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## Legionella in the veterans healthcare system: report of an eight-year survey

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### SUMMARY

The Veterans Health Administration (VHA) of the Department of Veterans Affairs tracks legionella disease in the system of 172 medical centres and additional outpatient clinics using an annual census for reporting. In fiscal year 1999, 3·62 million persons were served by the VHA. From fiscal year 1989–1999, multiple intense interventions were carried out to decrease the number of cases and case rates for legionella disease. From fiscal year 1992–1999, the number of community-acquired and healthcare-associated cases decreased in the VHA by 77 and 95·5% respectively ( $P=0\cdot005$  and  $0\cdot01$ ). Case rates also decreased significantly for community and healthcare-associated cases ( $P=0\cdot02$  and  $0\cdot001$ , respectively), with the VHA healthcare-associated case rates decreasing at a greater rate than VHA community-acquired case rates ( $P=0\cdot02$ ). Over the time of the review, the VHA case rates demonstrated a greater decrease compared to the case rates for the United States as a whole ( $P=0\cdot02$ ). Continued surveillance, centrally defined strategies, and local implementation can have a positive outcome for prevention of disease in a large, decentralized healthcare system.

### INTRODUCTION

Legionella are pleomorphic, aerobic, flagellated, gram-negative bacilli that inhabit freshwater and soil environments. They live and multiply within protozoan organisms such as amoebae [1]. *Legionella* spp.

are transmitted to susceptible humans by inhalation of aerosols from contaminated water or aspiration of water containing the organism [2]. In recent studies, sources of water contaminated with legionella have included cooling towers, evaporative condensers, whirlpool spas, showers, humidifiers, decorative fountains, potable water and respiratory therapy equipment rinsed with tap water [3, 4].

In humans, the bacilli are facultative intracellular pathogens that infect human alveolar macrophages leading to acute bronchopulmonary disease, legionellosis or Legionnaires' disease [1]. Legionnaires'

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disease has been noted to occur in three distinct settings: (1) acute epidemic outbreak (community source), (2) hyperendemic outbreak (healthcare-associated source), and (3) sporadic cases [4]. The incubation period for disease is 2–10 days [3]. People with chronic lung disease, advanced age, renal failure, immunosuppression, alcoholism and cigarette use are at a higher risk for infection [5, 6]. Each year in the United States an estimated 8000–18000 cases of legionellosis occur with approximately 23% of the cases reported to the Centers for Disease Control and Prevention (CDC) documented as healthcare-associated (HCA) [7]. Case fatality rates range from 5 to 30% with higher mortality rates seen in patients with advanced age, immunosuppression and HCA acquisition of disease as well as those not receiving erythromycin therapy [3, 8].

Various factors promote legionella growth in water distribution systems. These factors include hot water temperature  $< 60^{\circ}\text{C}$ , high concentrations of calcium and magnesium leading to scale, and water system materials with formation of a biofilm and commensal microflora such as amoebae [9]. Multiple focal or systemic disinfection modalities can be applied to water distribution systems to prevent colonization by legionella. Instantaneous heating systems, ultraviolet irradiation, thermal eradication (superheat and flush), copper/silver ionization and hyperchlorination all vary in cost, complexity and efficacy at eradicating *Legionella* spp. [9].

In eight United States federal fiscal years, the Veterans Health Administration (VHA) of the Department of Veterans Affairs has tracked the occurrence of community-acquired and HCA Legionnaires' disease in the veterans healthcare system. The results of that surveillance and the effect of interventions to reduce legionellosis case number and rates are reported here.

## METHODS

Annually the VHA conducts an Infectious Diseases/Infection Control census using a standardized, automated reporting form. This form is delivered electronically to each VHA facility with active patient care services. These sites are to report data accumulated during the previous fiscal year. Once completed the form is forwarded to a central processing site in the VHA Infectious Diseases Programme Office. In all cases data validation and accuracy are the responsibility of the reporting facility. Discrepant or unusual

data are verified by telephone. In this manner the VHA has collected data on the number of cases of community-acquired and HCA legionellosis from October 1991 to September 1999 (federal fiscal years 1992–1999) within the veterans healthcare system. A case was designated as HCA in origin by the reporting facility based on their definitions of HCA disease.

The reported case numbers provided the numerator data for analysis of case rates. Denominators were the number of unique persons served at the VHA facilities in that year, and were provided by the VHA's Allocation Resource Center located in Boston, MA. Persons served by the VHA are those presenting for an episode of care. These denominators for persons served from fiscal years 1992–1999 are the following: FY 1992,  $2.71 \times 10^6$ ; FY 1993,  $2.75 \times 10^6$ ; FY 1994,  $2.77 \times 10^6$ ; FY 1995,  $2.89 \times 10^6$ ; FY 1996,  $2.94 \times 10^6$ ; FY 1997,  $3.10 \times 10^6$ ; FY 1998,  $3.50 \times 10^6$ ; FY 1999,  $3.62 \times 10^6$ .

A linear regression model with time as the independent variable was used to analyze the decline in cases as well as the decline in case rates over the survey period. A linear regression model was also used to compare the rate of change in the rate of legionella cases between the VHA-served population and the United States population in general represented by case rates published by the CDC.

Several educational events and document distributions regarding legionella occurred in the veterans healthcare system. In particular, in 1985 a Domestic Hot Water Temperature Limits document was generated to provide guidance in establishing a hot water temperature policy and engineering procedures to prevent HCA acquisition of Legionnaire's disease in the VHA healthcare system while limiting the risk of scalding from hot water. The 1985 document recommended an increase in hot water temperature to  $70^{\circ}\text{C}$  ( $160^{\circ}\text{F}$ ) in hot water storage tanks. Additional recommendations regarding mixing valves to prevent scalding and other engineering controls were also noted. This document was updated in 1989 (and almost yearly thereafter) with more detailed recommendations regarding removal of tap aerators and providing more options for mitigation if Legionnaires' disease was occurring in the facility. A timeline of these events is seen in Table 1.

## RESULTS

Between FY 1992 to FY 1999, the cases of legionella pneumonia reported as community-acquired fell 77%

Table 1. *Timeline for legionella interventions in the VHA*

Date	Intervention
23 July 1985	Establishing New Domestic Hot Water Temperature Limits Circular
8 February 1989	Domestic Hot Water Temperature Limits Circular updated
18 June 1990	Domestic Hot Water Temperature Limits Circular updated
13 June 1991	Domestic Hot Water Temperature Limits Circular (extended through 18 June 1992)
4 November 1992	Domestic Hot Water Temperature Limits Directive (Circular information updated; title changed to a Directive)
15 December 1993	Domestic Hot Water Temperature Limits Directive updated
16 May 1995	Domestic Hot Water Temperature Limits Directive updated
16 May 1997	Domestic Hot Water Temperature Limits Directive updated
12 August 1998	VA Occupational Health Conference, Las Vegas, NV
1 January 1999	Emerging Pathogens Guidebook distributed
22 June 1999	VA Focus Group Annual Review, Baltimore, MD
14 September 1999	VA Occupational Health Conference, New Orleans, LA

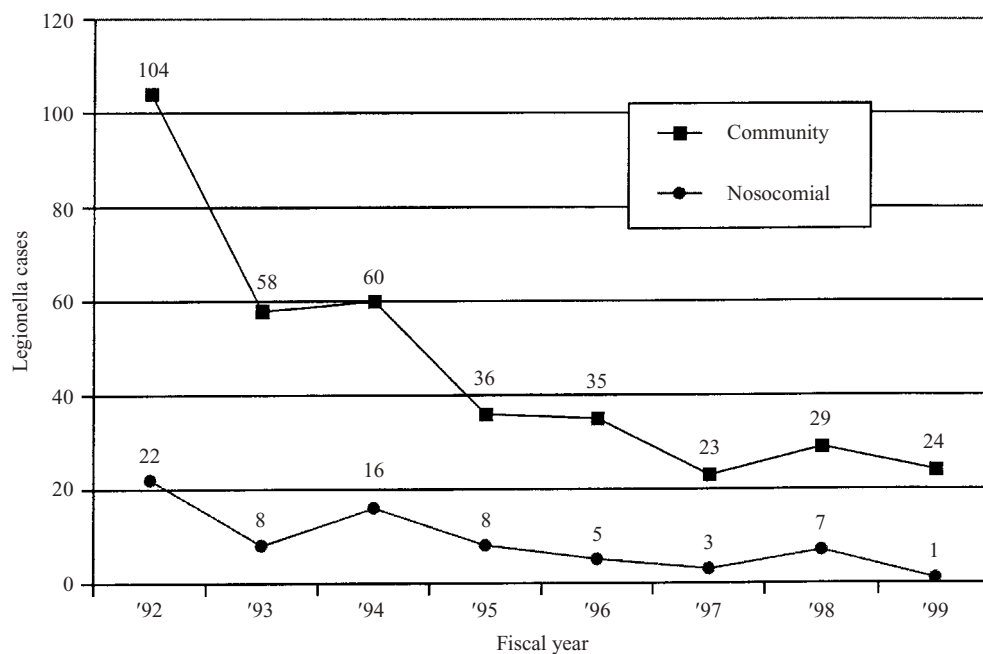
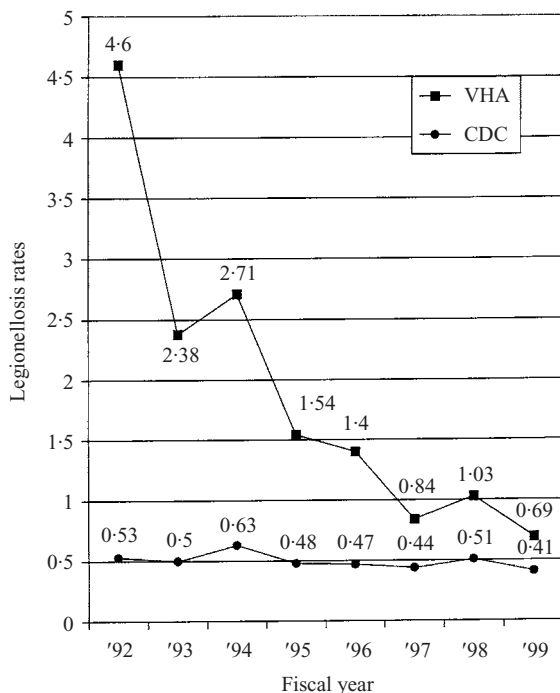


Fig. 1. Comparison of VHA community-acquired and nosocomial legionella cases by fiscal year.

( $P=0.005$ ) from 104 in 1992 to 24 in 1999, while those reported as HCA fell 95.5% ( $P=0.01$ ) from 22 in 1992 to 1 in 1999 (Figure 1). The community-acquired case rate in FY 1992, 3.84 per 100 000 persons served, fell significantly ( $P=0.02$ ) over time with the case rate in FY 1999 being 0.66 per 100 000 persons served. The HCA legionella case rate also had a significant decline over time ( $P=0.001$ ) with a case rate of 0.81 per 100 000 in FY 1992 that fell to 0.03 per 100 000 in FY 1999. The decline of the VHA HCA case rate over time was significant ( $P=0.02$ ) compared to the decline in the VHA community-acquired case rate.

Using the total number of reported VHA legionella cases, comparison can be made between VHA and national United States legionella case rates (Figure 2). It should be noted that the population of veterans served is different from the United States population or the United States veteran population as a whole. Specifically the denominator represents only those persons served by VHA medical facilities across the country. National case rates reported by the CDC remained fairly stable over the study interval with a non-significant decrease in case rates ( $P=0.11$ ) from 0.53 per 100 000 US population in FY 1992 to 0.41 per



**Fig. 2.** Comparison of VHA and CDC legionellosis rates. VHA rates calculated as rate per 100 000 persons served; CDC rates calculated as rate per 100 000 United States population.

100 000 in FY 1999. VHA case rates, however, dropped dramatically from 4.6 per 100 000 persons served in FY 1992 to 0.69 in FY 1999 ( $P=0.02$ ). Since the denominators in these calculations are different, direct comparison of actual cases would be impractical. Using the linear regression model to compare the slopes of the curves, a significant difference between VHA and CDC curves is noted ( $P=0.02$ ) with the VHA demonstrating a more significant decrease in legionella case rates.

## DISCUSSION

This report demonstrates the decline in incidence of legionella pneumonia in the VHA from FY 1992 to FY 1999. HCA cases fell dramatically (95.5%) over the study period while community-acquired cases fell significantly as well (77%). The decline in the HCA case rate shows a significant difference ( $P=0.02$ ) when compared to the decline in the community-acquired case rate. From this one can postulate that the decline in the HCA legionella cases cannot be fully explained by a decline in the number of community-acquired cases seen. It is likely that control measures to prevent the HCA transmission of legionella in the VHA have

had a significant impact on reducing the VHA HCA case rate. The VHA has implemented an aggressive infection control policy outlined in the Domestic Hot Water Temperature Limits Directives for prevention of HCA transmission of legionella. The intensity of intervention between the VHA Central Office and the field intensified beginning in 1989 with virtually yearly documents related to domestic hot water temperature distributed. In addition, educational reinforcement including feedback of national data has been provided at conferences. While direct relationships between interventions and changes in case rates are difficult to prove, the accelerated decrease in VHA HCA case rates compared to the VHA community-acquired case rate lends credence to the effectiveness of the intervention effort.

The VHA also demonstrates a significant decrease in overall case rates when compared to national legionella case rates reported by the CDC. This may reflect fewer cases being seen by the VHA, differences in the population groups studied, limitations of reporting to either agency, or other sampling differences. While no specific clusters of cases were reported in the VA in 1992–1993, the high number of cases could have been related to such occurrences.

There are several limitations to this study. A variety of clinical definitions and laboratory tests were likely used by the large number of facilities and over the length of time of data acquisition. While this could influence the data, this review was designed to accrue data that were used in the healthcare facilities for care of patients as provided to direct patient care providers, for infection control practitioners, and for facility administration.

Population based studies have shown that reporting to the CDC underestimates the incidence of community-acquired legionellosis and presumably the incidence of HCA disease [10]. Cases might be under-reported because of lack of suspicion and therefore lack of specific testing to diagnose Legionnaires' disease. The nature of the Infectious Diseases/Infection Control census lends itself to bias in that it requires the facilities to report cases and classify them as community-acquired or HCA. Each facility has a vested interest (legally and financially) in limiting HCA transmission of legionella. This bias may lead to misclassification of cases. However, all of these limitations also apply to cases reported to the CDC. In fact, the disincentive for diagnostic testing in the VHA is likely less than in the private sector because of the legal and financial implications that have

dramatically less impact on a federal healthcare system. Despite these limitations that, to some degree, are seen in virtually all large surveillance systems, clinically relevant data are presented indicating effectiveness of intervention strategies to decrease HCA legionella in the VHA.

*Legionella* species are an important cause of pneumonia with a high associated mortality in susceptible populations, particularly hospitalized patients. This report illustrates the impact that continued surveillance, centrally defined prevention strategies, and local implementation of those policies can have on preventing HCA Legionnaires' disease in a large, decentralized healthcare system.

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