LEPTOSPIROSIS ON OAHU: AN OUTBREAK ASSOCIATED WITH FLOODING OF A UNIVERSITY CAMPUS

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Abstract. On October 31, 2004, a stream overflowed, flooding the University of Hawaii (UH) campus. On November 19, 2004, a possible flood-related leptospirosis case (Patient 1) was reported to the Hawaii State Department of Health (HDOH). Surveillance for febrile illness was established through an Internet questionnaire. Active case finding was conducted among groups involved in the flood clean-up. Free leptospirosis testing was offered by HDOH. Patient 1’s illness was confirmed as leptospirosis by microscopic agglutination testing. A total of 271 persons responded to the Internet survey, of whom 90 (33%) reported a febrile illness within 30 days of contact with flood water. Forty-eight respondents (18%) were tested for leptospirosis. One additional acute leptospirosis case was identified. Patient 2 was epidemiologically linked to Patient 1. Health care providers should maintain a high level of suspicion for leptospirosis after flooding events, and local public health officials should promote leptospirosis awareness among flood-affected populations.

INTRODUCTION

Leptospirosis is a systemic illness caused by the spirochete *Leptospira interrogans* and is considered the most common zoonosis worldwide. Humans become infected by direct or indirect contact with urine from an infected animal. Historically, leptospirosis has been most identified as an occupational disease affecting farmers, veterinarians, abattoir workers, rodent-control workers, and military troops. However, since the 1970s, national trends and local data from Hawaii have shown that most cases are related to recreational exposures. We report on two epidemiologically linked cases of leptospirosis associated with freshwater exposure after a flood on the campus of the University of Hawaii (UH). These cases underscore the importance of maintaining clinical suspicion for leptospirosis after urban flooding in endemic areas and also highlight an unusual occupational exposure.

On October 31, 2004, heavy rains caused a stream adjacent to the UH campus in metropolitan Honolulu to overflow its banks. Faculty, students, and staff, with assistance from Hawaii’s Civil Defense and National Guard, began damage mitigation efforts later that same day. Standing water on the ground floors of affected buildings slowly receded during the next week as the clean-up continued and regular campus activities resumed.

On November 19, the Hawaii State Department of Health (HDOH) was informed that a UH professor (Patient 1) had been hospitalized with suspected leptospirosis. Patient 1, a man aged 56 years, had worked in his flooded genetics laboratory during October 31–November 2 and had waded in the 6-in. of water in sandals. Subsequently, he experienced blisters on his feet. He also had broken skin on his feet as a result of a chronic skin condition. He became ill with fever, chills, nausea, and vomiting on November 10. By November 14, the fever and chills had subsided, but other symptoms developed and increased, including tremor, poor balance, and visual flashes of colored light. On November 17, he presented to a local emergency department and was hospitalized for evaluation. An acute-phase serum specimen tested for leptospirosis with a qualitative IgM enzyme-linked immunoassay (rapid EIA Dip-S-Ticks; Leptospirosis test; Panbio, Columbia, MD) on November 17 was negative. The attending physician continued to suspect leptospirosis, and Patient 1 improved with a course of oral doxycycline. A second serum specimen collected November 24 tested positive for leptospirosis, with the previously mentioned IgM EIA. No blood or urine culture was obtained. His microscopic agglutination test (MAT) result was negative for the acute-phase serum specimen from November 17, but the convalescent-phase serum specimen obtained 7 days later revealed elevated MAT titers to the following *Leptospira* antigens: Serogroup *Australis* (serovar *bratislava*), titer of 1:51,200; Serogroup *Australis* (serovar *aust ralis*), titer of 1:25,600; Serogroup *Autumnalis* (serovar *autumnalis*), titer of 1:3,200; Serogroup *Icterohaemorrhagiae* (serovar *copenhageni*), titer of 1:400; and Serogroup *Grippotyphosa* (serovar *grippotyphosa*), titer of 1:100.

MATERIALS AND METHODS

Publicity regarding Patient 1 generated concern among others who worked on campus during the flooding, as well as anecdotal reports of febrile illness among campus workers. On December 06, 2004, in collaboration with UH, HDOH established surveillance for febrile illness among faculty, students, and staff through a brief Internet-based questionnaire announced through the university’s e-mail system. The same five-question instrument was used to interview persons who had been on campus during the flooding and who contacted HDOH by telephone. Respondents were asked if they had contact with flood water and if they had become ill (with a fever) within 30 days after that contact. HDOH also conducted active case finding among other groups who worked in the clean-up, including Hawaii Civil Defense and National Guard workers and the contractor hired to direct operations. These groups agreed to report ill workers, but declined to
provide a list of employees who worked on campus during the flooding. Testing at no charge for leptospirosis was offered through HDOH. The total number of persons who were on campus during the flooding is unknown. Classes at the university were suspended for at least 1 day. In some parts of the campus, the water did not recede for 7 days.

RESULTS

A total of 271 persons responded to the survey, of whom 233 (86%) were faculty or staff, 25 (9%) were students, and 13 (5%) were contractors or volunteers. Two hundred fifty-five of 271 persons (94%) responded using the internet, whereas the other 16 contacted HDOH by telephone (5 faculty, 3 students, and 8 contractors or volunteers). Ninety of the 271 respondents (33%) reported a febrile illness within 30 days of having contact with flood water. Seventy-five of 233 faculty or staff (32%) reported fever, as did 6 of 25 students (24%) and 9 of 13 contractors or volunteers (69%).

Forty-eight of the total 271 respondents (18%) were tested for leptospirosis either through their physician or directly through HDOH. Nine of 71 faculty or staff with febrile illness (13%) had already been tested for leptospirosis before completing the survey, as had 3 of 6 students (50%) and 4 of 9 contractors or volunteers (44%). An additional 32 persons requested and received testing (29 faculty or staff, 1 student, and 2 contractors). One of 48 persons tested positive for leptospirosis by IgM EIA.

The single additional case of acute leptospirosis identified was a male graduate student aged 27 years, Patient 1, who worked in the same laboratory with Patient 1. No blood or urine culture was obtained. MAT titers on his solitary serum sample, collected 9 days after symptom onset, were elevated to the same Leptospira antigens as Patient 1: Serogroup Autumnalis (serovar bratislava), titer of 1:102,400; Serogroup Autumnalis (serovar australis), titer of 1:51,200; Serogroup Grippotyphosa (serovar grippotyphosa), titer of 1:1,600; Serogroup Autumnalis (serovar autumnalis), titer of 1:400; and Serogroup Icterohaemorrhagiae (serovar copenhageni), titer of 1:400. Patient 2 sustained a laceration to his foot on the first day of the clean-up, October 31, and continued to work in the water for the rest of that day and 4 days thereafter. He became ill on November 10 with fever, chills, nausea, diarrhea, and headache. He recovered from his illness in 1 week without treatment, but he saw a physician on November 19 for testing after learning that Patient 1 had become ill with suspected leptospirosis. Neither patient recalled any relevant exposure during the month before illness that would have put them at risk for leptospirosis apart from the flood clean-up.

DISCUSSION

The findings in this study indicate that leptospirosis infection was acquired by two or more persons working on the UH campus in urban Honolulu after flooding occurred. Patient 1 had a laboratory-confirmed case based on the 4-fold increase in MAT titers between paired acute- and convalescent-phase serum specimens. Patient 2 meets the Centers for Disease Control and Prevention (CDC) surveillance case classification for probable leptospirosis, with a single serum specimen showing a MAT titer ≥ 1:200. Both patients had exposure to flood waters on the UH campus and no other known relevant exposures. Their shared exposure history and related MAT profile provide a strong epidemiologic link. Their risk for infection was increased by having open wounds. A previous analysis of leptospirosis cases occurring during a 25-year period in Hawaii concluded that 82% of patients reported skin wounds before exposure.

Leptospirosis occurs worldwide, but the climatic conditions in tropical and subtropical regions help provide an optimal environment for survivability of leptospires. Although leptospirosis was eliminated from the list of nationally notifiable diseases in the United States in 1995, the highest reported annual incidence of leptospirosis had consistently been in Hawaii. A number of studies have documented serologic evidence of unrecognized past leptospiral infections in a substantial number of urban residents from Baltimore and Detroit. Recent outbreaks among triathletes in Illinois and Wisconsin, Eco-Challenge participants in Malaysia, canoeists in Ireland, and hog farmers in Missouri highlight the ubiquitous nature of this disease. Natural disasters (e.g., floods and hurricanes) are recognized as increasing the risk for exposure to leptospires through contact with contaminated water or mud. Two cases of leptospirosis were reported after extensive flooding affecting farmlands in Iowa in 1993. Although flooding and increased rainfall have also been associated with an increased incidence of leptospirosis in urban areas, previous reports in the literature have focused on economically disadvantaged areas with substantial rodent populations, high human population density, and poor drainage. The UH campus has only the last characteristic.

Certain occupations have traditionally been identified as being at increased risk for leptospirosis, including farming, mining, working in a slaughterhouse, sewer or septic tank cleaning, and rodent control. The circumstances of the UH flood produced a situation leading to the exposure of a profession that would not normally be at risk (academics), in a location that would not commonly be considered risky (an urban university campus).

An astute emergency department physician obtained a thorough exposure history on Patient 1 and accurately suspected leptospirosis. However, even with a thorough exposure history, diagnosis of leptospirosis is difficult because of its protean clinical manifestations and the low likelihood of positive test results during early infection. Initial symptoms of leptospirosis resemble any influenza-like illness, and later manifestations might affect different organ systems. Leptospirosis is often misdiagnosed as influenza, encephalitis, dengue fever, typhoid, hepatitis, malaria, or other infections. Consideration of leptospirosis in the differential diagnosis of any febrile illness is important because prompt appropriate antibiotic therapy can prevent development of more severe disease. Persons with Leptospira infection often have only mild symptoms or subclinical disease; however, ~5–10% present with severe manifestations, including acute renal failure, jaundice, and pulmonary hemorrhage. Case-fatality rates for persons with severe disease range from 5% to 15%. The overall 25-year case-fatality rate in Hawaii during 1974–1998 was 1.4%.

Laboratory confirmation of leptospirosis is challenging. When leptospirosis is suspected, a clinician should not wait for positive test results before initiating antibiotic treatment. The sensitivity of blood cultures is low, and culture isolation
requires special media, specialized laboratory expertise, and up to 13 weeks of incubation. A screening rapid IgM EIA is commercially available and relatively easy to perform; however, sufficient time must have passed after symptom onset for detectable antibody to develop. The optimal performance of the screening IgM EIA is from 14 to 21 days after symptom onset, when it has a sensitivity of ~90%. Although detecting antibody is possible as early as 3 days after symptom onset, its sensitivity during the first week is < 25.19

The definitive serologic diagnostic assay, MAT, requires technical expertise and maintenance of multiple live serovars. Thus, it is performed at a limited number of laboratories worldwide.3 Hawai‘i state laboratory initiated MAT testing in November 2004. For serologic confirmation of infection, paired acute and convalescent samples must indicate 4-fold rise in titer. The recommended interval for serum specimen collection is 10–14 days, but when a patient presents with overt symptoms, an interval of 3–5 days might be adequate.3

MAT is performed by using a range of antigens that cover all serogroups of leptospires and all locally common serovars. Cross-reactivity is common, especially in acute-phase sera, but as titers decline, a presumptive infecting serogroup can be identified by its persistently high titer.1 The most common serogroups identified in Hawai‘i have been Australis and Icterohaemorrhagiae.4 Titers to the Australis serogroup were extremely high in both UH patients. Although MAT results might indicate the infecting serogroup, leptospire culture results are needed for definitive identification of the infecting serogroup and serovar.20,21

Limitations of our study included delay in implementation of the survey, because the first leptospirosis case was not reported until 3 weeks after the flooding. Response to the survey was voluntary, which introduced self-selection bias. The survey was primarily promoted to the university community by e-mail, which would have excluded those without internet access. We did not have access to a list of employees or volunteers who worked on campus during the flooding, which would have allowed us to contact the workers directly. Last, because leptospirosis may be mild or asymptomatic, there were likely other cases associated with the flooding of the UH campus that were not identified.

We recommend that health care providers maintain a high level of suspicion for leptospirosis after flooding events, even in well-developed urban areas, and that local public health officials promote awareness of leptospirosis among flood-affected populations. In endemic areas, residents are often aware that such activities as swimming in freshwater streams can place them at risk for leptospirosis. This awareness might not translate to taking appropriate precautions in a disaster situation. Workers in flooded areas where Leptospirosa might be present should be encouraged to adopt appropriate protective measures (e.g., wearing well-maintained waterproof boots, washing hands with soap and clean water, and wearing long-sleeved shirts and long pants). Workers with broken skin should be reassigned if possible to avoid contact with fresh water or mud; at the least, open wounds should be protected with an occlusive dressing. Additional information on flood risks and protection can be found online at http://www.cdc.gov/niosh/topics/flood. Medical attention should be sought promptly by any person who experiences a febrile illness within a month of working in a flood-affected area.

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