Outbreak of Legionnaires’ disease associated with a display whirlpool spa

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Background Recognized outbreaks of Legionnaires’ disease (LD) are rare; when they occur, they provide opportunities to understand the epidemiology of the illness and improve prevention strategies. We investigated a population-based outbreak.

Methods After the confirmation of LD in October 1996 in five people in neighbouring towns in southwest Virginia, active surveillance for additional cases was undertaken. A case-control study was conducted to identify exposures associated with illness, followed by a cohort study among employees of the facility at which the source of the outbreak was located in order to assess unrecognized exposure and illness. Samples of likely sources of LD in the facility were cultured for Legionella.

Results In all, 23 laboratory-confirmed cases of LD were eventually identified. Of the 15 cases in the case-control study, 14 (93%) reported visiting a home-improvement store, compared with 12 (27%) of 45 controls (matched odds ratio [MOR] = 23.3; 95% CI: 3–182). Among home-improvement centre patrons, 10 (77%) of 13 cases questioned recalled either visiting or walking by a display whirlpool spa, compared with 3 (25%) of 12 controls (MOR = 5.5; 95% CI: 0.7–256.0). Two cases’ sputum isolates were an exact match, by monoclonal antibody subtyping and arbitrarily primed polymerase chain reaction, to a whirlpool spa filter isolate from the store. Employees reporting more exposure to the display spas were more likely to report symptoms of LD or to have an elevated titre.

Conclusions This investigation shows that LD can be transmitted from a whirlpool spa used for display only, and highlights the need for minimizing the risk of transmission of LD from all water-filled spas.

Keywords Legionnaires’ disease, Legionella pneumophila, outbreak, whirlpool spa, community-acquired pneumonia, legionellosis, urinary antigens

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Key messages This paper describes an investigation of a population-based outbreak of Legionnaires’ disease (LD). A case-control study first identified a home-improvement store as the likely source of the outbreak. An environmental investigation later confirmed that finding, as two cases’ sputum isolates were an exact match, by monoclonal antibody subtyping and arbitrarily primed polymerase chain reaction, to a whirlpool spa filter isolate from the store. The spa was intended and used for display only.

An estimated 1–5% of adult hospital admissions for community-acquired pneumonia in the US have been attributed to Legionnaires’ disease (LD).1 Outbreak investigations have determined that inhalation of aerosolized water containing the bacteria Legionella pneumophila is the primary means of acquiring legionellosis. Outbreaks of legionellosis have been traced to contaminated cooling towers2 and evaporative condensers, showers, decorative fountains, humidifiers, respiratory therapy equipment and whirlpool spas.8
During 15–23 October 1996, the New River Health District in Virginia became aware of an increase in the number of patients who had pneumonia at three community hospitals. (This increase was later quantified by a review of discharge diagnoses from January 1994 through December 1996 at the three hospitals [Figure 1].) The increase over baseline of the expected number of cases of pneumonia at one of those three hospitals prompted the infectious control nurse there to be highly suspicious that something unusual—and which merited contact with the local public health district—was occurring, and eventually it was determined that all three hospitals had an increase in their census. After consultation with the Virginia Department of Health (VDH), the local public health district director recommended that the hospitals institute expanded testing in an effort to determine the aetiology of the pneumonias. By 24 October LD was confirmed in five of the patients who had pneumonia. In a health district with very few or no cases, five was considered something unusual—and which merited contact with the local public health district—was occurring, and eventually it was determined that all three hospitals had an increase in their census. After consultation with the Virginia Department of Health (VDH), the local public health district director recommended that the hospitals institute expanded testing in an effort to determine the aetiology of the pneumonias. By 24 October LD was confirmed in five of the patients who had pneumonia. In a health district with very few or no cases, five was considered much greater than the expected level of occurrence and thus was considered an outbreak.

While public health agencies do not ordinarily investigate sporadic cases of community-acquired LD, outbreaks are investigated. Investigations include confirming the aetiologic agent, conducting active surveillance of doctors’ offices, hospitals, and laboratories in order to determine the magnitude of the outbreak, conducting epidemiological and environmental investigations in order to determine the source of the outbreak, and devising interventions that can be implemented to prevent additional cases. This paper describes such an investigation (the preliminary findings of which have been earlier described).

Methods
Case finding
Investigators reviewed medical records and laboratory reports of patients who had onset of pneumonia between 15 September and 12 November. The medical charts of patients who had suspected cases of LD, determined on the basis of admission history or hospital course, were abstracted with a standardized data collection instrument. Examples of conditions for which LD was not suspected and that did not warrant a full chart review included aspiration pneumonia and pneumonia for which an aetiology other than Legionella was confirmed.

For patients already hospitalized when the investigation started, sputum, serum, and urine were collected for Legionella culture, serological testing, and antigen detection, respectively, regardless of whether a full chart review was conducted. For recently discharged pneumonia patients, attempts were made to collect serum and urine. For patients newly hospitalized with pneumonia, nasopharyngeal swabs and washings for viral respiratory pathogen identification were collected, as well as sputum, serum, and urine for diagnostic testing. For patients with pneumonia who were not hospitalized, specimens were collected at the discretion of the attending physician. If possible, convalescent-phase sera were collected from patients 4–6 weeks after onset of symptoms.

Legionnaires’ disease is a reportable disease in Virginia; therefore, potential cases were also brought to the attention of the investigative team by health-care providers reporting confirmed cases (i.e. through passive surveillance).

Laboratory methods
Sputum specimens collected from pneumonia patients were forwarded to either the Laboratory Corporation of America (LabCorp, Burlington, NC) or the Centers for Disease Control and Prevention (CDC). Specimens were plated on both selective and non-selective buffered charcoal yeast extract (BCYE) using previously described methods. Isolates from either laboratory were subtyped initially using a panel of monoclonal antibodies at CDC. Isolates also were analysed at CDC by arbitrarily primed polymerase chain reaction.

Urine samples were tested for the presence of Legionella urine antigen by using either an RIA kit (Binax, Portland, ME) at CDC or an EIA kit (Binax, Portland, ME) at LabCorp.

The state public health laboratory, Division of Consolidated Laboratory Services (DCLS, Richmond, VA) analysed all serum samples for the detection of antibody to L. pneumophila (serogroups 1–6) with a commercial indirect fluorescent antibody kit (Organon Teknika, Durham, NC). The DCLS also analysed nasopharyngeal specimens for the detection of respiratory viruses influenza A and B, parainfluenza 1, 2, and 3, respiratory syncytial virus, and adenovirus. Specimens were inoculated on to monolayer cell cultures of primary Rhesus monkey kidney (Viromed Laboratories, Inc., Minneapolis, MN) and A549 (Bartles, Inc., Issaquah, WA) cell lines.

Case definition
For the purposes of this study, a confirmed case of LD was defined as radiographically evident pneumonia in a resident of New River Valley who had onset of illness during 15 September through 12 November and who had laboratory evidence of LD. Laboratory evidence of LD was defined as isolation of Legionella from respiratory secretions, detection of L. pneumophila serogroup 1 (Lp1) antigens in urine by enzyme immunoassay or radioimmunoassay, or a fourfold rise in Legionella antibody titres to ≥1:128 between paired acute- and convalescent-phase sera.

Case-control study
To identify the source of the outbreak, members of the investigation team used a standardized open-ended interview form to obtain responses concerning the case patients’ health, work status and location, modes of transportation, time spent at home, recent travel history, home water supply, showering, and visiting...
of local businesses, local industrial plants with cooling towers, and other areas within the 2 weeks preceding onset of illness.

Three control subjects were selected for each case patient enrolled in a matched case-control study. Each control subject was chosen either from the office records of a case patient’s primary-care physician, or from another primary-care medical practice near the case patient’s residence if an appropriate control could not be located using the office records of the case patient’s physician’s practice, or if the case patient did not have a primary-care physician. Control subjects were matched with case patients for age (i.e. within 10 years), sex, and underlying medical condition (Table 1). Potential control subjects were excluded if they reported having had a fever and cough during September or October. From 2 to 9 November, interviews were conducted in person, using a standardized data-collection instrument, with case patients and control subjects to ascertain how frequently they had visited 14 facilities (including retail businesses and manufacturing plants) in New River Valley during the 2 weeks preceding the date on which the matching case patient had onset of illness. Detailed information was collected concerning exposures to water sources within the three facilities visited most frequently by case patients. Other potential exposures, including exposure to other popular shopping locations and potential sources of aerosolized water in the home and community, also were assessed. Data were analysed with Epi-Info (version 6.02)\(^18\) and SAS (version 6.11)\(^19,20\) software. All odds ratios represent conditional maximum likelihood estimates and CI were calculated for each one. An announcement implicating the source of the outbreak was made on 14 November, 5 days after completion of the case-control study.

**Environmental investigation**

Because early open-ended hypotheses-generating interviews conducted during 25–31 October suggested a popular home-improvement centre as the strongest common link between the case patients, the environmental investigation focused on this store. Sampling of likely sources of water in the store’s numerous departments was initiated on 28 October in an effort to identify potential sources of contamination and prevent further exposures. Water samples were collected in sterile one-litre polypropylene bottles from (a) the employee and patron restroom tap water faucets, (b) a freshwater hose and decorative goldfish pond in the greenhouse, and (c) a still-functioning whirlpool spa basin.

In recent years, whirlpool spas have become popular in home-building and remodelling, in addition to their use near outdoor and indoor swimming pools, and in fitness centres, hotels, ski resorts, and other recreational facilities. These spas resemble very large bath tubs, with seats in the sidewalls. They vary in size from two-person to ten-person models. Equipped with heaters and filtration systems, pumps re-circulate heated water and release it under pressure back into the basin of the spa. The ‘whirlpool’ refers to the circular movement of the heated water that is created from this release.

Moist areas that could have supported *Legionella* growth were sampled with sterile polyester-tipped swabs. Swabs of the whirlpool spa bubblers, filter cabinet, and grates were sealed in conical tubes with 2–3 ml of spa water to maintain the specimen. Two canister-type filters from the spa were put into separate, dry, clean plastic bags and sent for analysis. Additional moist swab samples were collected from public bathroom urinal fresh-water inlets, a sink tap aerator in an employee break area, employee and patron water fountains, and a fountainhead in a goldfish pond.

A whirlpool spa filter from a second display spa, which was no longer in the store but which had not yet been installed in the purchaser’s home, also was shipped to CDC. *Legionella* isolation was attempted according to an established CDC protocol.\(^{21}\) In addition to filtering the water obtained from the filter housing, the filter was immersed in one litre of sterile water using a 2-l beaker. After allowing the filter to soak for one hour, the filter was removed and the remaining water was filtered and cultured.

**Employee study**

Following completion of the case-control study, a cohort study was undertaken during 15–18 November to determine whether employees of the home-improvement centre had been exposed to *Legionella*, and, if so, whether they had become ill.

Using a standardized instrument, consenting employees who agreed to be interviewed were questioned regarding work locations within the store, the amount of time spent near the spa display on a typical work day, and a description of any illness during September and October. An attempt was made to collect serum specimens from each participating employee for the determination of a single *Legionella* antibody titre.

To compare exposure to the whirlpool spas between employees who worked different numbers of hours per week, the amount of time a worker reported spending near the whirlpool spas on a typical day was multiplied by the number of days worked in a typical week of September and October. To examine whether a dose-response relationship existed between spa exposure and a reported illness, weekly exposure to the spas was divided into categories based on the median, 75th percentile, and maximum exposures calculated for the employees. Minutes of exposure were then rounded to the nearest whole number.

**Table 1** Underlying medical conditions categories for case-control study

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category 1</strong></td>
<td>None of the conditions listed in categories 2 or 3</td>
</tr>
<tr>
<td><strong>Category 2</strong></td>
<td>Alcoholism, Congestive heart failure, Chronic pulmonary disease (including emphysema), Diabetes, History of cancer (other than basal or squamous skin cancers, or haematological), Renal failure requiring dialysis</td>
</tr>
<tr>
<td><strong>Category 3</strong></td>
<td>Acquired immunodeficiency syndrome, Use of steroids(^a) within 6 weeks of date of onset, Treated for cancer with chemotherapy within 6 weeks of date of onset, History of leukaemia, lymphoma, or myeloma, Transplant recipient</td>
</tr>
</tbody>
</table>

\(^a\) >5 mg/day of prednisone for at least 2 weeks or currently taking dexamethasone.
Results

Case finding

Legionnaires' disease was confirmed in 23 case patients. Onsets of illness were between 29 September and 22 October, with 18 (78%) occurring between 8 and 14 October (Figure 2). Two (9%) patients died. The median age of the case patients was 66 years (range: 42–86 years); 17 (74%) were men. Seven case patients had no underlying medical condition known to be associated with LD (Table 2). The only known medical risk factor for three case patients was past or current smoking. Of the 13 case patients in the moderately and strongly increased risk categories, 11 also reported a history of smoking. Many of the case patients had multiple medical conditions.

Of the 23 confirmed cases of LD, 15 were confirmed by detection of Lp1 antigens in urine; 3 by isolation of Lp1 in sputum; and 7 by a fourfold rise in Legionella antibody titres. Two case patients had Legionella isolated from sputum and Lp1 antigens detected in urine; four had positive serology and at least one other positive test. No viral or other pathogens were identified from 31 nasopharyngeal specimens collected from pneumonia cases during the heightened surveillance that took place during the outbreak.

Case-control study

Of the 16 case patients who had LD confirmed at the time the case-control study began, 15 were included in the study—the family of one patient who died declined to be interviewed. The dates of onsets of illness of the 15 case patients ranged from 29 September through 22 October, with 12 (80%) occurring during 8–14 October. Eight (53%) of 15 case patients, compared with 9 (20%) of 45 control subjects (matched odds ratio [MOR] = 19.5; 95% CI: 1.6–233.8), were current (versus never) smokers. Of the eight case patients not included in the study because of death or late confirmation of LD, six (75%) had onset of illness occurring during 8–14 October. The median age of the case patients included in the case-control study was 70 years (range 42–86 years); 13 (87%) were men.

Fourteen (93%) of 15 case patients, compared with 12 (27%) of 45 control subjects (MOR = 23.3; 95% CI: 3.0–182.0) recalled having been to the home-improvement centre within the 2 weeks preceding onset of illness (Table 3). Ten (67%) case patients had visited a discount variety store (‘Variety store #1’ in Table 3).

Table 2 Risk factors associated with confirmed cases of Legionnaires' disease (LD) (n = 23)

<table>
<thead>
<tr>
<th>Risk category</th>
<th>No. of confirmed casesa</th>
</tr>
</thead>
<tbody>
<tr>
<td>No known conditions</td>
<td>7</td>
</tr>
<tr>
<td>Past or current smoking only</td>
<td>3</td>
</tr>
<tr>
<td>Moderately increased riskb</td>
<td>10</td>
</tr>
<tr>
<td>Strongly increased riskb</td>
<td>3</td>
</tr>
</tbody>
</table>

a Eleven people who had confirmed cases of LD reported moderately or strongly increased risk AND past or current smoking.

b See Table 1 for definition of these terms.

Table 3 Association of visiting retail establishments with contracting Legionnaires' disease using a matched case-control study

<table>
<thead>
<tr>
<th>Site</th>
<th>Case patients (%) (n = 15)a</th>
<th>Control subjects (%) (n = 45)</th>
<th>Matched odds ratio (95% CI)</th>
<th>Adjusted matched odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home-improvement centre</td>
<td>14 (93)</td>
<td>12 (27)</td>
<td>23.3 (3.0–182.0)</td>
<td>22.2 (2.5–199.0)</td>
</tr>
<tr>
<td>Variety store #1</td>
<td>10 (67)</td>
<td>15 (33)</td>
<td>3.7 (1.1–12.6)</td>
<td>1.1 (0.2–6.3)</td>
</tr>
<tr>
<td>Supermarket</td>
<td>6 (46)</td>
<td>6 (13)</td>
<td>(not calculable)b</td>
<td></td>
</tr>
<tr>
<td>Variety store #2</td>
<td>3 (21)</td>
<td>7 (16)</td>
<td>1.3 (0.3–5.9)</td>
<td></td>
</tr>
<tr>
<td>Variety store #3</td>
<td>3 (23)</td>
<td>7 (16)</td>
<td>1.6 (0.4–7.6)</td>
<td></td>
</tr>
<tr>
<td>Restaurant #1</td>
<td>3 (21)</td>
<td>5 (11)</td>
<td>1.9 (0.4–8.8)</td>
<td></td>
</tr>
<tr>
<td>Industrial plant #1</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>(not calculable)b</td>
<td></td>
</tr>
<tr>
<td>Electrical supply store</td>
<td>1 (7)</td>
<td>0 (0)</td>
<td>(not calculable)b</td>
<td></td>
</tr>
<tr>
<td>Restaurant #2</td>
<td>0 (0)</td>
<td>5 (7)</td>
<td>(not calculable)b</td>
<td></td>
</tr>
<tr>
<td>Restaurant #3</td>
<td>1 (7)</td>
<td>1 (2)</td>
<td>3.0 (0.2–48.0)</td>
<td></td>
</tr>
<tr>
<td>Industrial plant #2</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>(not calculable)b</td>
<td></td>
</tr>
<tr>
<td>Variety store #4</td>
<td>4 (29)</td>
<td>4 (9)</td>
<td>4.4 (0.8–24.9)</td>
<td></td>
</tr>
<tr>
<td>Musical instrument store</td>
<td>0 (0)</td>
<td>1 (2)</td>
<td>(not calculable)b</td>
<td></td>
</tr>
<tr>
<td>Mall</td>
<td>6 (40)</td>
<td>11 (25)</td>
<td>2.2 (0.5–8.9)</td>
<td></td>
</tr>
</tbody>
</table>

a n not equal to 15 for all variables because all participants did not answer all questions.

b 'Not calculable' was due to either: (1) no pairs of exposed control subject/unexposed case patient or (2) no case patient and/or control subject having reported visiting that location.
located 0.5 miles from the home-improvement centre, compared with 15 (33%) control subjects (MOR = 3.7; 95% CI: 1.1–12.6). Six (43%) of the 14 case patients for whom this information was known had visited a supermarket ("Supermarket"), compared with 6 (13%) control subjects (MOR could not be calculated, as there were no exposed controls who were paired with an unexposed case patient). Of the case patients and control subjects who reported visiting the home-improvement centre, case patients (10 [71%] of 14) were no more likely than control subjects (8 [67%] of 12) to have also visited the discount variety store (adjusted MOR = 1.1; 95% CI: 0.2–6.3); of case patients and control subjects who reported visiting the discount variety store, the case patients (10 [100%] of 10) were more likely than controls (8 [53%] of 15) to have also visited the home-improvement centre (adjusted MOR = 22.2; 95% CI: 2.5–199.0).

Among study participants who recalled visiting the home-improvement centre and who could provide a detailed account of their in-store exposure, case patients averaged 79 minutes at the home-improvement centre during the 2 weeks preceding onset of illness, compared with 29 minutes for 12 control subjects (F-test P < 0.01). Within the home-improvement centre, 10 (77%) of the 13 case patients recalled either visiting or walking by a display whirlpool spa, compared with 3 (25%) of 12 control subjects (MOR = 5.5; 95% CI: 0.7–256.0). No increased risk associated with exposures to other water sources was identified. Only two case patients and three control subjects recalled having visited the greenhouse; only two case patients and no control subjects had been in either of the two restrooms in the store; and only one case patient and no control subjects reported drinking from either of the water fountains.

Environmental investigation

Following initial inspection, on 28 October, the home-improvement centre complied with the investigation team's request to turn off a display whirlpool spa (Spa 1) and any other potential sources of Legionella (e.g. the decorative goldfish pond and overhead water hoses). Store employees were interviewed to obtain information on the spa displays and its maintenance, and it was learned that a second spa (Spa 2) had been sold to a store employee. Spa 2 had been on display next to Spa 1 until the display was dismantled on 9 October 1996. The display whirlpool spa tubs were separate, self-contained units that had used closed, heated circulation systems and paper filter cartridges. They had been kept filled with municipal water. During the store's daily operation (from 7.00 a.m. to 9.00 p.m.), bubble jets could be turned on by customers or store employees for demonstration; turning on the bubble jets resulted in turning off the heater. Disinfection was provided by a plastic floating bromine-feeding device, which was replaced when the brominator flipped over (indicating it was empty). Interviews with store employees revealed that the paper filter cartridges had not been changed during almost 2 years of operation. Bromine levels were not monitored on a regular basis. Water in the tubs was changed completely every 6 months (the last draining and refill prior to this investigation had been in May 1996); in the interim, water was added to the tubs when necessary. After the 9 October dismantling of the display, Spa 1 was cleaned, refilled, and placed back on display—without a filter change—on 17 October.

A total of three spa filters were available for laboratory testing. One filter was obtained from Spa 2, which had been removed from the store 2 days after it had been drained on 9 October, though not operated since its purchase. The other two filters were from Spa 1. Lp1, monoclonal type 1, 2, 5, 6 was isolated from the previously sterile water in which the filter of Spa 2 was immersed. Two of the three available clinical isolates had the same monoclonal antibody (Mab) pattern; these clinical and spa filter isolates further demonstrated matching patterns by arbitrarily primed polymerase chain reaction. The clinical isolate which did not match by Mab subtyping (it had a 1, 2, 5, 7 pattern) was from the only case patient who had a date of onset >10 days after Spa 2 was removed. This case patient had not visited the home-improvement centre. All other specimens from water sources within the store, including the filters from Spa 1, were negative for L. pneumophila.

Employee study

Approximately 142 employees worked at the home-improvement centre; of these, 138 answered an interviewer-administered questionnaire. The employees were predominantly male (89 [65%] employees), young (median age, 29 years; range 18–65 years), and worked at the store full-time (99 [72%] employees). One employee had been hospitalized with pneumonia at one of the three community hospitals at which the number of patients with pneumonia was increased; this employee’s illness, although never confirmed as LD, was clinically compatible with the disease. Of the 138 employees, 126 (91%) submitted a serum specimen. Forty-six (37%) of the 126 employees reported having had an illness during September–October that was characterized by at least 4 of the 9 symptoms of LD (i.e. fever, chills, cough, abdominal pain, diarrhoea, malaise, anorexia, headache, and myalgia); 5 (11%) of these employees had a single Lp1 titre of >1:256. Of the 80 employees from whom there was sera and who did not report a compatible illness, 4 (5%) had Lp1 titres of >1:256 (relative risk [RR] = 2.2; 95% CI: 0.6–7.7).

Employees who reported at least four symptoms compatible with legionellosis and/or who had a single Lp1 titre of >1:256 were slightly more likely to have reported at least 3 minutes (the integer nearest the median) of weekly exposure to the display spas (RR = 1.5; 95% CI: 1.0–2.4; P = 0.06). Of 75 employees who reported less than 3 minutes of weekly exposure to the display spas, 22 (29%) reported four symptoms and/or had an elevated titre; of 28 employees who reported from 3–37 (integer nearest the 75th percentile) minutes of exposure, 10 (36%) reported four symptoms and/or had an elevated titre; and of 35 who reported more than 37 minutes of exposure, 19 (54%) reported four symptoms and/or had an elevated titre (χ² for trend = 6.0; P = 0.01). Employees who reported four symptoms and/or who had an elevated titre were slightly more likely to have had a primary worksite in very close proximity to the display spas, compared with other worksites in the store, although this association was not statistically significant (RR = 1.5; 95% CI: 0.9–2.6; P = 0.17).

Discussion

The results of our investigation suggested that a contaminated whirlpool spa on display in a home-improvement centre placed susceptible people at increased risk for LD. These findings
support previous evidence that LD can be transmitted from a whirlpool spa to people who do not enter a spa. The conclusion that the whirlpool spa was the source of transmission was based primarily on the findings that case patients were >23 times more likely than control subjects to have visited a particular home-improvement centre within the 2 weeks preceding onset of illness, and that isolates from a whirlpool spa on display in the home-improvement centre matched those from two of the case patients who were linked to the epidemic cluster and to the home-improvement centre. The employee study demonstrated that employees who had more prolonged exposure to the spas were more likely to have had an illness characterized by at least four symptoms compatible with Legionella. Limitations of the employee study are that some of the symptoms may be considered non-specific and could characterize a number of gastrointestinal pathogens; also after the announcement of the spa as the likely source of the outbreak employees may have been biased in their reporting of spa exposure. However, a dose-response relationship between exposure and illness was demonstrated in this part of our investigation. We feel that the employee study is worth noting because it looked at infection in a population known to have had prolonged exposure opportunities.

Although several other locations had been visited by a greater percentage of case patients than control subjects, only one location, a discount variety store, was significantly associated with risk for LD. However, when we looked at only those case patients and control subjects who had visited the home-improvement centre to calculate an adjusted MOR for visiting the variety store, that statistical significance was lost.

Although Lp1 was found in only one of the two whirlpool spas that were displayed adjacent to one another for >2 years, we could not be certain that only one of the spas was the source of the outbreak. Both spas might have had filters that contained Lp1. Various circumstances, including the dismantling of one spa and cleaning and refilling of the other, could have accounted for isolation of Lp1 from only one spa filter.

We can only speculate on why this outbreak occurred; we are not able to determine if the conditions associated with this outbreak are unique. We do not feel the temporal association between the dismantling/cleaning/refilling and the outbreak was anything other than coincidence; as Figure 2 shows, only a minority of the cases had an onset compatible with exposure on 9 October. However, we do feel that the disinfection procedure was inadequate. There was a lack of documentation that the manufacturer’s recommendations regarding spa maintenance were being followed. However, the spas were never intended to be operational—nor were they. Prior to our investigation and findings, the potential for a display whirlpool spa to be the source of an outbreak of LD was considered somewhat remote.

Legionnaires’ disease can occur in outbreaks; however, most cases occur sporadically. Sporadic cases, although not as easily traceable, may have similar sources to outbreak cases, though sources likely to expose large numbers of people (e.g. cooling towers) would be more likely to cause outbreaks than would sources exposing only a few people (e.g. home water heaters). Legionella are commonly present in natural and man-made aquatic environments. Transmission is generally thought to occur when water containing the organism is aerosolized in respirable droplet nuclei (1–5 μm in diameter) and inhaled by a susceptible host, though the relative importance of airborne spread via aerosolized water and aspiration of water containing the organism has yet to be determined.

This investigation has implications for the risk of transmission of LD from whirlpool spas. Although it is unknown how often whirlpool spas transmit disease (attributable risk), display spas should now be considered similar to operational spas in terms of the need to minimize the risk for transmitting L. pneumophila.

From a public health perspective, several events which followed the outbreak are notable. First, as a result of our findings, the major home-improvement centre chain involved in the outbreak instituted a policy change not to use working display spas in their stores. Second, the media’s substantial reporting on this outbreak alerted the public to the potential risk of LD transmission from water sources, and reports usually included suggestions that all spas be maintained according to manufacturer’s recommendations. Third, our findings contributed to the development of new recommendations by the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. for the maintenance of whirlpool spas—including those that are being operated only for display.

Whirlpool spas being used as displays should be regularly inspected and maintained with a continuous level of biocide. Free residual halogen and pH levels should be measured and recorded to ensure that the halogen is effective for disinfection. Spas must be drained, cleaned, and refilled as recommended by their manufacturers. All associated piping and filters should be purged with clean water at the end of the cleaning cycle. More information is needed on how filters should be cleaned and inspected, and how often they should be changed in order to minimize the risk for transmission of Legionella.

References


