

Outbreak of leptospirosis among triathlon participants in Langau, Austria, 2010

Christoph Radl¹, Maria Müller¹, Sandra Revilla-Fernandez¹, Stefanie Karner-Zuser², Alfred de Martin², Ulrike Schauer², Franz Karner², Gerold Stanek³, Peter Balcke⁴, Andreas Hallas⁵, Herbert Frank⁵, Albert Fürnschließ⁶, Friedrich Erhart⁶, Franz Allerberger^{1,7}

¹Austrian Agency for Health and Food Safety, Vienna, Austria

²Departments for Public Health, Environmental Health and Veterinary Health, Lower Austrian Regional Government, St. Pölten, Austria

³Department of Hygiene and Applied Immunology, Medical University Vienna, Vienna, Austria

⁴Department of Internal Medicine, General Hospital St. Pölten, St. Pölten, Austria

⁵Department of Internal Medicine, General Hospital Tulln, Tulln, Austria

⁶Department of Internal Medicine, General Hospital Amstetten, Amstetten, Austria

⁷Paracelsus Medical University, Institute for Medical Microbiology, Hygiene and Infectious Diseases, Salzburg, Austria

Received May 31, 2011, accepted after revision October 24, 2011, published online November 24, 2011

Leptospirose-Ausbruch nach einem Triathlon am Bergwerksee Langau, Österreich 2010

Zusammenfassung. Wir berichten über den ersten dokumentierten Leptospirose-Ausbruch in Österreich. Im Juli 2010, erkrankten vier Athleten nach Teilnahme am Bergwerksee Langau-Triathlon an serologisch verifizierter Leptospirose. Schwere Regenfälle hatten am Vortag des Sportereignisses Niederschläge von 22 mm erbracht. Der Indexpatient (Patient A) war ein 41-Jähriger, der am 8. Juli wegen Fieber von bis zu 40°C (seit drei Tagen) am Krankenhaus A stationär aufgenommen wurde; seine Erkrankung hatte 14 Tage nach dem Triathlon begonnen. Bereits am Vortag war Patient B, ein 42-Jähriger am gleichen Krankenhaus wegen Nierenversagen aufgenommen worden. Über drei Wochen wurde er hämodialysiert. Beim Patienten B war die erste Serumprobe (vom Aufnahmetag) negativ für Antikörper gegen *Leptospira* gewesen; eine Zweitprobe vom 28. Juli war positiv. Am 11. Juli wurde ein 40-Jähriger am Krankenhaus B wegen Nephritis stationär aufgenommen. Am 14. Juli wurde noch ein vierter Triathlon-Teilnehmer (am Krankenhaus C) aufgenommen, der seit zehn Tagen an Fieber, Husten und Kopfschmerzen litt. Dieser Ausbruch belegt, dass man sich auch in Österreich in natürlichen Badegewässern mit Leptospiren infizieren kann. Besonders nach schweren Regenfällen kann eine Einschwemmung von tierischem Urin nicht ausgeschlossen

sen werden. Aufgrund des immunsuppressiven Effekts von Triathlon, kann man Krankheitsausbrüche unter diesen Leistungssportlern als sensitive Indikatoren für mögliche Infektionsrisiken der Gesamtbevölkerung ansehen.

Summary. We report on the first documented outbreak of leptospirosis in Austria. In July 2010, four cases of serologically confirmed leptospirosis occurred in athletes after a triathlon held in Langau. Heavy rains preceded the triathlon (rainfall: 22mm). The index case (Patient A) was a 41-year-old previously healthy male, who was admitted to hospital A on July 8 with a four-day history of fever up to 40°C that began 14 days after attending the triathlon event. On July 7, patient B, a 42-year-old male, was admitted to the same hospital, with signs and symptoms of kidney failure. Hemodialysis was performed every other day for 3 weeks. While the serum drawn on the day of admission was negative for antibodies against *Leptospira*, a specimen from July 28 tested positive with *Leptospira interrogans*. On July 11, patient C, a 40-year-old male, was admitted to hospital B for nephritis. On July 14, patient D, a 44-year-old male, was admitted to hospital C with a ten days history of intermittent fever, mild dry cough and headache. Our report underlines that in Austria recreational users of bodies of freshwater must be aware of an existing risk of contracting leptospirosis, particularly after heavy rains. The suppressive influence of a triathlon on the immune system is well documented and therefore an outbreak in this population group can be seen as a sensitive indicator concerning possible risk for the general population.

Correspondence: Franz Allerberger, Österreichische Agentur für Gesundheit und Ernährungssicherheit (AGES), Spargelfeldstraße 191, 1220 Wien, Austria, E-mail: franz.allerberger@ages.at

Key words: *Leptospira interrogans*, microagglutination, serology, kidney failure.

Introduction

Leptospirosis is one of the most common zoonoses worldwide and is caused by more than 250 serovars of the spirochete *Leptospira*. The spectrum of human disease ranges from subclinical infection to severe clinical disease with multi-organ failure (Weil's disease) and high fatality, and depends both on the host and the infecting serovar [1]. Most cases occur in middle-aged men; despite the possibility of severe complications, the disease is most often self-limited and nonfatal [2]. Leptospirosis may occur either sporadically or in the context of an outbreak and is commonly related to occupational or recreational activities that involve direct or indirect contact with the urine of animal species that are reservoirs of the disease [3]. Leptospire may enter the body through cut or abraded skin, mucous membranes and conjunctivae. The incubation period is a few days to 4 weeks [4]. Leptospirosis can be a biphasic disease with an acute septicemic phase and a secondary phase of severe disease characterized by jaundice, renal failure, hemorrhage or hemodynamic collapse [1, 5].

The leptospiric phase generally lasts 4 to 7 days and is characterized by fever, myalgia, headache and conjunctival suffusion. Muscle pain, often severe, is most notable in the calf and lumbar areas. Skin rashes may occur. There may be an asymptomatic period lasting 1 to 5 days followed by the "leptospiruric" or "immune phase" that may last 4 to 30 days or longer [6]. This second phase of this systemic illness with protean manifestations usually begins with a recurrence of fever.

Nowadays outbreaks of leptospirosis occur less commonly after classical occupational exposure, but are increasingly encountered in recreational settings that involve exposure to materials infected by animal urine, especially water. We report on the first outbreak of leptospirosis described for Austria, which was related to a competitive sports event.

Outbreak

In July 2010, four cases of leptospirosis occurred in athletes after a triathlon (6th International Triathlon am Bergwerksee Langau, June 19, 2010) held in Langau, a village in the province of Lower Austria, close to the Czech Republic (Table 1). The manmade lake covers approximately 18 hec-

tares (45,000 acres) and has a maximal depth of 16 meters.

The index case (Patient A) was a 31-year-old previously healthy male, who was admitted to hospital A on July 8 with a four-day history of fever up to 40°C that began 14 days after attending a triathlon event. The patient complained of headache, anorexia, vomiting, abdominal pain and myalgia. Physical examination showed conjunctivitis and mild splenomegaly. Laboratory analyses revealed rising serum creatinine levels up to 2.59 mg/dl, mild elevation of liver enzyme levels (maximum serum aspartate and alanine aminotransferase levels were 179 U/l and 115 U/l, respectively, normal less than 40 U/l). C-reactive protein (CRP) was up to 19.9 mg/dl (normal <0.5 mg/dl). Results of urinalysis, and chest X-ray were normal. A blood specimen, drawn on day 2 of hospitalization, was tested for leptospirosis by microscopic agglutination test (with 15 reference serovars of live leptospire at the National Reference Laboratory for Leptospirosis at AGES) and yielded antibodies against *Leptospira interrogans* serovar Bratislava at a titer of 1:100. The patient was treated with amoxicillin and clavulanate potassium for seven days (2.0/0.2 g q 12 h IV). He responded to therapy within two days and was discharged after 7 days hospitalization. Serum creatinine levels fell to the normal range within 12 days as did liver enzyme levels within 30 days.

On July 7, patient B, a 42-year-old male, was admitted to the same hospital, with signs and symptoms of kidney failure. He had had fever up to 40°C for one week, as well as myalgia and anorexia. In order to control highly disabling complaints he had taken a nonsteroidal anti-inflammatory drug (mefenamic acid) for some days. On examination, the patient appeared severely ill. He had fever above 40°C and costovertebral angle tenderness. Urine output was less than 200 ml/day. Serum creatinine was 5.95 mg/dl at admission, and increased to 8.41 mg/dl within the next 48 hours necessitating initiation of hemodialysis. Renal biopsy was performed, which showed interstitial nephritis by light microscopy. Routine hemodialysis was performed every other day for 3 weeks. Notably, liver enzyme levels were normal and the CRP levels were only slightly elevated (3.35 mg/dl at admission). While the serum drawn on the day of admission was negative for antibodies against *Leptospira*, a specimen from July 28 tested positive with *Leptospira interrogans* serovar Grippotyphosa at a microagglutination-titer of 1:200, and with *Leptospira interrogans* serovar Australis at 1:400 when tested at the National Reference Laboratory. Initial antibiotic therapy consisted of cefpirome (2 g/day IV; after each hemodialysis session) and ciprofloxacin (200 mg/day IV; after each hemodialysis session), with switch to doxycycline (100 mg twice daily IV × 7 d) on day 3. Renal function normalized completely.

On July 11, patient C, a 40-year-old male, was admitted to hospital B, after suffering symptoms for 4 days. The patient complained of headache, nausea, vomiting and myalgia. Physical examination showed conjunctivitis and mild pharyngitis. Laboratory values were normal, except an elevated CRP (maximum serum 17.94 mg/dl) and se-

Table 1. Characteristics of four male athletes with leptospirosis after a triathlon held on June 19, 2010 in Austria

Patient	A	B	C	D
Age (years)	41	42	40	44
Date of admission (to hospital)	July 8 Hospital A	July 7 Hospital A	July 11 Hospital B	July 14 Hospital C
Symptom duration before first evaluation in hospital (in days)	4	7	4	10
Kidney failure requiring dialysis (duration of dialysis)	No	3 weeks	No	No

rum creatinine (maximum serum 1.20 mg/dl). The erythrocyte sedimentation rate and chest X-ray were normal. The result of urinalysis showed proteinuria and hematuria. Ultrasound revealed that the left kidney was enlarged, indicating nephritis. Serological testing by enzyme linked immuno-sorbent assay (SERION ELISA classic *Leptospira* IgG/IgM; Institut Virion\Serion GmbH, Würzburg, Germany) yielded *Leptospira* IgG-antibodies 8 U/ml (<5 negative, >9 positive) and *Leptospira* IgM-antibodies 76 U/ml (<15 negative, >20 positive). Retesting this specimen at the National Reference Laboratory by microscopic agglutination test revealed antibodies against *Leptospira interrogans* serovar Hardjö at a titer of 1:100. The patient was treated with IV ciprofloxacin 400 mg twice a day and IV fosfomycin 8 g twice a day for six days, followed by doxycycline 200 mg per os once a day for 10 days. He responded to therapy within two days and was discharged after 7 days hospitalization.

On July 14 patient D, a 44-year-old male, was admitted to hospital C with a ten days history of intermittent fever (up to 40°C), mild dry cough and headache. Laboratory findings yielded slightly increased CRP (1.6 mg/dl) and an erythrocyte sedimentation rate (after 1h) of 47 mm (normal <17 mm), a slightly elevated ALT of 56 U/l (normal <50 U/l) and amylase of 78 U/l (normal <53 U/l). Diagnostic imaging and physical examination showed no abnormalities. Serum creatinine levels remained within normal limits (maximum 0.96 mg/dl). No signs of haematuria or proteinuria were observed. Serological testing for leptospirosis by enzyme linked immuno-sorbent assay (SERION ELISA classic *Leptospira* IgG/IgM) yielded specific IgG (12 U/ml) and IgM antibodies (87 U/ml). Retesting this specimen at the National Reference Laboratory by microscopic agglutination test revealed antibodies against *Leptospira interrogans* serovar Grippotyphosa at a microagglutination titer of 1:400, and for *Leptospira interrogans* serovar Australis at 1:200. Patient D was discharged after one day of hospitalization without specific antimicrobial therapy.

As all four patients had attended a triathlon event for adult athletes on June 19 in Langau, this event was considered the source of the outbreak. Participants had to swim 1500 meters (3 rounds of 500 m) through a man-made lake. According to the local authorities, "150 to 180 persons out of the 280 participants were swimming in the lake". The lake is bathing water registered under the European Bathing Water Directive (2006/7/EC). Routine samples gained on July 12 yielded no abnormalities: *Escherichia coli* 15/100 ml, enterococci: <15/100 ml; depth of visibility: 0.6 m (rainfall that day: 19 mm). In previous tests, visibility depth was around 1.8 m. A water sample gained on July 26 was negative for *Leptospira* spp. when tested by PCR. The day before the triathlon event, the area was subjected to torrential rain (rainfall: 22 mm). The intense rain on the eve of the triathlon had caused flooding and "unusual turbidity" of the lake which prompted the organizer to pave the running trail with wood chips.

No active case finding was performed. As soon as the health authorities had information about two probable

cases of leptospirosis all hospitals in the affected province were informed. As the severe illnesses occurred at the end of incubation time, the participants of the triathlon were not contacted personally; they were only informed by an article about the occurrence of leptospirosis placed on the event's homepage advising participants to consult a physician in case of acute febrile illness.

Discussion

Recreational exposure to water is considered a major risk factor for contracting leptospirosis in recent years, especially in relation to water sports such as swimming, running, canoeing, rafting, water-skiing and other endurance or extreme sports. Although it may occur sporadically, at least 17 outbreaks of leptospirosis associated with water exposure have been documented during the last 50 years [3, 7]. Outbreaks of leptospirosis were repeatedly connected with triathlon [5, 8–12]. Other significant outbreaks with relation to water occurred in India, Argentina, Cuba, Brazil, Nicaragua and in 2009 in the Philippines after floods and other natural disasters [3]. In Austria, growing numbers of imported cases are reported in addition to autochthonous infections as a consequence of rising global travel activities [13]. The predominance of men among case-patients is well recognized. This predominance has been explained by the tendency of more men to participate in high-risk outdoor exposure activities [14]. Also the findings of highest age-specific case rates among adults 20–50 years of age are also consistently reported [14].

Leptospire are divided into serovars defined by agglutination after cross-absorption with homologous antigen [15]. More than 200 serovars of *L. interrogans* sensu lato are recognized. Serovars that are antigenically related have traditionally been grouped into serogroups [16]. Serogroups have no taxonomic standing, but the concept has proven useful for epidemiological understanding, particularly when interpreting the serological results from the microscopic agglutination test [15]. However, our finding impressively confirms that the microscopic agglutination test cannot predict the infecting serovar or even the infecting serogroup.

While serovar Australis and Bratislava both belong to serogroup Australis, serovar Grippotyphosa (serogroup Grippotyphosa) and serovar Hardjö (serogroup Sejroe) share no serological relationship. Infection with *Leptospira interrogans* serovars Bratislava and Australis are an important cause of porcine reproductive failure in Europe [17–20]. Infection with *L. interrogans* serovar Hardjö may suggest contamination of lake water by cattle [3, 21]. In Germany, a Grippotyphosa outbreak among harvesters working in a strawberry field after heavy precipitation in September 2007 was linked to voles (*Microtus arvalis*) [22]. Interpretation of the microscopic agglutination test is complicated by the high degree of cross-reactions that occur between different serogroups, especially in acute-phase samples [15]. Therefore, conclusions about infecting serovars cannot be drawn without isolates; at best the microscopic agglutination test data can give a general impression of which serogroups are present within a population [15, 23].

Heavy rains that preceded the triathlon are likely to have caused leptospiral contamination of the lake. Urine from small mammals (e.g. rodents like mice and rats), wild boars or domestic pigs are possible sources of *Leptospira*. At just 300 m distance from the lake (3 m below lake level) local hunters kept a feeding place for boars (to bait them for future hunting); multiple wallows exist around the lake. In direct proximity to the lake a petting zoo houses pot-bellied pigs. No cattle are raised in close proximity to the lake.

This is the first outbreak of leptospirosis that has been reported in Austria. While most human infections are acquired through occupational or recreational exposures, there is also a significant risk associated with water sport activity and water sport competitions. Persons can get leptospirosis by swimming or wading in fresh unchlorinated water contaminated with animal urine leptospirosis [8]. People can get leptospirosis also by contact with damp soil or vegetation contaminated by the urine of infected animals. Participants of the triathlon event for adult athletes on June 19 in Langau had to run 10,000 meters (3 laps around the lake) on a muddy track. The organism can enter through mucous membranes in the eye, nose or mouth or through lesions in the skin such as cuts or scrapes. Heavy rains that preceded the triathlon are likely to have increased leptospiral contamination of the lake [8, 24]. Doxycycline 200 mg p.o. once per week is sometimes recommended as prophylaxis for persons with exposure to environments at high risk for leptospirosis (e.g. swimming through jungle waters, kayaking in developing countries); however, infection may not be prevented [4, 25, 26]. Although doxycycline prophylaxis does not prevent leptospiral infection in an endemic area, it has a significant protective effect in reducing the morbidity and mortality during outbreaks [27]. Although no active case finding was performed in this Austrian outbreak, it would have been informative to know if any other participants experienced fever or illness, or if anyone was on doxycycline for prophylaxis via survey.

Our report underlines that recreational users of bodies of freshwater must be aware of an existing risk of contracting leptospirosis, particularly after heavy rains, even in Austria. The suppressive influence of a triathlon on the immune system is well documented and therefore an outbreak in this population group can be seen as a sensitive indicator concerning possible risk for the general population [28]. Avoiding swimming in lakes when water turbidity is increased ("Avoid bathing if you don't see your feet when standing in water up to your knees") is often recommended as a general rule. Compliance with this precautionary advice on the day of the triathlon could have prevented this outbreak.

Conflict of interest

The authors state that they have no conflict of interest.

References

- Bharti AR, Nally JE, Ricaldi JN, Matthias MA, Diaz MM, Lovett MA, et al. Leptospirosis: A zoonotic disease of global importance. *Lancet Infect Dis* 2003;3:757–71.
- Croda J, Neto AND, Brasil RA, Pagliari C, Nicodemo AC, Duarte MIS. Leptospirosis pulmonary haemorrhage syndrome is associated with linear deposition of immunoglobulin and complement on the alveolar surface. *Clin Microbiol Infect* 2010;16:593–9.
- Hadad E, Pirogovsky A, Bartal C, Gilad J, Barnea A, Yitzhaki S, et al. An outbreak of leptospirosis among Israeli troops near the Jordan river. *Am J Trop Med Hyg* 2006;74:127–31.
- Glynn K, Hartskeel R, Ko A, Meslin F. Leptospirosis. In: *Control of Communicable Diseases Manual*. 19th ed., Heymann DL ed., American Public Health Association, Washington DC 2008, pp. 351–64.
- Centers for Disease Control and Prevention. Outbreak of acute febrile illness among athletes participating in triathlons – Wisconsin and Illinois, 1998. *MMWR Morb Mortal Wkly Rep* 1998;47:585–8.
- Merwick A, Kelly S, Galvin R. Meningitis due to *Leptospira hardjo* – identifying a treatable cause of aseptic lymphocytic meningitis. *Irish Medical Journal* 2008;101:91–2.
- O'Meara M, Fitzgerald M. A cluster of leptospirosis cases in canoeists on a Dublin river. *Euro Surveill*. 2004;8:pii=2592.
- Morgan J, Bornstein SL, Karpati AM, Bolin CA, Austin CC, Woods CW, et al. Outbreak of leptospirosis among triathlon participants and community residents in Springfield, Illinois, 1998. *Clin Infect Dis* 2002;34:1593–9.
- Brockmann S, Piechotowski I, Bock-Hensley O, Winter C, Oehme R, Zimmermann S, et al. Outbreak of leptospirosis among triathlon participants in Germany, 2006. *BMC Infect Dis* 2010;10:91.
- Sejvar J, Bancroft E, Winthrop K, Bettinger J, Bajani M, Bragg S, et al. Leptospirosis in "Eco-Challenge" athletes, Malaysian Borneo, 2000. *Emerg Infect Dis* 2003;9:702–7.
- Centers for Disease Control and Prevention. Update: Outbreak of acute febrile illness among athletes participating in Eco-Challenge-Sabah 2000-Borneo, Malaysia, 2000. *MMWR Morb Mortal Wkly Rep* 2001;50:21–4.
- Tunbridge AJ, Dockrell DH, Channer KS, McKendrick MW. A breathless triathlete. *Lancet* 2002;359:130.
- Hoffmeister B, Peyerl-Hoffmann G, Pischke S, Zollner-Schwetz I, Krause R, Müller MC, et al. Differences in clinical manifestations of imported versus autochthonous leptospirosis in Austria and Germany. *Am J Trop Med Hyg* 2010;83:326–35.
- Katz AR, Buchholz AE, Hinson K, Park SY, Effler PV. Leptospirosis in Hawaii, USA, 1999–2008. *Emerg Infect Dis* 2011;17:221–6.
- Levett PN. *Leptospira*. In: *Manual of Clinical Microbiology*. 9th ed., Murray PR, Baron EJ, Jorgensen JH, Landry ML, Pfaller MA (eds.) ASM Press, Washington, D.C., 2007, pp. 963–70.
- Kmety E, Dikken H. Classification of the Species *Leptospira* Interrogans and History of its Serovars. University Press Groningen, Groningen, The Netherlands, 1993.
- Ellis WA, McParland PJ, Bryson DG, McNulty MS. Leptospire in pig urogenital tracts and fetuses. *Vet Rec* 1985;117:66–7.
- Ellis WA, McParland PJ, Bryson DG, Cassells JA. Prevalence of *Leptospira* infection in aborted pigs in Northern Ireland. *Vet Rec* 1986;118:63–5.
- Ellis WA, McParland PJ, Bryson DG, Thiermann AB, Montgomery J. Isolation of leptospire from the genital tract and kidneys of aborted sows. *Vet Rec* 1986;118:294–5.
- Ellis WA, McParland PJ, Bryson DG, Cassells JA. Boars as carriers of leptospire of the Australis serogroup on farms with an abortion problem. *Vet Rec* 1986;118:563.
- Ellis WA, O'Brien JJ, Cassells J. Role of cattle in the maintenance of *Leptospira interrogans* serotype hardjo infection in Northern Ireland. *Vet Rec* 1981;108:555–7.
- Jansen A, van Treeck U, Bradt K, Hoff-Gehlen M, Heuser G, Schlender T, et al. Die Rückkehr des Feldfiebers in Deutschland: *Leptospira-Grippotyphosa*-Ausbruch unter Erdbeerpflückern. *Epidemiologisches Bulletin* 2008;11:85–8.

23. Levett PN. Usefulness of serologic analysis as a predictor of the infecting serovar in patients with severe leptospirosis. *Clin Infect Dis* 2003;36:447–52.
24. Brockmann S, Piechotowski I, Bock-Hensley O, Winter C, Oehme R, Zimmermann S, et al. Outbreak of leptospirosis among triathlon participants in Germany, 2006. *BMC Infect Dis* 2010;10:91.
25. Vinetz J, Auwaerter PG. *Leptospira interrogans*. In: The Johns Hopkins ABX Guide. 2nd ed., Bartlett JG, Auwaerter PG, Pham PA, eds., Jones and Bartlett Publishers, Sudbury, MA, USA, pp. 279–80.
26. Gilks CF, Lambert HP, Broughton ES, Baker CC. Failure of penicillin prophylaxis in laboratory acquired leptospirosis. *Postgrad Med J* 1988;64:236–8.
27. Sehgal SC, Sugunan AP, Murhekar MV, Sharma S, Vijayachari P. Randomized controlled trial of doxycycline prophylaxis against leptospirosis in an endemic area. *J Antimicrob Agents* 2000;13:249–55.
28. Rohde T, MacLean DA, Hartkopp A, Pedersen BK. The immune system and serum glutamine during a triathlon. *Eur J Appl Physiol Occup Physiol* 1996;74:428–34.