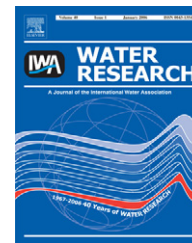


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# A Legionnaires' disease outbreak: A water blaster and roof-collected rainwater systems

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## ABSTRACT

In February 2006, an outbreak of Legionnaires' disease (LD) was identified in Beachlands, a small, isolated east Auckland suburb. It was investigated through case finding, a case-control study, sampling potential sources of infection and by molecular typing (using sequence-based typing (SBT) of all *Legionella pneumophila* serogroup 1 (Lp1) isolates). Lp1 was isolated from the respiratory tract of one case, the roof-collected rainwater systems of five households (three associated with cases) and from a water blaster at a nearby marina. All isolates were indistinguishable, exhibiting the same SBT allele pattern. Three LD cases lived within 500 m of the water blaster (the fourth case within 1250 m) and downwind in prevailing conditions. Another domestic roof-collected rainwater supply contaminated by Lp1 (identical SBT pattern) was incidentally identified in another suburb 4 km east of Beachlands. This is the first outbreak of LD linked to roof-collected rainwater supplies and the first isolation of *Legionella* from these systems in New Zealand. Aerosols containing *Legionella* discharged to air by the marina water blaster may have infected some cases directly or may have seeded roof-collected rainwater systems. Some cases may have been exposed by contaminated bathroom showers. Roof-collected rainwater systems need appropriate design, careful cleaning and the maintenance of hot water temperatures at a minimum of 60 °C to reduce the chances of *Legionella* multiplying. Further research into the ecology of *Legionella* in roof-collected rain water systems is indicated.

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## 1. Introduction

In February 2006, the Auckland Regional Public Health Service was notified of an 80-year-old male who had been hospitalised with Legionnaires' disease (LD) and had subsequently died. The diagnosis had been made on a positive *Legionella* urinary antigen test (Binax NOW *Legionella* urinary antigen test, Scarborough, Maine, USA, 1986) and the isolation of *Legionella pneumophila* serogroup 1 (Lp1) from a tracheal

aspirate. The case resided in Beachlands, an isolated suburb situated on the east Auckland coast of New Zealand's North Island, where approximately 2800 people inhabit 1400 households supplied with drinking water from roof-collected rainwater systems. The suburb had voted by referendum in 2004 not to install a town-reticulated water supply. Beachlands is home to a marina and a neighbouring golf resort, but has only a few commercial and no manufacturing businesses or cooling towers.

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## 2. Materials and methods

### 2.1. Case definition and finding

A case of LD was defined as follows:

A person who had resided in Beachlands and had a history of an illness clinically compatible with LD between mid-December 2005 and mid-March 2006, with positive laboratory test results consisting of

- isolation of *Legionella* spp. from lung tissue, respiratory secretions, pleural fluid, blood or other tissues, or
- detection of *Legionella* antigen in the urine,<sup>1</sup> or
- demonstration of *Legionella* spp. antigens in lung tissue, respiratory secretions or pleural fluid, or
- a four-fold or greater rise in IFA titre against *Legionella* spp. to >128, or
- a stable high *Legionella* titre  $\geq 512$  in convalescent phase serum.

Case finding was facilitated by canvassing all local general medical practitioners and by direct approach to householders through the use of a mail drop to all residences alerting them to the existence of a cluster of cases and the symptoms of LD. Records of all east Auckland patients with hospital discharge diagnoses of atypical pneumonia were reviewed for the period of January through to end of April 2006. Any person with an illness suggestive of LD underwent medical review. Six marina employees were offered serological testing but declined.

### 2.2. Case-control investigation

A case-control study was undertaken to investigate exposures associated with developing LD. The case-control study was designed to maximise statistical power given what was likely to be a low number of cases. For each case the study aimed to recruit six controls based on a power of 95%, expected odds ratio 2, exposure prevalence among cases at 33% and among controls at 20%. Cases were found and selected according to the criteria outlined in 2.1. Controls were selected on a geographic basis from within the suburb of Beachlands using Hawth's Analysis Tools 3.26 (in ArcGIS 9.1). This programme randomly generated geographic points in the suburb and selected the household addresses nearest to those points. Individual controls were selected if they were persons aged 40 years or older (restriction based on age of cases) with the next birthday in the household. Both cases and controls underwent face-to-face interview using the same questionnaire. For the deceased case, the spouse was interviewed. LD risk factors investigated were those documented in the international literature. The rainwater supplies were suspected because of the literature on instances of *Legionella* contamination (Broadhead et al., 1988) and an overseas outbreak associated with roof-collected rainwater systems (Schlech et al., 1985). Data concerning household

water supplies and individual exposures during the months of February and March were gathered via a structured questionnaire following informed consent. Three points were sampled for *Legionella* spp. in the water supplies of the control households so that results could be compared with case water supplies: the kitchen tap (1L first-catch sample from cold water system), the shower (1L first-catch sample and 1L second-catch sample after running hot for 2 min), and the water storage tank (1L sample from the bottom of the tank). Both case and control samples were taken during the middle of the day with the water supplies in normal use.

### 2.3. Targeted sampling of household rainwater systems

Targeted sampling of rainwater supplies in southwest Beachlands was carried out for 22 households in addition to the case and control supplies using the same three sampling points. Households were those in close geographic proximity to households where *Legionella* had already been isolated or were close to putative sources of environmental aerosols.

### 2.4. Local environmental survey

An environmental survey was conducted for potential aerosol-generating sources. Water systems and bodies of water at a nearby golf resort and marina were investigated and sampled. At the golf course, these included water used in the greens' sprinkler system, a water blaster used to clean green-keeping equipment and a pond near the resort centre with two waterfalls. An aerated wastewater pond at the golf course was also sampled. At the marina, water was sampled from the reticulation system, public showers and a high-pressure water blaster. A trace-back of water delivered by tanker to affected households was conducted and water delivery tankers sampled.

### 2.5. Review of meteorological data

Meteorological data for the Beachlands area, collected at a nearby station, were reviewed for the time period 1 December 2005–28 February 2006.

### 2.6. Isolation and culture of *Legionella* organisms

The microbiological methods used at the Institute of Environmental Science and Research (ESR) *Legionella* Reference Laboratory are based on the AS/NZS 3896 and ISO 11731 standard methods for the isolation of *Legionella* from environmental waters. The methods involve filter concentration of the water sample followed by acid or heat pre-treatment prior to spread plating onto *Legionella* selective media. The inoculated plates are incubated in a humidified atmosphere at 36 °C for 10 days, with viewing of growth carried out on days 2, 4, 7 and 10. Following macroscopic examination of any colonies growing on the plates, any *Legionella*-like colonies were picked off and sub-cultured onto BA plates and BCYE plates with and without L-cysteine. All presumptive *Legionella* colonies were identified to the serogroup level by the direct fluorescent antibody test using fluorescein isothiocyanate-conjugated antibodies specific for the individual *Legionella* sp. and

<sup>1</sup> Binax NOW *Legionella* urinary antigen test, Scarborough, Maine, USA.

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