

A Comparative Study of the Epidemiological Aspects of Legionnaires' Disease: Outbreaks in Korea and Japan, 2010 - 2014

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Abstract

Background: In the present study, we compared the epidemiological aspects of Legionnaire' disease (LD) outbreaks in Korea and Japan by analyzing the current state from 2010 to 2014.

Methods: The following factors were analyzed: nationwide cumulative incidence rate (CIR) per 100,000 populations and case-fatality rate in percentage, epidemiological aspects (i.e., case related to gender), male to female morbidity ratio (MFMR), age, seasonality and habitat distribution of LD cases.

Results: In total, there were 134 cases of LD with the CIR of 0.05 per 100,000 populations in Korea from 2010 to 2014. During the same period in Japan, there were 4,840 cases of LD with a CIR of 0.76 per 100,000 populations. The CIR in Japan was significantly higher than that in Korea. However, the case-fatality rates were at similar levels (3.0% vs. 5.9%). Moreover, LD affects both sexes differently, accounting for 2.05 and 4.41 of MFMR in Korea and Japan, respectively. In both countries, the incidence mainly occurred among people aged 40 years or older, and peaked in summer (37.3% vs. 33.7% of total cases). Significant differences were observed in the incidence of LD cases between the capital city and county areas in both two countries. These differences in LD risk factors reflect the different influences of reservoir/host with natural or artificial aquatic environments.

Conclusion: This study provides a quantitative analysis of the epidemiological aspects and risk factors of LD outbreaks in Korea and Japan. We hope this study would be helpful for providing insight on

effective future strategies to reduce LD outbreaks.

Keywords: Legionnaires' disease; Epidemic aspects; Risk factors; Korea; Japan

Introduction

Legionnaires' disease (LD) is a serious lung infection emerging in the second half of the 20th century, which is caused by *Legionella pneumophila* and related Legionella bacteria species. There is no direct human-to-human transmission [1-3]. The severity of LD varies from mild febrile illness (Pontiac fever) to a potentially fatal form of pneumonia (Legionellosis) that can affect anyone, but principally affects those who are susceptible due to age, illness, immunosuppression or other risk factors such as smoking. Water is the major natural reservoir for Legionella, and the bacteria are found worldwide in many different natural and artificial aquatic environments, such as cooling towers; water systems in hotel, home, ships, hospital and factories; respiratory therapy equipment; fountains; misting devices; and spa pools [1-10]. In Korea, LD was legally classified as a type III notifiable disease by the Communicable Disease Prevention Act of the Korea Center for Disease Control and Prevention (KCDC) in 2000 [5, 7], and in Japan, it has been classified as one of the category IV notifiable infectious diseases by the National Institute of Infectious Diseases (NIID) in 1999 [8, 10].

Recently, there has been a marked outbreak in new cases of LD in Korea and Japan [7, 8]. Therefore, understanding the epidemiological aspects and major risk factors of LD outbreaks in both Korea and Japan provides data necessary for performing risk assessment and establishment of public health policies. Korea and Japan are geographically close to each other and share similar socio-cultural characteristics for the lifestyle. The special distribution of reported cases of LD is influenced by local geography and topology, and at least in both countries, the incidences are associated with artificial aquatic environments for human health [1-6, 9, 10].

In this comparative descriptive study, we investigated the epidemiological aspects of the reported LD in Korea and Japan between 2010 and 2014, and compared the demographic and geographic characteristics of the cases between the two

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Table 1. Comparative Observation of the Epidemiological Aspects of Legionnaire' Disease in Korea and Japan, 2010 - 2014

| Item | Korea | | Japan | |
|------------------------|-------------|-------------|----------------|-------------|
| | Cases (%) | 95% CI | Cases (%) | 95% CI |
| Nationwide | | | | |
| Total cases | 134 | | 4,840 | |
| CIR/100,000 | 0.05 | 0.04 - 0.06 | 0.76** | 0.75 - 0.76 |
| Fatal-cases | 4 | | 286 | |
| Case-fatality rate (%) | 3.0 | 0.1 - 5.9 | 5.9 | 5.2 - 6.6 |
| Gender | | | | |
| Male | 90 (67.2) | 59.8 - 75.1 | 3,946 (81.5)** | 80.4 - 82.6 |
| Female | 44 (32.8)** | 24.9 - 40.7 | 894 (18.5) | 17.4 - 19.6 |
| P-value | < 0.01 | | < 0.01 | |
| MFMR (M/F) | 2.05 | | 4.41** | |
| Age | | | | |
| < 19 | 4 (3.0) | 0.1 - 5.9 | 14 (0.3) | - |
| 20 - 39 | 11 (8.2)** | 3.6 - 12.8 | 89 (1.8) | 1.4 - 2.9 |
| 40 - 59 | 33 (24.6) | 17.3 - 31.9 | 1,074 (22.2) | 21.0 - 23.4 |
| > 60 | 86 (64.1) | 60.0 - 72.2 | 3,663 (75.5)** | 74.3 - 76.4 |
| P-value | < 0.01 | | < 0.01 | |
| Season | | | | |
| Spring | 23 (17.2) | 10.8 - 17.2 | 802 (16.5) | 15.5 - 17.6 |
| Summer | 50 (37.3) | 29.1 - 45.5 | 1,632 (33.7) | 32.1 - 35.3 |
| Autumn | 36 (26.9) | 19.4 - 34.4 | 1,445 (29.9) | 28.6 - 31.2 |
| Winter | 25 (18.7) | 12.1 - 25.3 | 961 (19.9) | 18.2 - 21.0 |
| P-value | < 0.01 | | < 0.01 | |
| Habitat | | | | |
| Capital city | 26 (19.4)** | 12.7 - 26.4 | 375 (7.7) | 7.0 - 8.5 |
| County | 108 (80.6) | 73.9 - 87.3 | 4,465 (92.3)** | 91.5 - 93.1 |
| P-value | < 0.01 | | < 0.01 | |

CIR: cumulative incidence rate per 100,000 populations. 95% CI: confident interval of 95%. Case-fatality rate in %. Statistically significant levels set at *P < 0.05 and **P < 0.01.

countries.

Methods

We analyzed the data of LD on national incidence, and the regional distribution (capital city and other county areas), gender, age, and time of the year for reported cases. The raw data of confirmed legionellosis cases in Korea (n = 134) were obtained from the National Notified Disease Surveillance System of KCDC, an agency of the Ministry of Health and Welfare [7]. Data on reported LD cases in Japan (n = 4,840) were obtained from the National Epidemiological System, administered by NIID in Japan [8].

To quantify the impact of LD infections on health in Korea and Japan, we compiled and analyzed information includ-

ing cumulative incidence rate (CIR) per 100,000 populations in Korea and Japan estimated by the WHO. The upper and lower limits of the 95% confidence intervals (95% CIs) were calculated. Statistically significant differences between the epidemiological aspects and risk factors were compared using the Chi-square test or paired *t*-test. All data analyses were performed in Excel 2007 (Microsoft Co, WA, USA). Results were considered statistically significant for P-value less than 0.05.

Results and Discussion

Table 1 shows the incidence of LD in Korea and Japan between 2010 and 2014. In Korea, the CIR during the study period was 0.05 per 100,000 populations, and annual incidences were in the range of 0.04 - 0.06. The CIR in Japan was 0.76

over the same period and annual incidences were in the range of 0.59 - 0.98. When compared, the CIR of LD in Japan was much higher than that in Korea ($P < 0.01$). However, the case-fatality rates of LD patients in both Korea and Japan were not significantly different. This difference could be attributed to the divergence due to the source of infections with natural or artificial aquatic environments between Korea and Japan. Moreover, LD is acquired by Legionella bacteria in aerosolized water [1-6]. In addition, our results also show that in both countries, LD affects both sexes, accounting for 2.05 and 4.41 of male to female morbidity ratio (MFMR) in Korea and Japan, respectively ($P < 0.01$). Though remarkable, no overall gender predilection has been reported, except to the extent that males have more exposure to artificial aquatic environments for industrial works [1-5]. For example, in the United States, among LD cases identified during 2011 - 2013, 79% occurred in persons aged over 50 years, 65% were in males, and 72% of the patients were white [3]. Moreover, from 2005 through 2009, 3,039 cases of LD were reported in Japan, including 272 from the Tokyo metropolitan area and 149 from Saitama Prefecture. Of the 3,076 patients, 2,503 were males (81.4%) and 573 were females (18.6%). During the period, the number of males affected by the diseases was higher than that of females [9].

When we classified LD cases in Korea by age-specific group, 3.0% of the cases belonged to the group aged 19 years or younger, 8.2% were aged 20 - 39 years, 24.6% were aged 40 - 59 years, and 64.1% were aged 60 years or older, respectively. In Japan, the proportions for the same age groups were 0.3%, 1.8%, 22.2%, and 75.5%, respectively. The proportion of cases differed significantly by age-specific group within both countries ($P < 0.01$). This age-specific distribution also differed between both countries, with 88.8% and 97.9% of the cases occurring among individuals of 40 years or older in Korea and Japan, respectively. This is remarkable, according to an example in the USA, among cases identified during 2011 - 2013, 79% occurred in persons aged 50 years or older [3]. In addition, the affected patients from a total of 3,076 cases in Japan from 2005 to 2009 were predominantly 50 years old or older (90.8% of total cases) [9].

When we analyzed the seasonal pattern of reported LD cases in Korea, we found that 17.2% of the cases occurred in spring, 37.3% in summer, 26.9% in autumn, and 18.7% in winter, demonstrating significant seasonal variation in the case distribution ($P < 0.01$). In Japan, the proportions for these seasons were 16.5%, 33.7%, 29.9% and 19.9%, respectively, again representing significant seasonal variation ($P < 0.01$). During the period, reported cases in Korea increased markedly in June, peaked in September, and began decreasing in the end of November with the cool season. Meanwhile in Japan, reported cases increased from early summer until late autumn, which might be the result of flooding event in period [9, 10].

We also compared the incidence of LD between the capital cities of each country, both of which are intensely urbanized, as well as other regions including rural communities. In Korea, 26 cases (19.4% of total cases) were reported in the capital city of Seoul, home to approximately 20% of the Korean population, between 2010 and 2014. In comparison, 108 cases (80.6% of total cases) were reported in other regions of the country,

demonstrating a significantly higher incidence than the capital city. Conversely, in Japan, 375 (7.7% of total cases) were reported in the capital city of Tokyo, accounting for 11% of the national population, while 4,465 cases (92.3% of total cases) were reported in other regions, suggesting the lack of a significant regional variation.

Finally, Legionella most commonly occurs as isolated cases, but outbreaks occasionally are identified, usually associated with warm water aerosols (the organisms thrive at 20 - 45 °C) originating from air conditioning systems, whirlpool spas, plumbing systems, etc. Nosocomial infections also occur and give rise to the highest proportion of fatal cases. However, person-to-person transmission does not take place [1-5]. Therefore, control and prevention measures must be accompanied by proper vigilance on the part of general practitioners and community health.

In summary, the present study provides a retrospective assessment of quantitative ecological data concerning the epidemiological characteristics associated with reported LD in Korea and Japan. The difference in LD incidence between the two countries might not only suggest the contribution of unique socio-cultural characteristics, but also the variations in industrialization of at-risk areas. It is hoped that this information will be a useful reference in the further study of LD in Korea and Japan.

Conflicts of Interest

The authors declare no conflicts of interest relevant to this article.

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