

Original Article

The Control Strategies of Legionnaires' Disease in Public Places

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Abstract

The *Legionella spp.* has become noticeable since severe outbreak of Legionnaires' disease occurred in Philadelphia, US, 1976. Many countries also paid more attention to the prevention of Legionnaires' disease cluster in public places. In recent years, domestic epidemic of Legionnaires' disease occurred in hospitals, resorts, hotels and gyms as well. How to deal with epidemic in public places timely and properly is becoming an important topic with increasing social attention.

In fact, most people exposed to *Legionella spp.* do not develop symptoms. Pneumonia caused by *Legionella spp.* is likely to be underestimated and treated as a common type pneumonia, and would miss the opportunity to detect the bacteria from environmental specimens after notification. In addition, if investigation is not prudent enough, it is difficult to discover cluster in public places and identify high-risk pathogenic environment, thus people can not be protected from the threat of Legionnaires' disease.

However, if epidemic prevention personnel are familiar with various prevention measures and understand the causes of Legionnaires' disease, and has the concept of high-risk environment and prevention purposes, then they will be able to make the right judgment and arrangement when deal with the epidemic; improve the detection rate and identify potential high-risk environment.

Provide guidance for business premises with idea of "self-management" to strengthen the cleaning and disinfection of water installation, as well as water supply system and central air-conditioning cooling towers, is the fundamental way to prevent and control the Legionnaires' disease. It can certainly protect people from the hazard of *Legionella spp.* and guarantee citizens' health and welfare through community epidemic monitoring, notification, appropriate management of cases, careful epidemic investigation, appropriate administrative control soon after the source of infection determined, proceed environmental specimen collection, disinfection, and follow-up assistance.

Keywords: Legionnaires' disease , *Legionella spp.*, community-acquired, public place

Introduction

The beginning of the Legionnaires' disease clusters can be traced back to 1976, the large-scale of infection occurred among members of American Legion at their stayed hotel when the 58th annual meeting held in Philadelphia. There were 221 people successively developed unexplained fever, cough and acute pneumonia, and unfortunately caused 34 deaths [1-2]. The pathogen of this outbreak was cultured in the following year by the U.S. Centers for Disease Control in lung tissues removed from the deaths, and officially named *Legionella pneumophila*. Though *Legionella spp.* was found as early as 1943 [3-4], the damage of *Legionella spp.* to human body has gradually attracted people's attention since this serious outbreak, and *Legionella spp.* has been considered as a very important pathogen in community-acquired pneumonia and nosocomial pneumonia infections.

In recent years, the annual number of confirmed Legionnaires' disease cases is about 40 to 110 in Taiwan. Legionnaires' disease epidemic also occurred in hospitals, resorts, hotels and gyms [5-7]. Once a suspected epidemic cluster breaks out, besides the damage to public health, it may also cause social panic, discourage people's willingness of tourism, induce media attention effects, affect the business goodwill, and even result in consumers dispute. Therefore, how to timely response and properly handle the Legionnaires' disease epidemic has gradually become a social concern. To proceed immediately to strengthen the Legionnaires' disease control strategies in public places has actually become essential and pressing [8].

Prevention and control measures of Legionnaires' disease

The *Legionella spp.* bacteria often multiply in natural water, groundwater, artificial water, and even in the soil, and do not cause illness to healthy people. Hence the purpose of prevention and control is not to completely wipe out *Legionella spp.*, but to minimize risk. The current concept of Legionnaires' disease prevention and control in Taiwan is to remove the required growth conditions in water for *Legionella spp.*.

Under favorable conditions, the *Legionella spp.* in the environment may cause epidemic in communities. First, pathogens must exist in the environment. *L. pneumophila* is the major pathogen, and other bacterial species of the same genus has relatively lower impact to human health. Then, the *Legionella spp.* in the environment needs to enter the respiratory tracts of human body through the mist. Finally, when the elderly or immunocompromised susceptible host were exposed, they may be infected and fall ill.

Therefore, in terms of control, special attention should be paid to the high risk environment in a public place where the *Legionella spp.* can get access to human body, including the locations or facilities prone to mist, e.g., cooling tower, fountain, sprinkler system, spa water storage tank, hot tub, drinking fountain, water outlet as in shower and faucet, or other environmental equipment contaminated by *Legionella spp.*, especially

when water temperature is between 35°C to 45°C [9] that suitable for the growth of *Legionella spp.*, is more risky. In addition, the location of obstructed water flow or prone to generate biofilm are also good environment for the multiplication of *Legionella spp.*. With regard to environmental investigation of an epidemic, the locations of water supply systems where the cases were exposed frequently before their onset may be the likely infection sources that need particular attention. For the aforementioned high risk environment, especially public places that high-risk groups like elderly or immunocompromised people often access such as hospitals or nursing homes, need to be intensively controlled.

In Legionnaires' disease epidemic investigation, if any suspected or confirmed case had been found within six months at the same place where the current confirmed case might have exposed, it might be a suspected cluster and further control measures should be in placed in accordance with "Guidelines for prevention on suspected Legionnaires' disease cluster events in public places" [8].

Surveillance, notification and case management for community epidemic

To prevent community from Legionnaires' disease cluster, Taiwan has listed the Legionnaires' disease as a notifiable communicable disease since 1999. Once medical institution finds any outpatient with suspected symptoms, especially with unidentified pneumonia, differential diagnosis of Legionnaires' disease must be requested. Notify local health authorities as soon as possible if cases are highly suspected based on the Article 39 of "Communicable Disease Control Act" [8,10], at the utmost within one week.

When a case is confirmed, the important goals on community prevention and control are early detection and eradication of potential infective environment that may endanger the public. This must rely on primary investigation work on epidemic, list all public places wherever the patient went before the onset for detecting community cluster as soon as possible. Therefore, to enhance the epidemic investigation on patient's exposure history before the onset is very important in epidemic prevention. After all, rough epidemic investigation will lead to delay the discovery or unaware of the occurrence a community cluster, other high risk group might expose to the infection source and fall ill.

Nowadays, transport services are well developed and cross-regional business or travel frequently happened, so that the opportunity of infection at one public place has been substantially increased in the residents from different regions. Thus, how to defend cross region infection is an important task in Legionnaires' disease cluster prevention in communities. So monitoring the cases with the same infection source between cities and counties has become very critical.

If the infection source is a public place where tourists often visit, it is needed to inform other local health departments in recent epidemic investigation for Legionnaires' disease to make sure if their cases visited the same place before the onset [5].

In general, *Legionella spp.* has fewer hazards to healthy people. Patient can be cured with timely diagnosis and proper treatment with antibiotics. So far, whereas no human to human transmission cases have been confirmed yet, it is not necessary for hospital to quarantine a Legionnaires' disease patient.

Investigation of community cluster

Taiwan CDC has established "Communicable disease epidemic investigation system" to facilitate the epidemic investigation, and also has a specific form for Legionnaires' disease investigation. The information obtained from the confirmed cases is very helpful for epidemic prevention personnel to precisely control the epidemic [8].

The more important item is "exposure history" of cases, which refers to public places where a confirmed case has been to before the onset, including tourist accommodation or rest sites, recreation places, office buildings, and dwellings with water facilities.

When a community cluster is found, health authorities need to cautiously investigate the "environmental infection source", including recording the details of facilities in public places which patients had used, and mark out the *Legionella spp.* growth related risk factors, such as temperature, frequency of chlorination, residual chlorine, cleaning methods and frequency, and other disinfection methods.

Moreover, the management documents of facilities in the public places ought to be acquired as well, including building blueprints, especially pipeline diagrams which illustrate the cooling towers and water systems, and mark the actual water temperature of different segments, and chlorination modes and locations. The environmental maintenance and disinfection records of the public places are also important, including reference information of water temperature control, management mechanism, the time and frequency of cleaning and disinfection.

To understand the health condition of cases exposed to the same environment is also essential. People who recently exposed to the same infective environment with patients should be intensively followed. In order to actively look for other potential cases, epidemic prevention personnel should ascertain whether patient's relatives, friends, travel companies or staffs of the public places develop the symptoms of Legionnaires' disease.

The handling of the suspected infection source in public places

To deal with the suspected infection source in public places can be roughly divided into environmental sampling, disinfection, as well as the recommendation and administrative management to the business premises.

For environmental specimen collection in the suspected infection source, in order to avoid harmful infection source continue to endanger the public, health authorities will collect environmental specimen at the suspected infective place as soon as possible depending on the preliminary results of the epidemic investigation after reporting cases were laboratory

confirmed. After specimen collection, the public place should immediately take necessary disinfection measures for all suspected infective sources.

For other related details of the environmental specimen collection, please refer to the official documents of “The notes on environmental specimens sampling of Legionnaires' disease” [11], “Manual for specimen sampling”, and “Guidelines for *Legionella* control” [9].

With regard to environmental disinfection, when the test results from environmental samples are positive for *Legionella spp.*, regardless of any serogroup, the relevant business premises will be supervised to conduct the environmental cleaning and disinfection based on the “Guidelines for *Legionella* control”.

As for recommendation and administrative procedures to the business premises, the government will direct the business premises owners to cooperate with the health authorities for epidemic control and prevention; conduct epidemic investigation, environmental sampling, cleaning and disinfection, and educating with the correct knowledge on Legionnaires' disease. The government will also remind the business premises to regularly clean and disinfect water supply systems and cooling towers, and maintain good ventilation in the environment of business premises, as well as keep vigilant and always take notice of employees' health, attendance and leave reasons. They should keep in close contact with the health authorities if any suspected symptom of Legionnaires' disease is detected.

For the epidemic in public places, the relevant business premises in concert with county or city governments need to assess whether to suspend partial or all their facilities. It is recommended to reopen until the facilities are completely cleaned and disinfected without further infection risk after evaluation by the health authorities.

The fundamental to prevent and control the cluster of Legionnaires' disease in public place is to request the business premises to implement self-management, regularly clean water supply systems and cooling towers, and disinfection to protect the public from the hazard of *Legionella spp.* and safeguard citizens' health and welfare.

Conclusions

The current focus of infection control and prevention on Legionnaires' disease in Taiwan is “elevating the management in relatively high risk places (hospitals)”. Taiwan CDC has established the “environmental testing operations for *Legionella spp.* in hospitals and the associated guidelines of correspondent measures” to intensify the nosocomial control measures for Legionnaires' disease. As for community prevention, besides to strengthen the control measures of Legionnaires' disease in compliance with the “Communicable diseases control workbook” [10] and the “Guidelines for *Legionella* control” [9], Taiwan CDC also established the “Guidelines for prevention on suspected Legionnaires' disease cluster events in public places” [8] and “The notes on environmental specimens sampling of Legionnaires' disease” [11] to further regulate the environmental specimens collection and the prevention for suspected cluster, and fulfill the control measures of Legionnaires' disease.

The purpose of preventing Legionnaires' disease is not to “completely wipe out the *Legionella spp.*”, but to “minimize risk”. The current main concept of prevention and control of Legionnaires' disease is to control the *Legionella spp.* in water and change its required multiplication conditions.

Clinically, pneumonia caused by *Legionella spp.* is easy to be underestimated, and the detection rate is also influenced. In addition, if investigation is not prudent enough, it is difficult to discover a cluster and high risk environment, thus people cannot be protected from the harm of Legionnaires' disease. If epidemic prevention personnel familiar with prevention measures and understand the causes of Legionnaires' disease, the concept of high risk environment and prevention purposes, they will correctly judge and deal with the epidemic, improve the detection rate and identify potential high risk environment.

In addition, vacation is popular in recent years. Water safety in business premises is greatly valued. However, business premises are various and numerous. The immunocompromised people are more susceptible to Legionnaires' disease, and not all the *Legionella spp.* contacts will be infected. Therefore, one of the solutions is to promote “self-management” in the hospitals and business premises citywide or countywide. The task of promoting self-management in the business premises will be regular cleaning water terminal outlets or other environmental equipments which may be contaminated by *Legionella spp.*. The special advocacy of self-management focuses on the business premises where the elderly or immunocompromised people often access. These are ways to safeguard people from the hazard of Legionnaires' disease and protect citizens' health and welfare.

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The Current Business Sanitation Self-Regulation on Legionnaires' Disease

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Abstract

Legionella bacteria is mainly transmitted through the mist in the air, the cooling tower of air-conditioning system, spring pools, and mist from the shower heads are all important sources of infection. Other countries didn't include Legionnaires' disease into routine inspection items because most healthy people are resistant to this bacteria so the probability of infection is low, in addition, there is a wide range and a huge number of commercial establishments. Only Japan has regulation on bathhouse industry that spring water should not have any presence of *Legionella pneumophila*. Other industries like hotel industry didn't have regulation on the examination on *Legionella pneumophila*.

In order to reduce the risk of people with poor immunity that being infected by Legionnaires' disease in commercial establishments, Taiwan CDC has revised the "Business sanitation standards" on September 2011, and added a stipulation that requires water supply systems and water-cooling towers in the commercial establishments should be cleaned and sanitized more than once per six months. Taiwan CDC also issued documents to local health bureaus to discuss and include it into "Business sanitation self-regulation rules".

Introduction

Because an increasing interest in recreation among people, hot springs are becoming popular sites, which results in sprouting of business of hot spring hotels and public bathhouses. An instance of a tourist who was infected with Legionnaires' disease while stayed at a hot spring hotel in a county attracted media's attention, also affect the hotel's reputation. It prompted both health agencies and industries to emphasize on the potential occurrence of Legionnaires' disease and its prevention in commercial establishment.

Nowadays in our society, many kinds of commercial establishments are thriving and flourishing, which draw the frequent visiting of people to these places. In a more closed area,

an increasing of the population density means an increasing of density of probable pathogens in public places, including air, drinking water and excretions, etc. Therefore, it is inevitable that commercial places might affect individual and public health.

Regulation on business sanitation includes industries of hotel, beauty and hair salon, balneary, entertainment, movie theater, swimming pool, etc., and health management of the employees. As the increasing of these places, the quality of the health environment, the condition of the health equipment, and self-regulation on health of employees, could lead to the transmission of the disease due to contamination or carelessness and put consumers' health in jeopardy.

Business sanitation self-regulation in Taiwan

The goal of regulation on business sanitation is to strengthen the maintenance of hygiene in the commercial establishments and employee's health. To enhance the quality of hygiene in commercial establishments and take the sustainable development of industries into account, Taiwan CDC has referenced to other countries' regulation on business sanitation, and invited professionals, scholars and local health bureaus to prepare "Business sanitation standards" and issued on April 2007 [1]. The occupations applicable to this standard are industries of hotel, beauty and hair salon, balneary, entertainment, movie theater, and swimming pool, etc. Business can refer to this standard for the regulation on hygiene and take it as an administrative guidance. City and county health bureaus can also counsel business of health regulation based on this standard to meet with the local needs, or include it into the local "Business sanitation self-regulation rules", and formulate the range of administrative fines by local government. If business cannot conform to the hygiene standards, administrative sanctions can be imposed according to local "Business sanitation self-regulation rules". Eleven city and county have formulated the "Business sanitation self-regulation rules", these are Taipei City, Taoyuan County, Hsinchu County, Miaoli County, Nantou County, Yunlin County, Kaohsiung City, Hualien County, Taitung County, Lienchiang County and Kinmen County.

Based on the concept of the water safety in commercial establishments with reference to other countries' regulation, for water quality in the swimming pool, balneary and spa pool industry, the microorganism indicator, the total bacterial count should less than 500 CFU/ 1ml and *E.coli* should less than 1 CFU/100ml. Additionally, enhance sanitation inspection on related industries in peak seasons of swimming pool (from May to October) and in peak season of hot springs (from November to next February) and inspect the water quality once per two weeks in peak season and once per month in other months.

To improve the hygiene quality in commercial establishments, health authority should strengthen not only inspection and consultation, but also promoting self-regulation on health among commercial settings through training to the hygienic management personnel and business owners. Health authority provides sufficient professional training to businessmen and helps staff who are responsible for business hygiene to realize the issue of hygiene and their

responsibilities, performs business hygiene self-regulation evaluation, also provides health safety service for consumers, by which could reduce the incidence of infectious disease. The earlier business sanitation self-regulation didn't target on Legionnaires' disease, due to the outbreak event, Taiwan CDC revised the Business sanitation standards on September 2011 and added a stipulation saying "water supply systems and water-cooling towers in the commercial establishments should be cleaned and sanitized more than once per six months."

Other countries' business sanitation self-regulation

1. United States

- A. The regulations regarding hotels, beauty and hair salon, bathhouse, entertainment, swimming pool in the US is different from our country. The regulations are established by Centers for Disease Control and Prevention (CDC) and Food and Drug Administration (FDA) which aim at prevention of infectious disease, ensure food safety and other related issues and formulate hygiene standards, such as regulations of water or food safety. Each State sets specific management rules with regional standards.
- B. The U.S. government adopted decentralization management system and "Health and Safety Code/Guide", based on hygiene regulations of industries such as hotels, beauty and hair salon, bathhouse, entertainment and swimming pool. Regulations are formulated by each State and County. Take Maryland as an example, the guidance related to hotel industry was formulated by State Government. However "Guidelines for Licenses and Permits" related with beauty and hair salon, bathhouse, entertainment and swimming pool was formulated and regulated by county government and in charge of regulatory hygienic examinations.
- C. The regulatory departments of hotels, beauty and hair salon, bathhouse, entertainment, and swimming pool are different in States, some are regulated by State/county's Licensure and Regulatory Services, which is under Department of Health and Human Services; while in some States are under the Department of Consumer Affairs' related occupation councils (e.g., California State Board of Barbering and Cosmetology).

Legionnaires' disease was not listed as a regulatory testing in commercial places.

2. Australia

- A. The business hygienic regulations of beauty and hair salon, bathhouse and swimming pool were formulated by each Australian State government. Take Australian Capital Territory (ACT) as an example, "Public Health (Hairdressing) Code of Practice"[3] regulated and focused on beauty and hair salon workers' cleanness of hands and clothes, preventive measure of transmission of disease, daily cleanness, disinfection of instruments, towels and hair brushes. Determination of a Code of Practice for the Operation of Swimming and Spa Pools" [4] regulated that public swimming pools and public spa pools should be equipped with effective water circulation systems and filters

and recommended public swimming pools/spa pools being equipped with automated self-disinfection and automatic pH control.

- B. The business hygienic regulations of hotels and movie theater industry are under Australian federal law "Food Standards Code" and no specific regulations are made for these two commercial establishments. Also, Australia government didn't have specific regulation on entertainment industries.

Legionnaires' disease was not in the list as a regulatory examination in commercial establishments

3. Korea

"Public Health Control Act" [5] regulates hygienic control of equipment in commercial establishments where many citizens frequently go to, such as beauty salons, barber shops, laundries, hotels and public bathhouses. But the Legionnaires' disease was not listed as a regulatory examination in commercial establishments

4. Singapore

The Singapore National Environment Agency has formulated the Environmental Public Health Act, which regulates the related food hygiene, swimming pools and public cleaning. But the Legionnaires' disease was not listed as a regulatory examination in commercial establishments

5. Japan

- A. Hotel industry: Based on "Hotel industry in health management essentials".
B. Beauty and barber industry: Based on "Barbers and hairdressers administrative rules"
C. Bathhouse industry: Based on "Public baths rule" [6].

Ministry of Health, Labor and Welfare (MHLW) formulated the standard of water quality in spring pool and public pool in 2001. The content is as following: According to the Public baths rule and Hotel industry rule, administration of spring pool and public pool's hygiene is formulated by autonomous organizations, which is administered by environmental health inspectors of health bureau. To provide references for autonomous organizations to formulate regulations or hygiene administration, MHLW has formulated "Hotel industry health management essentials", "Essentials of hygiene management in public baths", "Standards of water quality in public bath", etc. The standard of water quality in spring pool includes following four items: 1. Turbidity cannot exceed 5 degrees. 2. Addition of potassium manganate cannot exceed 25 mg/L. 3. Coliform group in the spring cannot exceed 1 CFU/mL. 4. Perform test on *Legionella pneumophila* in the spring water body, once a year for uncirculated bathtub and twice a year for circulated bathtub. If the bathtub cannot be disinfected with chlorine, more than four times regular inspections per year are necessary. MHLW also listed requirements for self-regulated businessmen in regulations on spring industry. In addition, in order to prevent the breakout of Legionnaires' disease, MHLW provides laws such as

hygienic administrative method and measure, regulations on hygienic measure [7] for bathhouse and hotel industry.

D. Entertainment and movie theater industry: the 3rd provision of the 3rd ordinance in Execute ordinances of performance venue [8] illumination, hygienic standard, cleanness, ventilation.

E. Swimming industry: Banned regulations for swimming pool.

Conclusion

Legionella bacteria is mainly transmitted through the mist in the air, the cooling tower of air-conditioning system, spring pools, and mist from the shower heads are all important sources of infection. It can also cause disease by choking in the polluted water. People with a poor immune system is more susceptible to Legionnaires' disease, for example, elders, smokers, diabetes, chronic lung disease, kidney disease, malignant tumors and people who received corticosteroid treatment or having had an organ transplantation. Other countries didn't include Legionnaires' disease into routine inspection items because most healthy people are resistant to this bacteria so the probability of infection is low, in addition, there is a wide range and a huge number of commercial establishments. Only Japan has regulation on bathhouse industry that spring water should not have any presence of *Legionella pneumophila*. Other industries like hotel industry didn't have regulation on the examination on *Legionella pneumophila*.

In order to reduce the risk of people with poor immunity that being infected by Legionnaires' disease in commercial establishments, Taiwan CDC has revised the "Business sanitation standards" on September 2011, and added a stipulation that requires water supply systems and water-cooling towers in the commercial establishments should be cleaned and sanitized more than once per six months. Taiwan CDC also issued documents to local health bureaus to discuss and include it into "Business sanitation self-regulation rules" with references such as "Guidelines for Legionella Control" [9] and "Guidance of prevention on suspected Legionnaires' disease cluster events in public community" [10]. Local health bureaus should not only strengthen supervision and hold hygienic lectures, but also urge business to self-regulate on health to ensure public's health.

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Outbreak Investigation Express

Investigation of a Suspected Respiratory and Encephalitis Cluster among University Students in Central Taiwan

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Abstract

A student from an university in central Taiwan was hospitalized for respiratory tract infection and encephalitis in late April, 2012. He died 5 days after hospitalization. One of his classmates also showed symptoms of respiratory tract infection and ataxia and was admitted to a tertiary hospital two weeks after his death. In addition to the two students, 30 classmates presented symptoms of respiratory tract infection from late April to late May. Human Bocavirus was detected from the cerebrospinal fluid of the deceased student. Among the seven students with respiratory tract infection, three were found to have human herpesvirus 7 (HHV7) and two were found to have HHV7 and human coronavirus HKU1 by throat swab tests. The class was dismissed between May 24 and May 28. The school authority cleaned

the environment with bleach. No more student was found to have respiratory tract infection after the interventions.

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