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Review Article

Current Status of Legionnaires' Disease and Environmental Factors in Japan

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Abstract: Legionnaires' disease became widely known following an outbreak of pneumonia in the United States in 1976. It is often caused by infection from artificial water sources such as cooling towers, water supply and heating systems, and recirculating hot tubs. To effectively implement infection prevention measures for Legionnaires' disease, collaboration among healthcare workers, water supply and heating system managers, building hygiene personnel, and other relevant parties is essential. It is important to note that outbreaks of Legionnaires' disease continue to occur frequently both domestically and internationally. While the number of reported cases of Legionnaires' disease in Japan has increased, the mortality rate has decreased but has stabilized at a lower level. Caution is also required as reports have been made in association with disasters and travel, in addition to artificial environmental water.

Keywords: Legionnaires' disease, *Legionella pneumophila*, Outbreak, Serotype, Tsunami, Water supply

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1. Introduction

What is Legionnaires' disease?

Legionnaires' disease was first recognized in 1976 when an outbreak of pneumonia occurred among members of the Legion of Honor at a convention in Philadelphia, USA[1]. Detailed epidemiological investigations suggested that the air conditioning system of the hotel where the convention was held was the source of infection. Initially, the pathogen could not be isolated, leading to speculation that the cause might be a virus or rickettsia. However, the following year, a new intracellular Gram-negative rod-shaped bacterium was cultured using a special medium and later named *Legionella pneumophila* [2]. The unexplained infectious disease observed in conjunction with the Legionnaires' gathering came to be called "Legionnaires' disease," or Legionellosis.

Subsequently, it has been established that Legionella bacteria, the causative agents of Legionnaires' disease, are widely present in natural water systems and soil, and that infection occurs through inhalation of contaminated aerosols or aspiration. Additionally, infection sources include not only cooling towers but also circulating baths, hot springs, water supply and heating systems, water features (such as fountains), and other artificial facilities and structures [3].

These findings highlight the unique characteristics of Legionnaires' disease, which include a high frequency of outbreaks as outbreaks and the fact that artificial environmental water (hereinafter referred to as "artificial environmental water") serves as a source of infection. Therefore, to effectively prevent outbreaks of Legionnaires' disease, it is essential to promote mutual understanding and cooperation among stakeholders in the medical and public health fields, as well as in the architecture and civil

engineering fields, and to disseminate accurate information through administrative bodies and other channels.

2. Review

Occurrence in Japan and its causes

The first case of Legionnaires' disease in Japan was reported by Saito et al. in 1981[4]. Since then, numerous cases of Legionella infection have been reported, but until around 2000, the number of cases was significantly lower than in Europe and the United States. However, in recent years, changes have been observed in the number of cases due to increased awareness of Legionnaires' disease, the spread of new testing methods such as urine antigen testing, and the implementation of the Infectious Diseases Control Law in 1999, which made reporting of all cases mandatory shows the trend in the number of reported cases of Legionnaires' disease in Japan since 1999 (Figure 1). The number of reported cases was 56 in 1999, 154 in 2000, and 84 in 2001, while it was 280 in 2005, 517 in 2006, and 655 cases in 2007, showing a sharp increase [5]. Since then, cases have been reported at a consistent rate up to 2022. This is attributed to the introduction of Legionella urine antigen testing as a covered insurance procedure in 2003 and 2004, and the inclusion of this urine antigen testing in the treatment flowchart for pneumonia of moderate severity or higher in the Japanese Respiratory Society's guidelines in 2005, Furthermore, in 2019, the Ribotest Legionella test became available, enabling detection of a wide range of serotypes 1–15 of *Legionella pneumophila*, which likely contributed to increased awareness of Legionnaires' disease among healthcare professionals. While the slight upward trend observed since 2019 appears to have been halted, possibly due to the COVID-19 pandemic, the mortality rate remains at approximately 5%, necessitating continued vigilance.

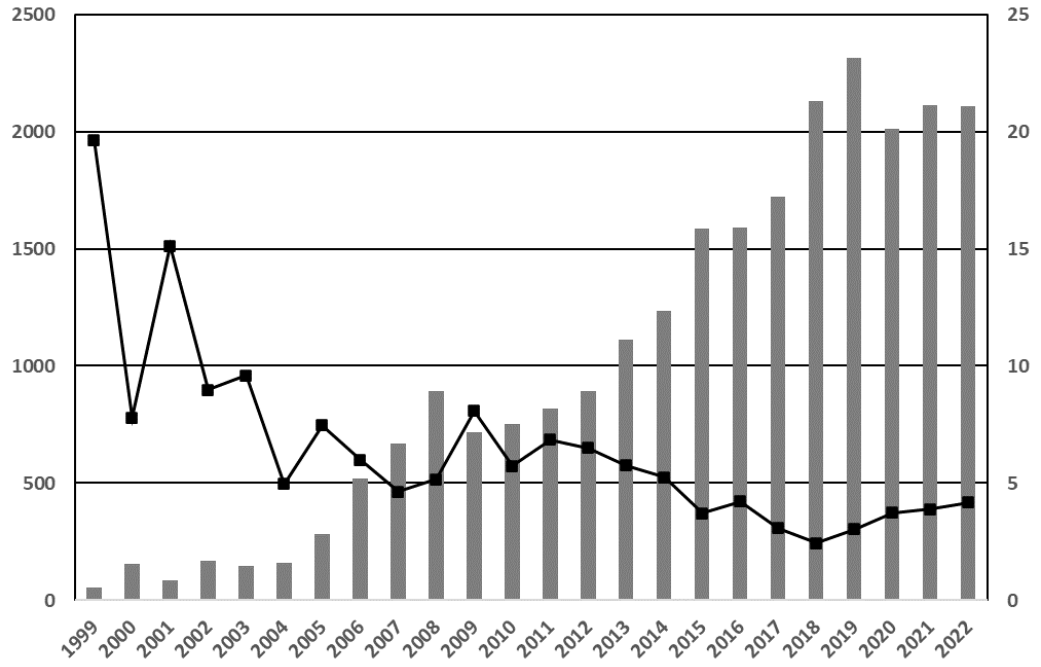

Figure 1. Trends in Annual Reports of Legionellosis and Mortality Rates in Japan Since 1999

Additionally, cases of outbreaks have occurred in various settings, including circulating baths, hot spring facilities, and university hospitals, becoming a social issue involving many people. The first reported outbreak in Japan was two cases of pneumonia observed in a nursing home in Nagasaki Prefecture in December 1990, reported by

Maesaki et al [6]. Unfortunately, the source of infection was not identified in this case, but the bacteria isolated from the two cases were confirmed to be the same strain based on restriction enzyme digestion patterns.

In 1994, a cluster of Pontiac fever (45 cases: *L. pneumophila* serogroup was reported in Tokyo, with a cooling tower suspected as the source of infection [7, 8]. In 1996, four cases of Legionella pneumonia were reported in the neonatal ward of a university hospital, with one fatality. In this case, elevated Legionella antibody titers of the same serogroup were confirmed in all four cases, and the same serogroup bacteria were detected from multiple sources within the hospital, including faucets, humidifiers, and showerheads.

In 2000, there were multiple incidents: in February, 23 people (including 2 deaths) were infected at a leisure facility in Shizuoka Prefecture after using hot springs, and in June, 45 people (including 3 deaths) were infected at a comprehensive welfare facility in Ibaraki Prefecture after bathing [9]. Furthermore, in 2002, there were outbreaks with fatalities at bathing facilities in Miyazaki Prefecture (July) and Kagoshima Prefecture (August). The outbreak in Miyazaki Prefecture was the largest in Japan, with a total of 295 infected individuals (46 confirmed cases) and seven deaths. In this case, the infection source was a so-called recirculating bath tub that uses water from the spring source, and infected individuals were already identified among trial bathers before the facility opened. Subsequent cases were reported at a hotel in Gifu Prefecture in September–October 2009, a sports facility in Kanagawa Prefecture in August–September 2011, and a hot spring facility in Saitama Prefecture in November–December 2012, with 8, 9, and 9 cases (no fatalities) respectively. Additionally, in May 2015, 13 cases (1 fatality) were reported at a public bathhouse in Iwate Prefecture, and in March 2017,58 cases (1 fatality) were reported at a hot spring facility in Hiroshima Prefecture, and 13 cases were confirmed at a hot spring facility in Shizuoka Prefecture in July and August 2019. However, there are many sporadic cases where the source of infection has not been identified, and caution is required in the future.

3. Conclusions

Occurrence of Legionnaires' disease related to disasters

Legionnaires' disease is caused by inhaling aerosols containing the bacteria, but it is believed that infection may occur through drowning in water containing soil environments, such as during a tsunami [10]. In the Great East Japan Earthquake of March 11, 2011, the situation of confirmed Legionnaires' disease patients who may have been infected and developed symptoms in association with the tsunami was examined [11]. Among patients who developed symptoms between March 11, 2011, and the end of April 2013, eight cases were ultimately identified.

Finally, we should take care of the Legionnaires' diseases in the regular environment, such as water supply and heating system managers, but also in the disaster, including tsunami.

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