VIRGINIA
EPIDEMIOLOGY BULLETIN

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February 1998 Volume 98, Number 2

An Outbreak of Legionnaires' Disease Linked to a Display Whirlpool Spa, Virginia, 1996

Background

On October 15, 1996, the New River Health District was notified by a hospital infection control practitioner of an increase in the number of patients admitted with pneumonia over the previous weekend. Six days later, Legionnaires' disease (LD) was confirmed by urine antigen testing in one of the patients, and by October 24, LD was confirmed in four other pneumonia patients. This report presents the findings of a case-control study conducted by the New River Health District, the Office of Epidemiology, and the Centers for Disease Control and Prevention (CDC) to determine the source of a community-wide outbreak of LD.

LD is a type of pneumonia usually affecting men of at least middle-age, especially those with some underlying medical conditions such as diabetes mellitus, congestive heart failure, malignancy, or emphysema. Inhalation of aerosolized water containing the bacteria *Legionella pneumophila* is presumed to be the primary means of acquiring LD. Outbreaks of LD have been traced to contaminated cooling towers and evaporative condensers, showers, decorative fountains, humidifiers, respiratory therapy equipment, and whirlpool spas.

Case Definition

A confirmed case was defined as radiographically evident pneumonia in a person who had spent time in the New River Health District, had laboratory evidence of *Legionella pneumophila* serogroup 1 (Lp1) infection, and whose onset date was between September 15 and November 12, 1996. Laboratory evidence of LD consisted of isolation of Lp1 from respiratory secretions, detection of Lp1 antigens in urine by enzyme immunoassay, or a four-fold rise in Lp1 titers to $\geq$1:128 in paired acute- and convalescent-phase sera.

Case Finding

To identify cases of LD, active surveillance was initiated at the three community hospitals in the New River Health District. Investigators reviewed medical records and laboratory reports of 68 patients admitted with pneumonia of unknown etiology since September 15, plus records of two area residents with confirmed LD who were hospitalized at a nearby referral hospital.

LD was eventually confirmed in 23 patients, two of whom died. Onsets of illness were between September 29 and October 22, with 21 (70%) occurring between October 8-14 (Figure 1).

Case-Control Study

To identify common factors which might be the source of the outbreak, detailed interviewing of the earliest confirmed patients began on October 25. They were questioned about their occupation, modes of transportation, time spent at home, recent travel history, home water supply, and local businesses visited within the two weeks prior to their becoming ill. Based on the findings of these intensive, hypotheses-generating interviews, a case-control study was initiated on November 2. Fifteen of the 23 patients with confirmed LD participated in the case-control study. Onsets of illness ranged from September 29 to October 22 (Figure 1). The median age of the case-patients included in the case-control study was 70 years (range: 42 to 86 years); thirteen (87%) were male.

Three controls were selected for each case-patient from the office records of the case-patient's primary care physician. Controls were matched with case-patients by age (within ten years), sex, and medical status. Case-patients were asked if they had spent any time at any of 14 facilities (including retail businesses and manufacturing plants) in the New River Valley during the 14 days prior to their onset of illness. Controls were asked the same questions for the same two week period as the case-patients to whom they were matched. Details about specific locations visited within certain establishments were also requested. To minimize recall bias, interviewees were shown a calendar and asked to refer to receipts or checkbooks to confirm dates and retail establishments visited. The data were analyzed using Epi-Info and SAS software.

Fourteen of the 15 (93%) case-patients, as compared to 12 of the 45 (27%) controls (matched odds ratio [MOR]=23.3; 95% confidence interval [CI]=3.0-182.0), recalled having been to a particular home-improvement center within the two weeks prior to case onset of illness. A discount variety store had been visited by 10 (67%) case-patients, as compared to 15 (33%) controls (MOR =3.7; 95% CI=1.1-12.6); a supermarket had been visited by six of 14 (43%) case-patients and 6 (13%) controls (this MOR could not be calculated because there were no exposed controls who were paired with an unexposed case-patient). Controlling for exposure to the home-improvement center, the MOR for exposure to the discount variety store decreased to 1.1 (95% CI=0.2-6.3); controlling for exposure to the discount variety store, the MOR for exposure to the home-improvement center re-

mained almost constant at 22.2 (95% CI=2.5-199.0).

Case-patients averaged 79 minutes at the home-improvement center, as compared with 29 minutes for the 12 controls (F-test p<.01). Within the home-improvement center, ten of 13 case-patients (77%) recalled at least walking by a display whirlpool spa as compared to three of the 12 (25%) controls (MOR=5.5; 95% CI = 0.7-256). No other water sources within the home-improvement center had an elevated MOR.

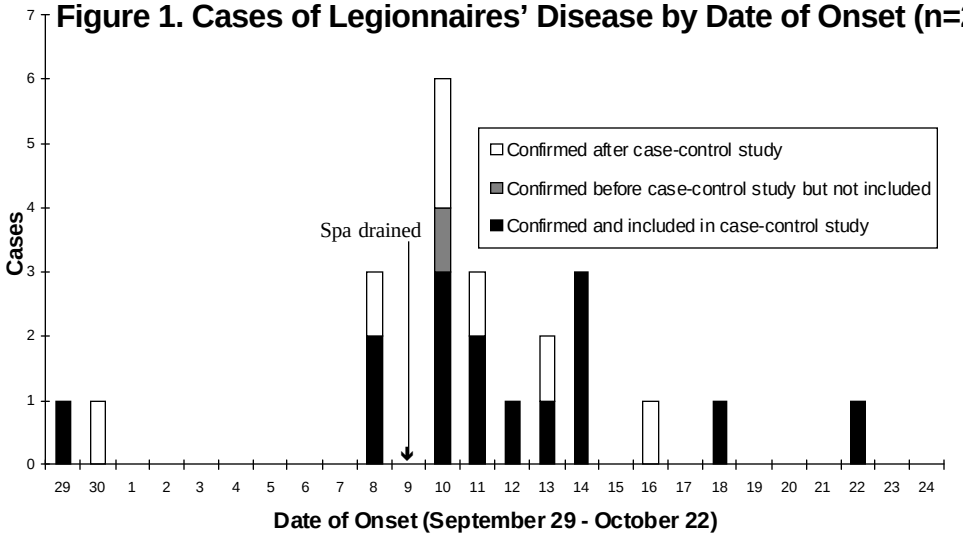
Environmental Investigation

Several facilities in the New River Valley area were inspected and evaluated as potential sources of this outbreak. However, when early interviews suggested a home-improvement center as the strongest common link among case-patients, the environmental investigation focused on this store. On October 28, sampling of likely sources of aerosolized water in the store was initiated. Water samples were collected in sterile 1-liter polypropylene bottles from the employee and public restroom taps, the freshwater hose and a decorative goldfish pond in the greenhouse, and from a display whirlpool spa. Moist areas which could have supported legionellae growth, such as the whirlpool spa bubblers and fountainhead in the goldfish bowl, were sampled with sterile polyester-tipped swabs.

Until October 9, 1996, two whirlpool spas had been on display in the store. The display spas were separate, self-contained units, using closed and heated circulation systems and paper filter cartridges. They were filled with municipal water. During the store's daily operation, bubble jets could be turned on for demonstration. Disinfection was provided by a 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 the nearly two years of operation. Water in the tubs was changed completely every six months and was added as needed in the interim.

The original dual-hot tub display was dismantled on October 9, and the smaller tub was sold to a store employee. The remaining tub was refilled without changing the paper filters on October 18 and was on display when this investigation was initiated. Following initial inspection, the home-improvement center complied with the investigation team's request to turn off the spa and all other potential sources of aerosolized water, such as a decorative goldfish pond and overhead water hoses in the greenhouse.

Figure 1. Cases of Legionnaires' Disease by Date of Onset (n=23)



Laboratory Investigation

Respiratory tract specimens were collected and forwarded to either the Laboratory Corporation of America (LabCorp, Burlington, NC) or the CDC to attempt isolation of *Legionella*. Urine samples were collected and sent to CDC where the samples were tested for the presence of *Legionella* soluble urine antigen using an RIA kit (Binax, Portland, ME) or to LabCorp where they were tested using an EIA kit (Binax, Portland, ME).[1] The Division of Consolidated Laboratory Services (Richmond, VA) analyzed acute and convalescent serum samples for the detection of antibody to *L. pnuemophila* (Serogroups 1-6) with a commercial indirect fluorescent antibody kit (Organon Teknika, Durham, NC).[2]

Three of the confirmed case-patients were confirmed by isolation of Lp1 in sputum; 15 by detection of Lp1 antigens in urine, and 11 by a four-fold rise in *Legionella* antibody titers. Several case-patients were confirmed by more than one laboratory method. The three clinical isolates were initially subtyped using a panel of monoclonal antibodies by the CDC[3] and then further analyzed by arbitrarily primed polymerase chain reaction.[4]

Three spa filters were available for laboratory testing: two from the spa still on display and one from the spa that had been purchased by the employee but had not yet been installed. The filters were shipped to CDC without additional water, along with the other environmental samples, where *Legionella* isolation was attempted. Lp1, monoclonal type 1,2,5,6 was isolated from the filter of the purchased spa.

Two of the three available clinical isolates had the same monoclonal antibody (Mab) pattern (1,2,5,6) as the spa filter; these clinical and spa filter isolates further demonstrated matching patterns by arbitrarily primed polymerase chain reaction. The third clinical isolate, from the one case-patient who had not visited the home-improvement center, had a different Mab pattern (1,2,5,7). All other specimens from water sources within the store, including the filters from the other spa, tested negative.

Discussion

This investigation showed that a contaminated display whirlpool spa placed susceptible individuals at increased risk for contracting community-acquired LD. Although studies of previous outbreaks have documented an association between being near a contaminated recreational spa and contracting LD,[5] this investigation represents the first time that people became ill without anyone entering the spa.

The case-control study revealed that case-patients were over 23 times more likely than controls to have visited a particular home-improvement center. Futhermore, the environmental investigation revealed an exact DNA match among the isolates from a display whirlpool spa in the home-improvement center and two of the case-patients.

Although Lp1 was found in only one of the two display spas that sat side by side for over two years, it is not possible to state absolutely that only one of the spas was the source of the outbreak. Various circumstances, including the dismantling of the implicated spa and cleaning and refilling of the other one, could account for isolation of Lp1 from only one spa filter.

One limitation of the case-control study should be addressed. Statistical power was low because only 15 case-patients could be included and the matched design required a matched analysis in which many case-control quadruplets could not be included in the final

analysis. In particular, there were no discordant quadruplets in which a case-patient was unexposed and a control was exposed. This may explain the lack of a statistically significant association between illness and visiting the spa within the home-improvement center.

The major recommendation stemming from this investigation was that display spas should use the same safeguards against legionellosis as operational spas.[6] Whirlpool spas used as displays need to be regularly inspected and maintained with a continuous level of biocide. Free residual halogen and pH levels (to ensure that the halogen is effective for disinfection) should be measured and recorded. 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. Filters need to be routinely changed.

Finally, the efficiency with which the source of the outbreak was found and confirmed resulted from rapid reporting from the community hospitals to the local health department, timely responses from the state health department and CDC, collaborative efforts with private laboratories, and full cooperation by the management and employees of the home-improvement center.

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LABORATORY TESTS FOR DIAGNOSING LEGIONNAIRES' DISEASE

Legionnaires' disease cannot be distinguished clinically or radiographically from pneumonia caused by other agents. The following commercially available laboratory techniques are commonly used to confirm the diagnosis (because of the limitations discussed below, more than one type of test may need to be conducted) :

1. **Culture** - *Legionella* species may be isolated from respiratory secretions, lung tissue, pleural fluid, or other normally sterile sites if special selective media and techniques are used in the laboratory and if the laboratory is alerted to look for the organism. The organism grows slowly and may take up to 13 days to detect.

2. **Direct fluorescent antibody (DFA)** - This can be done on the same specimens that are collected for culture. Because it can be done rapidly, DFA testing should be considered whenever a culture for *Legionella* species is ordered. The DFA test will detect specific species and/or serogroups of *Legionella*. The sensitivity is highly variable (25%-75%), but the specificity is very high (96%-99%).

3. **Urine antigen test** - Only *L. pneumophila* serogroup 1 antigen can be detected in a urine specimen by radioimmunoassay (RIA) or enzyme-linked immunosorbent (EIA) assay. The turnaround time for this test is very rapid. The sensitivity is 60%-80%, but the specificity approaches 100%. (*L. pneumophila* serogroup 1 is responsible for approximately 80%-90% of all *Legionella* infections.)

4. **Serology** - Indirect fluorescent antibody (IFA) and enzyme-linked immunosorbent assay (EIA) are most commonly used. Diagnosis is based on a fourfold rise in antibody titer to $\geq$1:128 (the units for the EIA test may be expressed differently) between acute and convalescent specimens, collected 4 to 6 weeks apart. Ideally, both specimens should be tested at the same time; therefore, the acute serum specimen should be properly stored until the convalescent specimen is collected.

Of note, single serologic results are difficult to interpret and not of much use. A single titer $\geq$1:256 collected at least 3 weeks after onset of illness, in conjunction with a compatible illness, may be indicative of recent disease. However, approximately 1-16% of healthy adults will also have a *Legionella* titer $\geq$1:256.

Cases of Selected Notifiable Diseases Reported in Virginia*

Disease	Total Cases Reported, January 1998						Total Cases Reported Statewide, January		
	State	Regions					This Year	Last Year	5 Yr Avg
		NW	N	SW	C	E			
AIDS	35	10	6	6	10	3	35	91	71
Campylobacteriosis	17	7	3	2	2	3	17	2	14
Giardiasis	19	1	3	5	5	5	19	2	8
Gonorrhea	546	23	52	69	208	194	546	770	837
Hepatitis A	10	2	6	0	2	0	10	12	9
Hepatitis B	3	1	0	1	1	0	3	0	5
Hepatitis NANB	1	1	0	0	0	0	1	0	1
HIV Infection	42	10	8	2	17	5	42	50	55
Influenza	76	45	13	14	0	4	76	282	210
Legionellosis	2	1	0	1	0	0	2	0	1
Lyme Disease	0	0	0	0	0	0	0	0	0
Measles	0	0	0	0	0	0	0	0	0
Meningitis, Aseptic	3	1	1	0	0	1	3	8	8
Meningitis, Bacterial†	4	1	1	1	1	0	4	3	3
Meningococcal Infections	4	0	2	0	1	1	4	3	3
Mumps	0	0	0	0	0	0	0	0	1
Pertussis	0	0	0	0	0	0	0	0	1
Rabies in Animals	34	9	7	7	6	5	34	18	23
Rocky Mountain Spotted Fever	0	0	0	0	0	0	0	0	0
Rubella	0	0	0	0	0	0	0	0	0
Salmonellosis	41	3	6	6	10	16	41	11	46
Shigellosis	8	0	6	0	1	1	8	7	15
Syphilis, Early‡	61	6	5	9	14	27	61	57	84
Tuberculosis	5	0	0	1	4	0	5	20	17

Localities Reporting Animal Rabies This Month: Alexandria 1 raccoon; Amherst 1 dog; Augusta 1 cat; Charlotte 1 skunk; Clarke 1 raccoon; Essex 1 raccoon; Fairfax 4 raccoons; Franklin County 1 skunk; Hanover 1 skunk; Henrico 1 cow, 2 raccoons; King and Queen 1 skunk; Loudoun 2 raccoons; Louisa 1 skunk; Lynchburg 1 raccoon; Nelson 2 skunks; New Kent 1 raccoon; Pittsylvania 1 raccoon; Pulaski 2 skunks; Rockingham 1 skunk; Spotsylvania 1 raccoon; Stafford 1 raccoon; Suffolk 2 raccoons; Virginia Beach 1 raccoon; Warren 1 raccoon; Wythe 1 cat.
Occupational Illnesses: Arsenic Exposure 1; Asbestosis 23; Carpal Tunnel Syndrome 77; DeQuervain's Syndrome 2; Hearing Loss 10; Pneumoconiosis 9.
*Data for 1998 are provisional. †Other than meningococcal. ‡Includes primary, secondary, and early latent.

Published monthly by the
VIRGINIA DEPARTMENT OF HEALTH
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P.O. Box 2448
Richmond, Virginia 23218
http://www.vdh.state.va.us
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