

MAJOR ARTICLE

A Newborn with Domestically Acquired Legionnaires Disease Confirmed by Molecular Typing

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***Legionella pneumophila* serogroup 6 was recovered from a bronchoalveolar lavage specimen from a 1-week-old, full-term newborn with pneumonia, as well as from water samples from the maternity hospital and the newborn's home (an apartment). Amplified fragment-length polymorphism typing revealed that the strains isolated from the newborn and her home were indistinguishable from each other but were clearly different from the hospital and control strains. To our knowledge, this is the first report of domestic acquisition of legionnaires disease in a newborn to have been confirmed by molecular typing.**

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Legionnaires disease (LD) is an important cause of nosocomial and community-acquired pneumonia. Several outbreaks of LD involving contaminated water systems have been reported. Among children, legionellae are uncommon causes of pneumonia occurring mainly in those who have underlying immunosuppressive conditions or who are receiving mechanical ventilation [1]. Among infants, LD is extremely rare, and the reported cases among neonates have been nosocomially acquired [2].

We investigated the source of culture-confirmed LD in an otherwise healthy female newborn. Because she developed respiratory symptoms at 7 days of age (4 days after discharge from the maternity ward), the infection was initially considered to be most probably nosocomial [3]. Samples from water systems in both the hospital and the home were obtained for culture for legionellae, and environmental isolates were compared with patient isolates by use of amplified fragment-length polymorphism (AFLP) analysis.

METHODS

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To determine the newborn's exposure to water aerosols before the onset of symptoms, we interviewed the mother and maternity ward nurses and reviewed medical records. Maternity hospital A has 125 beds; there were 4567 newborns delivered in 1999. Water samples (1000 mL each) were obtained from water taps in the hospital and home from sites where the child was nursed. Samples from the hot and cold water systems in the infant's home (an apartment building) were obtained before and after the interventions, and the temperature of the water from these sources was measured.

Water samples were tested for *Legionella* species using standard methods. Isolates recovered from the patient and the environment were typed according to the European Working Group for Legionella Infections (EWGLI) typing harmonization group's protocol for AFLP analysis [4]. To identify additional cases, we searched the hospital's clinical microbiology laboratory database and the National Infectious Disease Registry, a laboratory-based national surveillance system maintained by the National Public Health Institute (Helsinki).

RESULTS

Clinical description. On 2 October 1999, a healthy, full-term female newborn (weight, 3200 g) was delivered vaginally and discharged from the maternity ward at the age of 3 days. At 7 days of age, she developed respiratory symptoms, and, at 9 days of age, she was admitted to the hospital because of suspected pneumonia. At admission, the child was exhausted and had tachypnea. Oxygen saturation while breathing room air was 75%, and a chest radiograph revealed bilateral interstitial pneumonia. The WBC count was 13,500 cells/mm³, and the C-reactive protein concentration was initially 10 mg/dL, peaking at 128 mg/dL. In the intensive care unit, the newborn received ampicillin and netilmicin therapy and supplemental oxygen, but she did not need mechanical ventilation. During the next 3 days, her condition gradually improved, but the infiltrates visible on chest radiographs did not resolve. The results of blood cultures were negative.

On the newborn's 12th day of age, a high-resolution CT scan showed inflammatory changes in both lungs but no cavitations. Diagnostic bronchoalveolar lavage (BAL) specimens were obtained for bacterial, viral, and fungal cultures. Antigen tests were performed to detect legionellae and several respiratory viruses, and PCR was performed to detect cytomegalovirus, *Toxoplasma* species, *Chlamydia trachomatis*, herpesviruses, and *Mycobacterium tuberculosis*. The BAL specimen yielded *L. pneumophila* serogroup 6 on culture. The result of a direct fluorescent antibody test of bronchial secretions was also positive. Antibiotic therapy was changed to parenteral erythromycin, and rifampin was later added. When the newborn was 16 days of age, her general condition and radiological findings had improved and she was discharged from the hospital. She received 2 subsequent courses of oral azithromycin (3 days each, with an interval of 7 days).

Two weeks after discharge from the hospital, the child was healthy, and the chest radiograph abnormalities had resolved almost completely. During follow-up at age 2 years, the child was considered to have developed normally. No immunodeficiencies were diagnosed: immunoglobulin levels, the complement system, T cell subsets, and

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α -1-antitrypsin levels were normal; cystic fibrosis was excluded on the basis of the results of a sweat test.

Epidemiologic and environmental investigation. During the incubation period, the newborn was only at the hospital or at home. At the hospital, her airways were not manipulated, and she was not exposed to humidifiers or nebulizers. She was bathed twice. The newborn was exclusively breast-fed and did not drink unboiled tap water. *L. pneumophila* serogroup 6 (concentration, 500 cfu/L) grew on cultures of 2 of 10 water samples obtained from the taps in infant care rooms on 22 October 1999.

The family lived in a 1-bedroom apartment in a 72-unit building, which was built in 1972. No recent plumbing work had been done, and no cooling towers were located in the neighborhood. There was a single hot water system and no mechanical air-intake system. The temperatures of water leaving from and returning to the heat exchanger were 53°C and 40°C, respectively. *L. pneumophila* serogroup 6 grew on cultures of water samples obtained from kitchen and bathroom taps. On 25 October 1999, the concentration of *L. pneumophila* serogroup 6 in both samples was 200 cfu/L. One week later, the concentrations were 1000×10^4 cfu/L for the sample from the kitchen tap and 1.0×10^4 cfu/L for the sample from the bathroom tap. *L. pneumophila* serogroup 6 (concentration range, 2.0×10^4 cfu/L to 2.1×10^5 cfu/L) grew on cultures of samples of water leaving from and returning to the heat exchanger.

The *L. pneumophila* serogroup 6 isolates recovered from the infant and her home were indistinguishable on AFLP analysis. In contrast, isolates recovered from the 2 water sources in the maternity ward, unrelated clinical and environmental isolates, and the American Type Culture Collection control strain of *L. pneumophila* serogroup 6 (ATCC 33215) were clearly different from the patient isolate ([figure 1](#)). Active surveillance identified no additional cases of LD due to *L. pneumophila* serogroup 6 at the hospital or in the community.

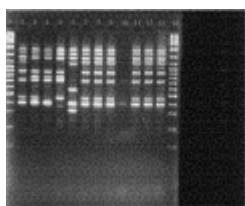


Figure 1. Results of amplified fragment-length polymorphism typing of *Legionella pneumophila* serogroup 6 strains recovered from a newborn, the maternity hospital, and the newborn's home, as well as unrelated clinical and environmental control strains. *Lanes 1 and 14*, Molecular weight markers. *Lane 2*, Strain recovered from the newborn. *Lane 6*, Strain recovered from the maternity hospital. *Lanes 7–13*, Strains recovered from the infant's home building, as follows: from kitchen and bathroom water (*lanes 7–10*), from water returning to and leaving from the furnace room (*lanes 11 and 12*, respectively), and from water from the laundry tap (*lane 13*). The unrelated control strains of *L. pneumophila* serogroup 6 are an environmental strain (*lane 3*), a clinical strain (*lane 4*), and American Type Culture Collection strain ATCC 33215 (*lane 5*).

At the maternity ward, we recommended against the use of tap water for rinsing suction catheters, and we recommended regular cleaning of the water outlets and changing of the rubber fittings of the water taps in units where immunosuppressed persons or newborns are treated. In the apartment building, the temperature of hot water leaving the heat exchanger was increased, in 2 steps, from 53°C to the highest temperature possible in the system (mean, 64°C). Legionellae were eradicated from hot water leaving the heat exchanger and from the 2 taps in the apartment. In hot water

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returning to the heat exchanger, however, legionellae were still detected at concentrations of ≈ 1000 cfu/L. After the interventions, the temperature of the water returning to the heat exchanger ranged from 42°C to 48°C ([figure 2](#)).

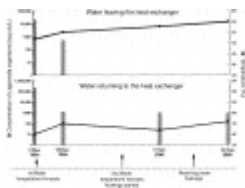


Figure 2. Concentrations of legionellae and water temperatures in the circulating hot water system of the patient's home (an apartment building) before and after interventions. The temperature of the water leaving the heat exchanger was increased to a mean of 60°C on 3 December 1999. On 5 January 1999, the temperature was increased to the highest possible (mean, 64°C) and flushings were started. On 31 January 1999, specific flushings of returning warm water were started.

DISCUSSION

The newborn's exposure history and molecular typing of clinical and environmental isolates indicated that the *L. pneumophila* infection was acquired in the home. Although the exact mechanism of transmission is unknown, it probably occurred through inhalation of aerosolized water droplets. A recent review of 9 cases of neonatal LD considered all of the cases to have been nosocomially acquired, and all but 1 of the subjects in this review had underlying conditions [2]. However, environmental testing was done for only 4 cases.

When a single case of LD is thought to have been community acquired, routine testing of water systems for legionellae is generally not recommended [5], because legionellae can often be found in the water systems of buildings and because the distribution of various subtypes of legionellae in the environment is unknown. In a study from Finland, legionellae were isolated from 30% of the hot water systems in large apartment buildings, with *L. pneumophila* serogroups 1, 5, and 6 being the most common strains [6]. Without supportive epidemiologic evidence, the interpretation of culture and typing results is difficult. Because the newborn's only potential places of exposure were the maternity ward and the home, we also tested the home's water system.

Legionellae may be concentrated in water systems if inadequate temperature, plumbing materials, design, and/or water flow make conditions favorable for bacterial growth. Identical subtypes of *L. pneumophila* have been recovered both from patients with sporadic LD and from the potable water in their homes [7]. In our study, the apartment building's hot water system was heavily contaminated with *L. pneumophila* serogroup 6, and the hot water temperature was lower than that recommended in national guidelines (i.e., $>50^{\circ}\text{C}$). No other risk factors, such as the presence of nearby cooling towers or recent plumbing work, were observed [8]. Our investigation emphasizes the need for good maintenance practices, including the maintenance of sufficiently high hot water temperatures.

The AFLP typing method may be a useful epidemiologic tool for investigating the source of LD. It has been shown to be effective in typing strains of *L. pneumophila* serogroup 1 [4, 9]. When applied in accordance with the EWGLI protocol, AFLP typing also efficiently discriminated *L. pneumophila* serogroup 6 strain isolates recovered from the newborn and her home from the strain recovered from the maternity hospital.

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Legionellae are frequent contaminants of water systems and may occasionally cause neonatal infection. The source of neonatal LD can be found in either the hospital or the community. Our investigation underscores the importance of etiologic diagnosis of severe pneumonia in newborns. It also highlights the challenge of selecting an appropriate public health response to a single community-acquired case of LD with a known source. For immunocompetent persons, the risk of LD transmission from contaminated household water supplies appears to be low [10], and it is unclear whether interventions targeted at the home water system influenced the risk of LD in other residents. Future studies should evaluate the need for environmental investigations and the cost-effectiveness of interventions in sporadic cases of LD.

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