), anorexia (20%), and dysesthesias (20%). One of the patients was hospitalized; there were no deaths. All five patients had traveled outside the continental United States during the two weeks prior to onset of illness. Two had been to India; the others had been to Nigeria, Puerto Rico, and Trinidad.

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