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LEPTOSPIROSIS AFTER RECREATIONAL EXPOSURE TO WATER IN THE YAEYAMA ISLANDS, JAPAN

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Abstract

Leptospirosis is a global zoonotic disease with a variety of clinical manifestations. We report an outbreak of leptospirosis in the Yaeyama Islands, Japan, in the summer of 1999 associated with heavy rainfall. Fourteen people were diagnosed with leptospirosis and required hospitalization. All cases were found to have exposure to contaminated soil or water. A history of recreational activities involving water sports was more frequent (71%) than occupational risk factors related to agriculture or construction (29%). Fever was the primary symptom in all cases, followed by chills (93%), headache (86%), myalgias (57%) and conjunctival suffusion (57%). All cases were successfully treated with antimicrobial therapy except one patient who improved spontaneously. Jarisch-Herxheimer reactions were seen in six cases (43%). The increasing incidence of leptospirosis related to recreational sports is an important public health problem in resort areas. A high-index of suspicion, early treatment, and prevention are crucial in this latently endemic area.

INTRODUCTION

The Yaeyama Islands consist of two major islands, Ishigaki and Iriomote, and a number of smaller islets located in the most southern part of Japan. Due to its location at a latitude of 24 degrees, the climate of the Yaeyama Islands is subtropical. As in other subtropical resort locations, such as Hawaii and Florida, marine sports are major tourist attractions in this area.

Leptospirosis has a worldwide distribution. The incidence is higher in the tropics than in temperate regions.¹ In both developing and developed countries, leptospirosis is an important public health problem related to poor housing conditions. The disease is seasonal, with peak incidence occurring in summer or fall in temperate regions.² Extensive flooding and seasonal rainfall are significant risk factors for exposure to water contaminated with leptospires. A report

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from Brazil described a relationship between rainfall and human leptospirosis.³ Leptospirosis was formerly considered to be primarily an occupational disease associated with agriculture, mining, livestock farming, and military maneuvers.^{1,4}

Although leptospirosis related to occupational exposure has decreased, reports of recreational exposure involving water-sports including swimming, canoeing, or rafting have been increasing conspicuously.^{5–8} Travelers returning from locations where leptospirosis is endemic are at risk. The incubation period of the disease is usually 5–14 days but may last up to 1 month.⁹ Therefore, the relationship between symptoms and the water exposure may not always be apparent. In this report, we describe 14 cases of leptospirosis requiring hospitalization in a 2-month period, with the majority acquiring the disease after recreational exposure to water.

MATERIALS AND METHODS

The medical records of all patients with a laboratory diagnosis of leptospirosis during summer 1999 at the Yaeyama Hospital, Okinawa, Japan, were retrospectively reviewed. In some cases, patients were also interviewed during hospitalization.

In this institution, all patients suspected to have leptospirosis on the basis of history and symptoms were studied by two methods: culture isolation and serological diagnosis. Blood, urine, and cerebrospinal fluid were inoculated into Korthof media (Denka Seiken Co. Ltd., Tokyo, Japan), followed by subculturing 300 µL into 5 mL of Stuart media. Repeated weekly subculturing was continued at least 4 weeks until positive growth was visualized by dark-field microscopy. Otherwise, the results were regarded as negative. Serotyping of isolates was performed by cross-agglutination absorption.

As for serological diagnosis, microcapsule agglutination test and microagglutination tests were performed on paired acute and convalescent sera.

A positive laboratory diagnosis of leptospirosis required one of the following two criteria: 1) culture isolation or 2) serological diagnosis by greater than 4-fold elevation in paired sera, or a titer of greater than 1/80 in a single serum. Laboratory studies were performed by the microbiology section at the Okinawa Prefectural Institute of Health and Environment.

The following clinical information was collected; exposure history of contaminated water or soil, injury on extremities, resident or nonresident, occupation, clinical symptoms, and clinical data from all hospitalized 14 cases.

Descriptive weather data including the amount of rainfall during summer 1999 in the Yaeyama Islands were retrieved from the Ishigakijima Local Meteorological Observatory. The timing of the onset of symptoms of leptospirosis and heavy rainfall were compared.

RESULTS

Fourteen cases met criteria for a laboratory diagnosis of leptospirosis. 11 cases occurred in the Iriomote Island and 3 cases in the Ishigaki Island. Most patients were males (86%). The average age was 35 years. All patients reported exposure to contaminated water or soil, and 4 cases (29%) had an open wound on hands or feet. Nine patients (64%) were nonresidents of the Yaeyama Islands. Ten of 14 (71%) patients reported recreational exposures, including kayaking or canoeing.

In terms of clinical findings, fever (100%), chills (93%), and headache (86%) were the most common symptoms. Myalgia, arthralgia, and conjunctival suffusion were seen more than half

of cases. Jarisch-Herxheimer reactions (JHR) characterized by rigors followed by hypotension were seen in 6 cases (43%) after ampicillin administration. Urinary protein was seen in 50%.

Leptospire isolates were isolated in 9 cases (2 cases from the Ishigaki Island, 7 cases from the Iriomote Island). Serovar identity was determined either by serotyping of isolates or by serology and the majority of cases were due to serovars hebdomadis or grippityphosa (Table 1).

Detailed clinical information is provided in Table 2. The incubation period was defined as the period from the day of exposure to contaminated water or soil to the day of onset of symptoms. Incubation periods were determined in only 4 cases, ranging from 6 to 14 days (Table 2). The other cases were exposed to water or soil on a regular basis, making it difficult to estimate the incubation period. There were no cases of icteric leptospirosis (Weil disease). One case had a typical biphasic clinical course accompanied by aseptic meningitis. All cases recovered without long-term complications.

Cases were clustered from July to September in 1999, after unusually heavy rainfall (Figure 1). During summer 1999, peaks of rainfall alternated with dry weather. According to the the Ishigakijima Local Meteorological Observatory, only September 1999 showed a significant increase in precipitation of 150–200% greater than average. Most of this excess precipitation occurred over a relatively short period of a few days.

DISCUSSION

The epidemiology of human leptospirosis reflects the ecologic relationship between humans and chronically infected mammalian reservoir hosts.¹⁰ Three epidemiologic patterns of leptospirosis were originally defined by Faine.¹¹ The first pattern is a “farming type” that occurs in temperate regions, due to direct contact with animals through exposure to a limited number of serovars that infect cattle and pigs.¹² The second pattern is an “urban type” that comprises rodent-borne infection in the urban environment.^{13,14} The third pattern is a “tropical type” that occurs in humid, wet areas, from exposure to a larger number of serovars infecting a diversity of reservoir animals including rodents and farm animals. The outbreak in the Yaeyama Islands corresponds typically to this “tropical type.” Eleven out of our 14 cases were from the Iriomote Island.

Transmission frequently occurs via skin abrasion or exposed mucous membranes. Haake and others reported in their case report of leptospirosis that leech bites, skin abrasions, and maceration might have served as risk factors for infection.⁶ All cases in the outbreak presented here demonstrated water-soil exposure, and 4 cases (29%) were confirmed with some injury on extremities. Many of our cases were tour guides or water-sports instructors with frequent exposure to white water. Three cases reported swimming in a river and were presumed to be exposed through immersion in contaminated water. In our study, skin maceration, conjunctivae, and skin injury were possible portals of entry. In mice, immunity to leptospirosis is exclusively humoral.¹⁵ Immunity is strongly restricted to the homologous serovar or closely related serovars.^{16–18}

Nine cases (64%) of leptospirosis occurred in nonresidents of the Yaeyama Islands. This finding may suggest that nonresidents are more susceptible to leptospirosis in the Yaeyama Islands, due to a lack of immunity. A report from the Okinawa Prefectural Institute of Health and Environment showed that 29% of the population in Iriomote Island had positive antibodies for serovars hebdomadis and 13% for serovars grippityphosa.¹⁹ Leptospirosis can be prevented by serovar-specific vaccination or prophylactic antibiotic therapy. Of note, from 1977, serovar-specific vaccination as protection against serovars pyrogenes, autumnalis, and hebdomadis had succeeded in the Izena Island, Okinawa, Japan.²⁰ As Bharti and others mentioned, several problems confront the development of vaccines to prevent human

leptospirosis.¹ Further study of the role of immunization for prevention of leptospirosis in water-sports instructors in endemic areas is warranted.

Human infections of leptospirosis may be acquired through two types of exposures: occupational and recreational.² In the previous report from this area, the main occupational exposures were secondary to agriculture or construction.²¹ By contrast, the current report from the Yaeyama Islands found that recreational exposure predominated. Recent case reports and review articles describe recreational exposure including ecotourism as epidemiologic risk factors.^{2,5–10,22,23} Young male patients were predominantly affected in this outbreak, a predilection that seems to be related to recreational exposure. The leading demographic characteristics of this outbreak were tour guides or instructors of water-sports, such as kayaking or canoeing. They were exposed to contaminated turbulent river water daily while paddling. Their activity as the cause of infection related to river water in the Yaeyama Islands represents an overlap between occupation and recreation.

The clinical spectrum of leptospirosis is broad, ranging from asymptomatic illness to the classic syndrome of Weil disease. The great majority of infections caused by leptospirosis are subclinical, thus, patients probably will not seek medical attention.² In Japan, including the Yaeyama Islands, leptospirosis only became a reportable disease in 2003 through a revision of the infectious diseases reporting regulations. We have only described hospitalized cases; it is likely that larger numbers of people were affected who did not require hospitalization.

The biodiversity of leptospirosis in the environment is affected by geography, climate, biotic interactions, and anthropogenic activities.¹ Leptospiral diversity is limited in islands such as Barbados, where only four pathogenic serovars infectious to people have been identified.^{24, 25} On the other side, in tropical regions with a rich diversity of animal reservoir species such as in the Amazon basin or rural areas in Southeast Asia, leptospires are also highly diverse. A report described 11 serovars in Okinawa Prefecture includes the Yaeyama Island.²⁶ The result showed 9 cases of serovars kremastos, 5 cases of canicola, 3 cases each of hebdomadis, pyrogenes, rachmati, 2 cases each of autumnalis and javanica, one case each of australis, castellanis, icterohemorrhagiae, and pomona. The result on Table 1 shows four serovars. It is interesting to observe that serovars grippityphosa was found on two separate islands, Ishigaki and Iriomote. Multiple serovars are also found in the mainland of Japan because the climate and reservoir animals are diverse.

For prevention, travelers and tour instructors should know how to minimize exposure to contaminated soil and water. Protective clothing is recommended to prevent skin injury.⁶ Walking with bare feet should be avoided. Swimming in fresh water should be abandoned in endemic areas.

Chemoprophylaxis with doxycycline is likely to be useful for adventure travelers who visit endemic areas.^{1,27} In a study of U.S. army soldiers in Panama, doxycycline, 200 mg weekly, was found to reduce the attack rate of symptomatic leptospirosis.²⁷ A study suggested that the use of postexposure chemoprophylaxis may be useful for rural residents of an area of high endemicity with flood-associated outbreaks of leptospirosis.²⁸ In the Yaeyama area, chemoprophylaxis should be considered, especially for high-risk subjects to prevent serious complications. Administrative interventions including public information and education also play an important role.

Human exposure to leptospires is not limited by occupation but results more often from widespread environmental contamination, particularly during rainy seasons. Large outbreaks of leptospirosis are most likely to occur following floods, hurricanes or other disasters. Outbreaks of leptospirosis associated with water sports have demonstrated the ability of pathogenic leptospira species to survive in water for extended periods.⁹ Survival of pathogenic

leptospire in the environment is dependent of several factors, including pH, temperature, and the presence of inhibitory compounds. In soil saturated with rainwater, leptospire have been found to survive for at least 3 weeks.²⁹ Outbreaks of leptospirosis followed extensive flooding.^{30–32} Cases of leptospirosis in Puerto Rico increased in 1966 after a hurricane,³³ and a report of urban epidemic in Brazil described peaks of leptospirosis after excessive rainfall.³ Other authors found an association between leptospirosis and seasonal rainfall.^{3,33–36} As Figure 1 shows, most of the cases of leptospirosis in this outbreak occurred after heavy rainfall. The role of rainfall in outbreak of leptospirosis is thought to occur as follows: Leptospire are shed by reservoir hosts and accumulate in moist soil during drier periods. The spirochete requires a warm, moist climate of 25°C and water and soil pH level of 7.0–8.0 for optimal survival outside the host.³⁷ When precipitation from a heavy rainstorm exceeds the capacity of the soil to absorb the moisture, leptospire are gathered from contaminated soil into rivers. The meteorological conditions during the outbreak described in this report meets with these environmental conditions. The caveat is that this relationship between rainfall and outbreaks of leptospirosis might represent the exception rather than the rule. Further investigation is warranted for public health of residents and visitors to the Yaeyama Islands.

CONCLUSION

Increasing cases of leptospirosis due to recreational sports affects public health in a resort area. Our study suggested the relationship of large volume of rain precipitation and the outbreak of leptospirosis. Understanding the relationship between the epidemiology and rainfall in a subtropical area is crucial to prevention of leptospirosis outbreaks. Further observational study is warranted to confirm these conclusions.

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Figure 1.

Relationship between rainfall and leptospirosis. Cases of leptospirosis were clustered from July to September 1999, several days (latent period) after unusually heavy rainfall. According to the Ishigakijima Local Meteorological Observatory, most of this excess precipitation occurred over a relatively short period of a few days.

Table 1

Identified serovars of leptospirosis

Serovar(s)	Ishigaki		Iriomote		Total
	Serologically diagnosed	Isolated microbiologically	Serologically diagnosed	Isolated microbiologically	
Hebdomadis	0	0	3	4	7
Grippityphosa	0	2	1	2	5
Krenastos	1	0	0	0	1
Pyrogenes	0	0	0	1	1
Total	1	2	4	7	14

Table 2

Detailed clinical information of 14 cases of leptospirosis

Case	Occupation	Summary of leptospirosis (all cases)				JHR	IP (days)
		Water/soil exposure	Native vs.nonresident	Serovar(s)	Clinical course		
61 yr M	Agriculture	Rice farming	Nonresident	Pyrogenes	Thrombocytopenia, renal failure	+	NA
22 yr M	Agriculture	Rice farming	Nonresident	Hebdomadis	Improved without antibiotics	-	NA
26 yr M	Tour guide	River	Nonresident	Hebdomadis	Thrombocytopenia	+	NA
49 yr M	Tour guide	River	Nonresident	Hebdomadis	Conjunctival hemorrhage, calf muscle pain	+	NA
13 yr M	Junion high student	Swimming	Native	Grippityphosa	Vomiting, diarrhea, concerned HUS	-	6
28 yr M	Tour guide	River	Nonresident	Grippityphosa	Headache without meningismus	+	NA
54 yr M	Tour guide	River	Native	Hebdomadis	Arthralgia, myalgia	-	NA
22 yr M	Agriculture	Swimming	Nonresident	Hebdomadis	General joint pain	-	NA
22 yr M	Tour guide	River	Nonresident	Hebdomadis	Doxycycline, switched to ampicillin	-	NA
48 yr M	Tour guide	River	Nonresident	Hebdomadis	Headache and lower back pain	-	NA
31 yr M	Doctor	Canoeing	Nonresident	Grippityphosa	Biphasic clinical course with aseptic meningitis	-	10
30 yr M	Laborer	River	Native	Kremastos	Severe JHR	+	NA
25 yr F	Office worker	Swimming	Native	Grippityphosa	Well clinical course	-	14
60 yr F	Agriculture	Rice farming	Native	Grippityphosa	General fatigue, joint pain	+	7

HUS, hemolytic uremic syndrome; JHR, Jarisch-Herxheimer reaction; IP, incubational period; NA, not assessed.