Recurrence of Legionnaires Disease at a Hotel in the United States Virgin Islands over a 20-Year Period

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We investigated 3 cases of legionnaires disease (LD) that developed in travelers who stayed at a hotel in the United States Virgin Islands where cases of LD occurred in 1981–1982 and in 1998. The temperature of the potable water at the hotel was in a range that could optimally support the growth of *Legionella* species, and the potable water was colonized with *Legionella pneumophila* in 1981–1982 and in 2002–2003.

Legionnaires disease (LD) is a severe pneumonia that causes 8000–18,000 hospitalizations each year in the United States [1]. Testing for LD is often not performed for patients with community-acquired pneumonia, and only a fraction of the estimated number of cases of LD that occur annually in the United States are diagnosed [2, 3]. *Legionella* bacteria occur in freshwater environments and frequently colonize potable water systems; infection of humans may result when contaminated water is inhaled as an aerosol or is aspirated [2]. Eighty percent of reported cases of LD are not associated with a recognized outbreak [2].

One risk factor associated with LD is recent travel [4]. Travel-associated outbreaks of LD are often linked with transmission of *Legionella* bacteria in hotels [5, 6], but such outbreaks are difficult to detect because the attack rates are low and because hotel guests disperse [6]. There exists no formal system for reporting travel-associated LD in the United States. Since 1987, the European Surveillance Scheme for Travel Associated Legionnaires' Disease (EWGLINET) has aimed to rapidly identify outbreaks of LD to facilitate immediate investigations and initiation of outbreak-control measures [7].

In January 2003, the EWGLINET notified the US Virgin Islands Department of Health of 3 cases of LD in travelers who had stayed at a hotel in the US Virgin Islands where an outbreak of LD occurred in 1981–1982 [8]. We report the results of an investigation of this cluster of cases of LD.

Methods. We investigated 3 cases of LD that occurred in Danes who used the same tour operator and stayed at the same hotel (i.e., "hotel A") on St. Croix during the 2–10-day incubation period for LD in November and December 2002. We defined possible cluster-associated cases of LD as physician-diagnosed cases of pneumonia that occurred within 14 days of travel to St. Croix after 1 October 2001. We sought to identify additional cases by searching the electronic Epidemic Information Exchange (i.e., "Epi-X"; Centers for Disease Control and Prevention [CDC; Atlanta, GA]) and the Emerging Infections Network of the Infectious Diseases Society of America (Portland, OR) and by mailing a letter to >1700 visitors to St. Croix who were identified through searches of the guest lists of hotel A, 2 hotels located near hotel A on St. Croix, and the tour operator used by the 3 Danish case patients. The letter reported the cases of legionellosis that had occurred at the hotel and advised that individuals seek medical attention if they were currently ill. We also reviewed EWGLINET archives from 1989 to 2003.

The water supply, treatment, and distribution systems of hotel A were surveyed, and samples were obtained from potable and nonpotable water sources, including water from the showers and sinks in the rooms of the 3 case patients and in 3 other hotel rooms. Water samples were also obtained from a sprinkler system and a decorative fountain located at sites visited by the case patients.

Environmental samples were cultured at the CDC. Monoclonal antibody testing and amplified fragment–length polymorphism (AFLP) testing were performed to evaluate the genetic relatedness of isolates.

Results. Case patient 1 stayed at hotel A on St. Croix from 9 November to 15 November 2002 and became ill on 18 November. Case patient 2 stayed at hotel A from 23 November to 30 November 2002 and first noted symptoms on 2 December. Case patient 3 stayed at hotel A from 19 December to 29 December in 2002, and her symptoms started on 31 December. All 3 case patients visited the sites that were standard stops on the tour company's tours of St. Croix. Interviews with the case

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patients did not reveal other sites, such as restaurants, that all the case patients may have visited on St. Croix or on other islands. Two patients reported that they took showers 2–3 times per day during their trip. For all case patients, diagnosis of LD was made by *Legionella* urinary antigen testing. All patients survived.

No additional confirmed cases of LD were reported as a result of the alerts posted on electronic message boards. The medical histories of 2 letter recipients were consistent with community-acquired pneumonia (1 case of which was confirmed by chest radiography) during the 2 weeks after the recipients had stayed in hotel A on St. Croix; neither recipient was tested for LD.

The EWGLINET archives included 1 patient who had LD diagnosed by *Legionella* urinary antigen testing in 1996; he spent part of his exposure period at hotel A. The archives also included 1 patient who had LD in 1998 and who spent his entire exposure period at hotel A.

The survey of the water system at hotel A showed no water recirculation features, blind ends, or closed loops in the main building where the case patients stayed. Fifty-two water and swab samples were collected from hotel A. The median temperature of the water from all hot, cold, or "mixer" (i.e., hot/cold) taps was 34.1°C, with a minimum temperature of 26.8°C (recorded for water obtained from a sink in a guest room) and a maximum temperature of 45.8°C (recorded for water obtained from the main water heater). Municipal water was stored in a tank beneath the floor of the upper story of a hotel building. Fourteen water samples from hotel A (i.e., 27% of the total number of water samples obtained from the hotel) tested positive for *Legionella* species. Of these samples, 12 (86%) were positive for *Legionella pneumophila* serogroup 1 (Lp1), and 5 were positive for other *L. pneumophila* serogroups (i.e., serogroups 5, 7, and 10). The 12 samples that were positive for Lp1 were among the water samples and swab specimens obtained from the sinks and showers in the rooms of the 3 case patients and in 3 other guest rooms at the hotel. For all samples obtained from 2 water heaters, the storage tank, the waterfall, the outside foot wash and shower (both of which used water from the potable water system), the swimming pool, and a sprinkler system and ornamental fountain at 2 tour sites, the results of tests for *Legionella* species were negative. Six Lp1 isolates (1 isolate from a case patient and 5 environmental isolates) recovered during the outbreak of LD that occurred at hotel A in 1981–1982 were stored at the CDC, and the Statens Serum Institut of Denmark (Copenhagen) sent to the CDC the isolate recovered from the patient who had LD in 1998. These 7 isolates and the 12 Lp1 isolates obtained in 2002–2003 shared the same monoclonal antibody pattern: Lp1 Knoxville-1 (1, 2, 3).

The environmental isolates recovered during the outbreaks of LD that occurred in 1981–1982 and in 2002–2003 could each be sorted into 4 groups, respectively, on the basis of the results of AFLP testing. The AFLP patterns of groups of isolates recovered during the same sampling period were similar, but the AFLP patterns of the isolates recovered in 1981–1982 differed from those of the isolates recovered in 2002–2003. The AFLP pattern of an isolate recovered from a patient in 1998 was identical to the AFLP pattern of a group of isolates recovered in 2002–2003. This finding suggests that the potable water system at hotel A was either continuously colonized or repeatedly recolonized with the same *Legionella* strain.

In the absence of US guidelines for the control of legionellosis in hotels, the management of hotel A was advised to implement measures consistent with those outlined by the CDC and the Healthcare Infection Control Practices Advisory Committee [9]. These measures included (1) hyperchlorination of the hotel's potable water system after the investigation of an outbreak, and (2) collection of specimens for culture at 2-week intervals for 3 months and, if no legionellae were detected, on a monthly basis for 3 months thereafter. Other recommendations were daily monitoring of chlorine levels at hotel A and enhanced surveillance for cases of LD at hospitals in the US Virgin Islands. Since the implementation of these measures, no cases of LD have been identified among guests of hotel A.

Discussion. Two documented outbreaks and at least 1 sporadic case of LD have been associated with hotel A over a 20-year period. A recurrent nosocomial outbreak and persistence of LD in a single hospital over a decade have been reported elsewhere [10, 11]. Hospitals and hotels have similar predispositions for persistent transmission of LD because they are large buildings with complicated water distribution systems and have fluctuations in room occupancy that might lead to growth of *Legionella* species in standing water.

Because the cases of LD that developed in guests of hotel A in the 2002–2003 outbreak were diagnosed by *Legionella* urinary antigen testing, no isolates recovered from patients could be genetically compared with environmental *Legionella* isolates. Therefore, it is possible that the 3 case patients were not infected at hotel A. However, this seems unlikely, given the *Legionella* colonization and history of transmission of LD at hotel A, and given that the water samples obtained at other sites on St. Croix had negative results of tests for *Legionella* organisms.

The results of environmental sampling suggest that the source of transmission of legionellae was the potable water system at the hotel. Recurrence of LD at this hotel raises the possibility that the potable water system was continuously colonized with the same *Legionella* strain for >2 decades. Although the AFLP patterns of Lp1 isolates recovered during 1982 differed from those of Lp1 isolates recovered during 2002–2003, the strain isolated during 1998 had an AFLP profile that was identical to the AFLP profile of some strains isolated during 2002–2003. Multilocus sequence typing may shed light on the

relatedness of available strains from 1981 to 1982, from 1998, and from 2002 to 2003. The results of AFLP testing suggest that legionellae were reintroduced after control measures were introduced in 1982 and that at least 1 strain persisted from 1998 to 2003.

The water temperature and the fact that visitors took frequent showers suggest a possible mechanism of transmission of legionellae. The temperatures of both hot and cold potable water at hotel A were in the optimum range (i.e., 25°C–42°C) for amplification of *Legionella* bacteria; the recommended temperature ranges for the prevention of amplification of legionellae are <20°C (for cold water) and >49°C (for hot water) [12]. These factors are not specific to either hotel A or the guests. In 1981–1982, cases of LD occurred in tourists who had stayed at other hotels on St. Croix, and a serosurvey found that many local residents had evidence of previous *Legionella* infection [8]. In the tropics, year-round ambient temperatures are high enough that chilling would be necessary to keep the temperature of cold water supplies at <20°C.

Detection of this cluster of cases of LD and of previous sporadic cases of LD demonstrates the usefulness of appropriate diagnosis of LD and surveillance for travel-associated cases. All 3 case patients who were identified in 2002–2003 and 6 of 27 patients with LD who were identified in 1981–1982 were Danes, yet Danes account for <1% of visitors to the US Virgin Islands (USVI Bureau of Economic Research, unpublished data). Denmark has both a policy of testing patients with community-acquired pneumonia for the presence of *Legionella* bacteria and a central reference laboratory for the diagnosis and reporting of cases (C. Joseph, personal communication); travel-associated cases of LD diagnosed in Denmark or in 35 other collaborating countries are reported to EWGLINET. Given that US residents take >30 million trips outside the United States [13] and >1 billion trips within the United States [14] each year, a program of enhanced surveillance for LD among US travelers that is similar to EWGLINET might improve our ability to detect and intervene in travel-associated outbreaks of LD.

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