

Clinical reports

Severe *Legionella pneumophila* pneumonia associated with the public bath on a cruise ship in Japan

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Introduction

The relatively large number of patients with *Legionella pneumophila* pneumonia infected through attendance at bathing facilities is a Japanese characteristic [1]. Contamination of 24-h home bath water with legionella species has been reported, and eradication of the organism has been tried [2]. The Infectious Agents Surveillance Report (IASR) (<http://idsc.nih.go.jp/iasr/iasr-ggl.html>) reported that samples taken from 808 bathing facilities in Japan were contaminated by legionella species in 2003. However, the public baths on cruise ships traveling to and from Japan are poorly investigated, and there is no legal inspection by the appropriate public organization. We present a case of severe *L. pneumophila* pneumonia acquired from the public bath-system on a cruise ship traveling from Osaka to Taiwan; this case raises the necessity for investigation of both systems on cruise ships.

Case report

A 70-year-old Japanese man was admitted to the emergency room with the symptom of severe dyspnea. He had a 1-week history of diminished appetite, general fatigue, and a 2-week history of dry cough and mild fever. He had traveled to Taiwan on a cruise ship for 10 days. He had returned home 7 days prior to admission. He had used the public bath at least seven times on the cruise ship. As he showed difficulty in breathing, and his

SpO₂ was 80% (ambient air) on admission, he was transferred to the intensive care unit (ICU). Because of his progressive respiratory failure, tracheal intubation and mechanical ventilation was needed, with continuous intravenous administration of propofol. Arterial gas analysis with ventilatory support (FiO₂ 1.0; PEEP, 5 cmH₂O; SIMV = 18 min⁻¹) showed pH 7.48, PaO₂ 66 mmHg, and PaCO₂ 55 mmHg. A chest radiograph revealed bilateral diffuse pneumonia with existing emphysema. A computed tomogram (CT) of the chest revealed multiple areas of infiltration. Laboratory examination showed a leukocyte count of 16500/mm³; C-reactive protein (CRP) level was 36.4 mg/dl and total bilirubin level was 2.6 mg/dl. The administration of panapenem (1 g/day i.v.) was started. On hospital day 1, we obtained a specimen for determination of the causative microorganism by bronchoendoscopy, but culture of the aspirated fluid showed no significant growth of organisms. Based on this finding, with the characteristics of the chest radiograph, we suspected interstitial pneumonia, and methylrednisone (1 g/day) was given for 3 days. In spite of the treatment, the infiltrative shadow grew, and the patient's oxygenation remained unimproved. His condition continued to deteriorate, with ongoing multiple organ failure (MOF) and refractory hypotension.

On hospital day 4, *Legionella pneumophila* was isolated from culture of the sputum on buffered charcoal yeast extract with alpha-ketoglutarate (BCYE- α) agar plates. Culture of bronchial lavage was positive for *L. pneumophila* serogroup 5. After confirmation of these colonies, the antibiotic administration was switched to erythromycin (2000 mg/day i.v.), ciprofloxacin (400 mg/day i.v.), and rifampicin (450 mg/day p.o.) in combination. Specific urinary antigen detection of *L. pneumophila* was later reported to be positive (Binax, Portland, ME, USA). His condition was ameliorated dramatically after the changing of antibiotics. Arterial gas analysis with ventilatory support (FiO₂, 0.4; CPAP

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with PEEP, 5 cmH₂O) showed pH 7.48, Pa_O₂ 78 mmHg, and Pa_{CO}₂ 41 mmHg on hospital day 9. His trachea was extubated but his oxygenation deteriorated in spite of treatment by nasal positive pressure ventilation. His trachea was reintubated on hospital day 10. He rapidly developed refractory hypoxemia and the Pa_O₂/F_IO₂ (P/F) ratio was under 70 on hospital day 11. CT of the chest revealed diffuse fibrotic change, especially in the lower lobe, and atelectasis of the dorsal side. Methylprednisolone (1 g/day) was given for 2 days for the alleviation of fibrotic change after the diffuse alveolar damage caused by *L. pneumophila*. His oxygenation gradually improved. A tracheotomy was performed on hospital day 13. The atelectasis of the dorsal side was ameliorated by respiratory therapy done with the patient in the prone position for the purpose of prompting excretion of the sputum. The patient was discharged from the ICU on hospital day 22.

To identify the source of *L. pneumophila*, environmental sampling of the ship's water system was performed. Cultures taken from the water system in the men's bathroom yielded an isolate of *L. pneumophila* serogroup 5. Pulsed-field gel electrophoresis (PFGE) of DNA showed that the patient's pathogen and the strain obtained from the bath water were identical.

Discussion

Legionella pneumophila is a common cause of sporadic community-acquired pneumonia. Cigarette smoking, chronic lung disease, advanced age, and immunosuppression have been consistently implicated as risk factors [3–6]. Our patient was 70 years old and a heavy smoker, with previously existing mild emphysema. His severe pneumonia required admission to the ICU and he rapidly showed MOF accompanied by septicemia. The pneumonia was progressive and characterized by acute multifocal alveolitis. Chest CT showed interstitial or intraalveolar edema with subsequent pulmonary fibrosis. We administered methylprednisolone after we diagnosed legionnaires' disease, because the patient's oxygenation deteriorated consistently in spite of the proper selection of antibiotics for *L. pneumophila*. On hospital day 9, his trachea was extubated, but his oxygenation deteriorated, and his trachea was reintubated on hospital day 10 in spite of the administration of erythromycin, ciprofloxacin, and rifampicin. Careful observation is required for *L. pneumophila* patients after the administration of methylprednisolone, because a withdrawal syndrome may occur, as happened in our case. Another reason for the treatment difficulty was the delay of hospitalization in our patient. Besides, the patient's predisposing pulmonary condition affected the severity of the pneumonia.

L. pneumophila is a facultative intracellular pathogen that infects human macrophages, monocytes, and epithelial cells [7–9]. In the aquatic environment, it can survive and multiply within amoeba, which act as natural hosts. Bacteria growing within amoeba are changed phenotypically and exhibit an increased resistance to antibiotics and biocides when compared with cells grown in conventional media [10–12]. *L. pneumophila* is chlorine-tolerant; the organism survives the water treatment process and passes into the water distribution system. The natural habitat of *L. pneumophila* appears to be aquatic bodies, including rivers, lakes, streams, and thermally polluted waters. In general, warm water seems to promote the growth of many legionellae, and very high numbers have been isolated from biofilms associated with hot springs and from hot water plumbing systems. Jermigan et al. [13] reported an outbreak of legionnaires' disease associated with a cruise ship in 1996. This outbreak represented the first documented instance of legionnaires' disease aboard a cruise ship docking in United States ports. Surveillance of cruise ships was reinforced after the outbreak. In Japan, the Ministry of Health, Labor, and Welfare reported that legionella species were detected in 2946 baths (16.7%) among 17614 public baths that were investigated in 2003. The IASR reported, in 2003, that legionella species were detected in the samples taken from 808 bathing facilities in Japan. *L. pneumophila* serogroup 5 was detected in 155 (19.2%) of 808 samples. However, the public baths on cruise ships have been poorly investigated by the appropriate public organization. Soon after we reported this case, the public health center examined the bath system in this cruise ship. The men's and women's public baths proved to be contaminated by *L. pneumophila* serogroups 5 and 1, respectively. *L. pneumophila* serogroup 5 was identified as the strain in the water obtained from the men's bath, and PFGE of DNA showed that the patient's pathogen and the strain obtained from the water of the men's bath were identical. The samples obtained from the water of the women's bath were positive for *L. pneumophila* serogroup 1. Another person (a woman) on the same ship suffered from legionnaires' disease and required admission to hospital in Tokyo at nearly the same time. Although culture of her sputum was negative, specific urinary antigen detection of *L. pneumophila* was positive. Our case suggests that surveillance for the presence of *L. pneumophila* and periodic check-ups of water supply systems on cruise ships are necessary to prevent legionnaires' disease outbreaks.

In summary, a 70-year-old Japanese man presented with severe *L. pneumophila* pneumonia and MOF. The pathogen proved to have been acquired from the public bath on a cruise ship traveling from Osaka to Taiwan. The patient's strain of *L. pneumophila* and the strain of

L. pneumophila obtained from the water in the public bath on the cruise ship were both identified as serogroup 5. Although the patient showed MOF caused by septicemia, he was successfully treated with erythromycin, ciprofloxacin, rifampicin, and methylprednisolone. The public baths on cruise ships have been poorly investigated by the appropriate public organization in Japan. This case raises an important public health issue regarding the prevention of legionellosis in Japan.

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