Surveillance and outbreak reports

LEGIONNAIRES' DISEASE CLUSTER LINKED TO A METAL PRODUCT AQUEOUS PRE-TREATMENT PROCESS, STAFFORDSHIRE, ENGLAND, MAY 2008

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In May 2008, a report of two workers from the same construction equipment manufacturing plant who were admitted to hospital with Legionnaires' disease confirmed by urine antigen prompted an outbreak investigation. Both cases were middle aged men, smokers, and with no travel, leisure or other common community exposure to *Legionella* sources. There were no wet cooling towers at the plant or in the surrounding area. No increase in respiratory disease or worker absenteeism occurred at the plant during the preceding month. Wider case ascertainment including alerts to hospitals and medical practitioners yielded no further cases. The environmental investigation (and sampling of water systems for *Legionella*) identified a *Legionella pneumophila* serogroup 1 (Mab 2b) count of $>3.0 \times 10^4$ cfu/l in water samples from an aqueous metal pre-treatment tunnel, which generates profuse water aerosol. Drainage, cleaning and biocide treatment using thiazalone eliminated *Legionella* from the system.

Introduction

Legionnaires' disease is an atypical pneumonic illness caused by the inhalation of aerosolised *Legionella* bacteria. These bacteria are found naturally in environmental water sources usually in low numbers. Multiplication of this organism is favoured when water is stagnant and warm. Poorly maintained aerosol-generating devices and water systems such as wet cooling towers, and spa pools are well documented sources of Legionnaires' disease [1]. Aside from travel exposure, the majority of cases and clusters of Legionnaires' disease in Europe are associated with community sources, mainly cooling towers and spa pools. Direct links with industrial manufacturing processes are less common [2,3].

On 15 May 2008, public health authorities in the West Midlands, England, were notified of two confirmed cases of Legionnaires' disease, admitted to the same hospital on the previous day. Both cases worked on the production line at the same construction and agricultural equipment manufacturing plant (plant X). The local health protection unit declared this a presumptive Legionnaires' disease cluster and led an outbreak control team to investigate common infection sources at work and in the community. This paper describes the disease cluster, the environmental investigation and the control measures implemented.

Methods

A confirmed case of Legionnaires' disease was defined as a person working at plant X who had clinical symptoms of pneumonia, was confirmed radiologically and by laboratory evidence of infection with *Legionella pneumophila* serogroup 1 (Lp-1), with onset of symptoms after 22 April 2008. Laboratory confirmation consisted of detection of Lp-1 antigen in urine.

Searching for additional cases included a review of worker sickness absenteeism and reports of respiratory illness at plant X during the preceding month. The occupational health service at the plant informed the work force of potential risks and advised early reporting of respiratory symptoms. All workers with onset of respiratory symptoms after 22 April 2008 were urgently investigated and offered a urine antigen test. In addition, clinicians and microbiologists at local medical referral centres and hospitals, as well as neighbouring health protection units were alerted.

The cases and their close family members were interviewed in hospital shortly after admission using a standardised questionnaire to elicit demographic details, clinical history, risk factors for Legionnaires' disease, and sources of potential *Legionella* exposure during the previous 14 days. Details were obtained regarding travel (abroad and locally), recreational activities (water exposure, spa pool exposure), hospital admissions, domestic risk factors, and occupational activities.

Environmental health and safety officials undertook an environmental investigation and risk assessment including a review of local wet cooling towers, and a description of water systems at the plant with collection of water samples for *Legionella* culture and isolation.

Laboratory confirmation of clinical cases used *Legionella* urine antigen Binax NOW rapid immunochromatographic assay for the qualitative detection of *L. pneumophila* serogroup 1 antigen in urine samples [4]. Isolation and typing of environmental *Legionella* consisted of concentrating 1 litre water samples by membrane filtration and elution of the deposit. The deposit was heat- and acid-treated to reduce unwanted bacterial growth. Treated and untreated

portions of the deposit were inoculated onto selective buffered charcoal yeast extract agar containing cysteine and iron [5].

Results

Two confirmed cases (cases A and B) were admitted to hospital on 14 May 2008 with clinical pneumonia. Symptom onset had been on 6 and 8 May 2008, respectively. Both cases were 40-50 year-old men with a history of heavy cigarette smoking. They responded well to standard treatment, did not require mechanical ventilation, and were discharged from hospital after eight days. Attempts at sputum sample collection were unsuccessful and clinical Lp-1 isolation was therefore not possible.

The cases lived in different towns (9 miles apart) and drove to work using different routes. Both had not travelled locally, within the country or abroad in the preceding two months, and had no exposure to common domestic, leisure and community aerosolised water sources. Both were full-time production line workers at plant X but were not close friends and had no contact outside of work. They reported working on different stages of the production line approximately 20 metres apart.

Plant X has a workforce of 642 people and is situated in a semi-rural town in a district of approximately 500,000 residents. Case searching at the plant did not yield any further cases. No increase in absenteeism was detected at the plant during the six months prior to identification of the two cases. Fourteen workers were identified who had been absent from work in the previous four weeks, of which 11 reported respiratory symptoms. None of these had clinical pneumonia or were admitted to hospital, and all tested urine antigen-negative for Lp-1. The two confirmed Legionnaires' disease cases did not represent an increase in notifications above the average of two cases (range: 0-9) per year that occurred in the prior 14 years in this district. A review of all industry-linked Legionnaires' disease reports in this district since 1994 identified only two cases but their exact exposure could not be identified.

The plant has a basic rectangular floor plan, housing a comprehensive production line and small administrative section. No wet cooling or air conditioning systems are used at the plant. In addition there are no cooling towers in the town or in the immediate vicinity of the plant with no adjacent industries or office buildings.

The plant used four water systems:

1. Two independent domestic type hot and cold water systems supplying the restroom and changing facilities. These systems had been drained in April 2008, were regularly monitored, and had no stagnant water sections.
2. A paint mist trap in an unheated spray paint booth. Here a below ground-water jet traps paint mist under negative pressure to an extraction stack. The water is at ambient temperature.
3. An aqueous metal pre-treatment tunnel. Steel parts on a monorail move through a degreasing and rinsing tunnel in preparation (pre-treatment) for painting. The system has a complex network of pipelines and tanks providing jet spraying of parts with solutions (including alkaline degreaser and an acidic phosphate solution) and water (which has a pH neutralising effect) at successive stages inside a tunnel.

Different solutions and water are drawn from their respective tanks by pumps and fed to spray nozzles inside the tunnel. There are six pre-treatment stages: a cleaning stage followed by two water rinses, then a 'keying chemical' stage with a further two water rinses. Each stage has its respective supply and collection tank. The chemical tanks were heated to 55-60 °C. The water for rinsing is mains-fed and supplies four unheated water tanks (volume of each tank: 8,000 to 15,000 litres) at 25-38 °C. The brushes covering the conveying railing were missing and there was no local extraction for the tunnel. Aerosols were visibly leaking from the gap of the conveying railing and the large openings at the entrance and exit of the tunnel.

Prior to this incident, the aqueous pre-treatment process had not been risk-assessed as a source of *Legionella* organisms and potential human exposure. No management system (protocol) for monitoring (including *Legionella* sampling), disinfecting and cleaning the water systems was in place.

Case A worked on the assembly production line, and Case B worked at the aqueous pre-treatment and powder coating section. Case A walked past the pre-treatment plant a number of times daily to an adjoining factory exit where he smoked.

Baseline sampling and culture of all water systems (a, b, and c) was undertaken on 16 May 2008. No *Legionella* was isolated from the domestic hot and cold water system (a) or the paint mist water trap system (b). Water samples from the aqueous pre-treatment system (c) contained *L. pneumophila* serogroup 1 (Mab 2b) at a count of $>3.0 \times 10^4$ colony-forming units (cfu)/l.

Drainage and cleaning of the aqueous pre-treatment system (c) and the domestic-type hot and cold water system (a) were undertaken during the initial two weeks following the detection of the two cases, followed by chlorine dioxide shock treatment of the pre-treatment system. For maintenance, biocide treatment with thiazalone was preferred over chlorine and other halogen-based products, as these may interact with degreasing chemicals, causing corrosion and affecting product quality. The subsequent dosing regime was reviewed regularly and modified until a suitable balance was achieved, taking into account the short half life of thiazalone. During plant shut down at each weekend, all tanks were completely drained and cleaned.

Subsequent water samples from the water tanks supplying the metal pre-treatment process (c) yielded *L. pneumophila* serogroup 1 (Mab2b) in diminishing numbers over a four week period, leading to eradication on 20 June 2008.

Discussion and conclusions

We report on two epidemiologically linked Legionnaires' disease cases with likely occupational exposure to an aqueous pre-treatment system in a construction equipment manufacturing plant. The aqueous pre-treatment system carried the highest risk as a probable source of infection because of the isolation of *L. pneumophila* serogroup 1 from the water and associated aerosolisation. Because clinical samples were not available for further typing and matching to Lp-1 isolated from the water samples, definitive causality could not be established. Future investigations should therefore prioritise obtaining clinical isolates to confirm the aqueous pre-treatment system as the source of infection. The domestic systems (a) were reasonably controlled, and the paint-mists water trap system (b)

had a *Legionella*-inhibitory temperature (below 15 °C) with water aerosols under suction. Therefore, the risk of human exposure from those systems is low.

No prior risk assessment of the aqueous pre-treatment system had been undertaken at the plant. Immediate and medium-term control measures (water sampling, biociding, cleaning/drainage) were effective in controlling *Legionella* growth and preventing further cases of Legionnaires' disease.

Legionnaires' disease clusters have been reported from industrial settings with workers exposed to sources of aerosolised water, including from biological treatment plants in the pulp and paper industry [6], contaminated metal-working fluids in the automotive industry [7], factories that use water to cool moulded plastics [8], and waste water treatment facilities [9]. Aqueous cleaners are generally believed to present a low risk to workers' health and gained popularity in industry as degreasing of metal parts by organic solvents was gradually phased out [10]. To the best of our knowledge this is the first report implicating an aqueous metal pre-treatment plant as a possible source of *Legionella* linked to a cluster of Legionnaires' disease.

Aqueous pre-treatment systems are prone to *Legionella* growth due to favourable water temperature, the presence of nutrients such as rusts and dirt from metal parts, convoluted surfaces that favour biofilm development, and recirculation of the water. Since the report of these two cases, five similar aqueous pre-treatment systems have been inspected by the United Kingdom's Health and Safety Executive, and *Legionella* has been isolated in four. A cleaning and disinfection regime similar to the one reported here was implemented and has prevented further growth of *Legionella*. The findings of this subsequent investigation are being submitted for publication.

Significantly, aqueous pre-treatment systems generate profuse water aerosol, and preventing escape may prove complex. Assessing the risks for Legionnaires' disease in similar systems, common in the metal manufacturing industry, is recommended.

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