

Aeromonas infection from river and playa lake waters in West Texas and southeastern New Mexico

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ABSTRACT

Trauma occurring in direct contact with freshwater bodies may result in wounds contaminated with a variety of microorganisms. Bacteria belonging to the genus *Aeromonas* have been recovered from these types of infections. We report two cases of *Aeromonas hydrophila* infections occurring from freshwater-contaminated wounds. One of these infections was acquired from a river in southeastern New Mexico; the other was from an urban playa lake in West Texas. The latter case prompted an ecological study of the seasonal occurrence of *Aeromonas spp.* and the incidence of resistance to antimicrobial agents in two of these local lakes. Recent scientific and medical literature data show that *Aeromonas* should be considered as a possible agent of infection in immunocompetent hosts from water exposure, even if the water is a running river or a seemingly unpolluted (“clean”) freshwater lake.

Key words: *Aeromonas*, water borne infection, playa lakes

INTRODUCTION

Members of the bacterial genus *Aeromonas* are known to infect wounds that occur in contact with either polluted or unpolluted (“clean”) freshwater.^{1–3} We report a scalp-wound infection and a unique bloodstream infection occurring in two patients exposed to freshwater sources in West Texas and southeastern New Mexico, respectively. *Aeromonas* infection in the former patient led to a year-long study of the seasonal occurrence and incidence of resistance to antimicrobial agents among *Aeromonas* isolates from two urban playa lakes within the city limits of Lubbock, TX.⁴

In addition, we surveyed the recent (1998–2011) scientific and medical literature for reports of *Aeromonas* infections and summarize pertinent information.

CASE REPORTS

Case 1. A 32-year-old white woman sustained a blast injury and 60% body burn in a natural gas pipeline explosion while camping beside the Pecos River near Carlsbad, NM (Figure 1). She dove into the river to quench the fire. She was admitted to the burn ICU in critical condition. She was febrile at the time of admission and became septic. On the second day of hospitalization, her blood cultures grew *Aeromonas hydrophila*. Her wounds did not grow this organism, nor did bronchial washings. The large-line intravenous

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(IV) device, which was placed at the scene while she was still wet from the river, also grew *A. hydrophila*. She was treated with appropriate antibiotics, but died after 30 days due to burn trauma and inhalation injury.

Case 2. A 26-year-old Hispanic man lacerated his scalp while swimming in a local playa lake in Lubbock, TX (Figure 1). The wound was initially closed and subgaleal infections ensued. He developed massive facial and neck edema and required intubation. He required incision and drainage twice. *A. hydrophila* was recovered in pure culture. The patient was treated with appropriate antibiotics and discharged after 10 days of antibiotic therapy. He was followed for a one-year period with his face and scalp returning to normal.

MATERIALS AND METHODS

All clinical specimens were collected by cotton-tipped swabs, suction catheters, or standard blood culture techniques. They were processed for species identification and antimicrobial sensitivities in the hospital clinical microbiology laboratory at Texas Tech University Health Sciences Center by using a replicator device of standard manufacture with reagents and equipment from the same company (Dade MicroScan™, Dade Behring, Inc., 1584 Enterprise Blvd., West Sacramento, CA 95691). The playa-lake study procedures have been described previously.⁴

PERTINENT LITERATURE REVIEW

Genus definition. The genus *Aeromonas* consists of Gram-negative, rod-shaped bacteria that are generally motile by means of single polar flagella. They are facultative anaerobes.^{5,6}

Organism distribution. *Aeromonads* are ubiquitous in aquatic environments and have been isolated from fresh and brackish water^{7,8}, urban wastewater⁹, aquatic sediments⁴, and soils that have been recently irrigated or flooded.¹⁰ They have also been found in drinking water supplies, perhaps because they can form biofilms that are resistant to chlorination.¹¹ *Aeromonads* have been detected in bottled natural mineral waters¹² and in various foodstuffs, including raw fish and shellfish, poultry, meat products, milk, and fresh vegetables.^{13,14} *Aeromonas* is also found in association with a growing list of invertebrate and vertebrate animals, including molluscs (snails and mussels)^{15,16}, annelids (leeches)¹⁷⁻¹⁹, crustaceans (shrimp)²⁰, insects (mosquitoes)²¹, fishes²², amphibians (frogs)²³, reptiles (snakes and crocodiles)^{24,25}, birds²⁶, and mammals²⁷. In some cases, the *aeromonads* form part of the host animal's normal microbial flora; in others, they act as invading parasites that can cause potentially lethal infections.

Disease associations. *Aeromonas* species cause diseases in several poikilothermic animals, including fish, frogs, and other amphibians (primarily



Figure 1. Geographical locations of the sites where the *Aeromonas* infections in these cases occurred

A. hydrophila).^{28,29} Several *Aeromonas* species also act as pathogens in humans.^{30,31} *Aeromonas hydrophila* is the most frequently isolated species in cases of human infection. *A. caviae* and *A. veronii* biovar *sobria* are also commonly isolated.³² Other less frequently isolated human pathogens are *A. veronii* biovar *veronii*, *A. jandaei*, and *A. schubertii*.³³ A single case of infection by *A. popoffii* has been reported.³⁴

Traditionally *Aeromonas* has been described as an opportunistic pathogen, but more recent reports in the medical literature of *Aeromonas* infections in healthy, immunocompetent adults suggest that, in some cases, *Aeromonas* may be regarded as a primary pathogen as well. Gastroenteritis is the most commonly reported clinical illness associated with *Aeromonas* infection, which typically manifests as acute, watery diarrhea.³⁵ Although this condition is usually self-limiting in otherwise healthy individuals, the symptoms can be more severe in children, the elderly, and immunocompromised patients.³⁶⁻⁴¹ Severe cholera-like or dysenteric diarrheal diseases occur more rarely.³² The association between *Aeromonas* and diarrheal symptoms has recently been questioned.⁴² *Aeromonas* has also been recovered from fecal samples taken from healthy, asymptomatic individuals. The bowel carriage rate is generally considered to be about 3–5% in temperate regions⁴³ but higher in tropical areas. One study found a carriage rate as high as 27% in a Thai population of 51 healthy adults.⁴⁴ Thus, the human gastrointestinal tract may serve as a reservoir for potentially pathogenic *Aeromonas* strains. Iatrogenic *Aeromonas* infections have been associated with medicinal leech therapy due to a specific host-microbe symbiosis with *A. veronii*.¹⁸

Routes of infection. The principal routes by which *Aeromonas* enters the human body are the gastrointestinal tract (by ingestion of contaminated food or water) and wounds to the skin surface (cuts, scratches, punctures, and burns) from water exposure. The latter infections are usually self-limiting, but on occasion, entry of *Aeromonas* into the bloodstream can result in life-threatening septicemia. Other apparent routes of infection include the respiratory tract (inhalation leading to pneumonia or

other types of pulmonary infections), urinary tract, and ocular infections.³³ *Aeromonas* infections have also resulted from the treatment of surgical incisions with medicinal leeches, which appear to form a stable host-symbiont association with *A. veronii* in the leech digestive tract.⁴⁵⁻⁴⁷

Disease consequences. Wound (skin and soft-tissue) infections are the second most common type of infections caused by *Aeromonas* species. These infections are generally self-limiting in immunocompetent individuals but can become life-threatening if septicemia develops, especially in immunocompromised individuals. Among 305 survivors of the December 2004 tsunami in southern Thailand who were treated for skin and soft-tissue infections, 145 of 641 (22.6%) bacterial isolates from the pus and/or wound cultures were identified as *Aeromonas*, including 104 *A. hydrophila* and 41 *A. veronii* biovar *sobria*.⁴⁸

Antibiotic resistance. Many clinical isolates of *Aeromonas* have a high-level resistance to β -lactam antibiotics and first-generation cephalosporins in vitro. Unbiased surveys of both clinical and environmental strains typically show that the prevalence of ampicillin resistance is 70–90%.⁴⁹⁻⁵¹ Several different *Aeromonas* clinical isolates have been analyzed in detail and found to produce two or three chromosomally encoded β -lactamases with overlapping substrate specificities.^{52,53} Occasionally, strains have also been isolated that carry plasmid-borne β -lactamase genes.^{52,54} Resistances to other antimicrobial drugs and antibiotics have been reported. For example, a recent study in India of 21 *A. hydrophila* isolates from children with acute diarrhea found a high prevalence of resistance to several antibiotics, including bacitracin (95.2%), novobiocin (95.2%), vancomycin (90.5%), cefazoline (85.7%), methicillin (85.7%), kanamycin (81%), rifampicin (76.2%), erythromycin (71.4%), tetracycline (71.4%), and nalidixic acid (62%).⁵⁵ Resistances found among 138 environmental aeromonads isolated from two European rivers included nalidixic acid (59%), tetracycline (14%), fosfomicin (8%), tobramycin and cotrimoxazole (7%), cefotaxime (4%), chloramphenicol (2%), and gentamicin (1%).⁵⁶ In another study, 217 clinical

and non-clinical *Aeromonas* isolates were resistant to various antimicrobials, including clindamycin (100%), vancomycin (100%), erythromycin (69.27%), cefazoline (57.34%), sulfamethoxazole (35.78%), rifampicin (21.56%), and tetracycline (9.63%).⁵⁷ These results support the idea that a correlation exists between the prevalence of antibiotic resistance among aeromonads and the source of their isolation. Resistance to tetracyclines has been associated with plasmid-encoded genes^{51,58,59}, and sulfonamide/trimethoprim drug resistance has been associated with integrons⁶⁰, confirming that *Aeromonas* is quite capable of acquiring antimicrobial resistance determinants from other groups of bacteria by lateral gene transfer. Quinolones and second- and third-generation cephalosporins are generally considered to be the most effective antimicrobial agents against aeromonads in current clinical settings.

RESULTS AND DISCUSSION

The *A. hydrophila* recovered from the blood stream of Case 1 was resistant to ampicillin, ampicillin/sulbactam, cefazolin, cefoxitin, and imipenem. This organism originated from the Pecos River, a different water source than for Case 2 and the playa lake study.⁴ The *A. hydrophila* from the wound infection of Case 2 was resistant only to ampicillin. An *A. hydrophila* with similar biotyping and antibiotic sensitivities was recovered from the lake where the accident occurred.

Case 1 is representative of the many types of *Aeromonas* infections from freshwater exposure that have been reported previously.⁶¹⁻⁶⁴ However, this patient was not immunosuppressed or ill prior to the acute burn injury.⁶⁵ The early onset of the bacteremia and the lack of *Aeromonas* recovered from specimens other than the blood and the IV line tip led us to surmise that river water contaminated the IV line at the time of emergency placement. In contrast to the organism recovered from Case 1, the *Aeromonas* isolate from Case 2 was susceptible to multiple antimicrobial agents consistent with results obtained with the *Aeromonas* isolates from the two urban playa lakes.⁴

In summary, we report a case with bacteremia

from an IV line placed under emergent circumstances in skin contaminated with river water and a case with a scalp wound from a laceration sustained in a local playa lake. Both infections occurred in immunocompetent individuals who acquired the *A. hydrophila* infections subsequent to trauma accompanied by direct exposure to freshwater environments. The infection contributed to a fatal outcome in the former patient, whereas the latter patient recovered completely. Infections due to *Aeromonas* species from freshwater sources have been previously reported.⁶⁶ Most serious infections affect immunocompromised hosts. *Aeromonas* should be considered as a possible agent of infection from water exposure even if the water is a running river or a small, seemingly "clean" freshwater playa lake and should be considered in wounds with exposure to these waters in immunocompetent hosts.

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REFERENCES

1. Hanson PG, Standridge J, Jarrett F, Maki DG. Freshwater wound infection due to *Aeromonas hydrophila*. *J Am Med Assoc* 1977; 238:1053-4.
2. Joseph SW, Daily OP, Hunt WS, Seidler RJ, Allen DA, Colwell RR. *Aeromonas* primary wound infection of a diver in polluted waters. *J Clin Microbiol* 1979; 10:46-9.
3. Pitlik S, Berger SA, Hummer D. Nonenteric infections acquired through contact with water. *Rev Infect Dis* 1987; 9:54-63.
4. Warren WJ, Jeter RM, Kimbrough RC, Zak JC. Population

patterns and antimicrobial resistance of *Aeromonas* in urban playa lakes. *Can J Microbiol* 2004; 50:397-404.

5. Holt JG, Krieg NR, Sneath PHA, Staley JT, Williams ST. *Bergey's Manual of Determinative Bacteriology*, Ninth Edition. Philadelphia: Lippincott Williams & Wilkins, 2000.

6. Martin-Carnahan A, Joseph SW. Family I. *Aeromonadaceae* Colwell, MacDonell and De Ley 1986, 474VP. In: Brenner DJ, Krieg NR, Staley JT, eds. *Bergey's Manual of Systematic Bacteriology*, Second Edition, Volume 2 The Proteobacteria, Part B The Gammaproteobacteria. New York: Springer, 2005.

7. Presley SM, Rainwater TR, Austin GP, Platt SG, Zak JC, Cobb GP, Marsland EJ, Tian K, Zhang B, Anderson TA, Cox SB, Abel MT, Leftwich BD, Huddleston JR, Jeter RM, Kendall RJ. Assessment of pathogens and toxicants in New Orleans, LA following Hurricane Katrina. *Environ Sci Technol* 2006; 40:468-74.

8. Sharma A, Dubey N, Sharan B. Characterization of aeromonads isolated from the river Narmada, India. *Int J Hyg Environ Health* 2005; 208:425-33.

9. Villarruel-López A, Fernández-Rendón E, Mota-de-la-Garza L, Ortigoza-Ferado J. Presence of *Aeromonas* spp. in water from drinking-water- and wastewater-treatment plants in México City. *Water Environ Res* 2005; 77:3074-9.

10. Vally H, Whittle A, Cameron S, Dowse GK, Watson T. Outbreak of *Aeromonas hydrophila* wound infections associated with mud football. *Clin Infect Dis* 2004; 38:1084-9.

11. Sen K, Rodgers M. Distribution of six virulence factors in *Aeromonas* species isolated from US drinking water utilities: a PCR identification. *J Appl Microbiol* 2004; 97:1077-86.

12. Villari P, Crispino M, Montuori P, Boccia S. Molecular typing of *Aeromonas* isolates in natural mineral waters. *Appl Environ Microbiol* 2003; 69:697-701.

13. Daskalov H. The importance of *Aeromonas hydrophila* in food safety. *Food Control* 2006; 17:474-83.

14. Isonhood JH, Drake M. *Aeromonas* species in foods. *J Food Prot* 2002; 65:575-82.

15. Kiebre-Toe MB, Lacheretz A, Villard L, Richard Y, Kodjo A. Pulsed-field gel electrophoresis profiles of aeromonads isolated from healthy and diseased *Helix aspersa* from French snail farms. *Can J Microbiol* 2005; 51:817-20.

16. Ottaviani D, Santarelli S, Bacchiocchi S, Masini L, Ghittino C, Bacchiocchi I. Occurrence and characterization of *Aeromonas* spp. in mussels from the Adriatic Sea. *Food Microbiol* 2006; 23:418-22.

17. Braschler TR, Merino S, Tomás JM, Graf J. Complement resistance is essential for colonization of the digestive tract of *Hirudo medicinalis* by *Aeromonas* strains. *Appl Environ Microbiol* 2003; 69:4268-71.

18. Graf J, Kikuchi Y, Rio RVM. Leeches and their microbiota: naturally simple symbiosis models. *Trends Microbiol*

2006; 14:365-71.

19. Worthen PL, Gode CJ, Graf J. Culture-independent characterization of the digestive-tract microbiota of the medicinal leech reveals a tripartite symbiosis. *Appl Environ Microbiol* 2006; 72:4775-81.

20. Vaseeharan B, Ramasamy P, Murugan T, Chen JC. In vitro susceptibility of antibiotics against *Vibrio* spp. and *Aeromonas* spp. isolated from *Penaeus monodon* hatcheries and ponds. *Int J Antimicrob Agents* 2005; 26:285-91.

21. Pidiyar V, Kaznowski A, Narayan NB, Patole M, Shouche YS. *Aeromonas culicicola* sp. nov., from the midgut of *Culex quinquefasciatus*. *Int J Syst Evol Microbiol* 2002; 52:1723-8.

22. Radu S, Ahmad N, Ling FH, Reezal A. Prevalence and resistance to antibiotics for *Aeromonas* species from retail fish in Malaysia. *Int J Food Microbiol* 2003; 81:261-6.

23. Huys G, Pearson M, Kämpfer P, Denys R, Cnockaert M, Inglis V, Swings J. *Aeromonas hydrophila* subsp. *ranae* subsp. nov., isolated from septicemic farmed frogs in Thailand. *Int J Syst Evol Microbiol* 2003; 53:885-91.

24. Jorge MT, Nishioka SA, Oliveira RB, Ribeiro LA, Silveira PVP. *Aeromonas hydrophila* soft-tissue infection as a complication of snake bite: report of three cases. *Ann Trop Med Parasitol* 1998; 92:213-7.

25. Turutoglu H, Ercelik S, Corlu M. *Aeromonas hydrophila*-associated skin lesions and septicemia in a Nile crocodile (*Crocodylus niloticus*). *J S Afr Vet Assoc* 2005; 76:40-2.

26. Zbikowski A, Szeleszczuk P, Karpinska E, Rzewuska M, Malicka E, Binek M. Epidemic deaths of mallard ducks after *Aeromonas hydrophila* infection. *Medycyna Wet* 2006; 62:720-2. [Article in Polish].

27. Ghenghesh KS, Abeid SS, Jaber MM, Ben-Taher SA. Isolation and haemolytic activity of *Aeromonas* species from domestic dogs and cats. *Comp Immunol Microbiol Infect Dis* 1999; 22:175-9.

28. Kahn CM, Line S, eds. *The Merck Veterinary Manual*, Ninth Edition. Whitehouse Station, NJ: Merck & Co., 2005.

29. Pasteris SE, Bühler MI, Nader-Macias ME. Microbiological and histological studies of farmed-bullfrog (*Rana catesbeiana*) tissues displaying red-leg syndrome. *Aquaculture* 2006; 251:11-8.

30. Figueras MJ. The clinical relevance of *Aeromonas* sM503. *Rev. Med. Microbiol.* 2005; 16:145-53.

31. Zhiyong Z, Xiaoju L, Yanyu G. *Aeromonas hydrophila* infection: clinical aspects and therapeutic options. *Rev Med Microbiol* 2002; 13:151-62.

32. Abbott SL. *Aeromonas*. In: Murray PR, Baron EJ, Jorgensen JH, Pfaller MA, Tenover FC, Tenover FC, eds. *Manual of Clinical Microbiology*, Eighth Edition. Washington, DC: ASM Press, 2003; 701-5.

33. Janda JM, Abbott SL. Evolving concepts regarding the genus *Aeromonas*: an expanding panorama of species, dis-

ease presentations, and unanswered questions. *Clin Infect Dis* 1998; 27:332-44.

34. Hua HT, Bollet C, Tercian S, Drancourt M, Raoult D. *Aeromonas popoffii* urinary tract infection. *J Clin Microbiol* 2004; 42:5427-8.

35. Vila J, Ruiz J, Gallardo F, Vargas M, Soler L, Figueras MJ, Gascon J. *Aeromonas* spp. and traveler's diarrhea: clinical features and antimicrobial resistance. *Emerg Infect Dis* 2003; 9:552-5.

36. Essers B, Burnens AP, Lanfranchini FM, Somaruga SGE, von Vigier RO, Schaad UB, Aebi C, Bianchetti MG. Acute community-acquired diarrhea requiring hospital admission in Swiss children. *Clin Infect Dis* 2000; 30:192-6.

37. Filler G, Ehrich JHH, Strauch E, Beutin L. Acute renal failure in an infant associated with cytotoxic *Aeromonas sobria* isolated from patient's stool and from aquarium water as suspected source of infection. *J Clin Microbiol* 2000; 38:469-70.

38. Juan H-J, Tang R-B, Wu T-C, Yu K-W. Isolation of *Aeromonas hydrophila* in children with diarrhea. *J Microbiol Immunol Infect* 2000; 33:115-7.

39. Robles-Medrandá C, Lukashok HP, Novais P, Biccás B, Fogaça H. Chronic diarrhea as first manifestation of liver cirrhosis and hepatocarcinoma in a teenager: a case report and review of the literature. *J Pediatr Gastroenterol Nutr* 2006; 42:434-6.

40. Taneja N, Khurana S, Trehan A, Marwaha RK, Sharma M. An outbreak of hospital acquired diarrhea due to *Aeromonas sobria*. *Indian Pediatr* 2004; 41:912-916.

41. Teka T, Faruque ASG, Hossain MI, Fuchs GJ. *Aeromonas*-associated diarrhoea in Bangladeshi children: clinical and epidemiological characteristics. *Ann Trop Paediatr* 1999; 19:15-20.

42. Chu YW, Wong CH, Tsang GKL, Kwok MSW, Wong RKO, Lo JYC, Kam KM. Lack of association between presentation of diarrhoeal symptoms and faecal isolation of *Aeromonas* spp. amongst patients in Hong Kong. *J Med Microbiol* 2006; 55:349-51.

43. Millership SE, Curnow SR, Chattopadhyay B. Faecal carriage rate of *Aeromonas hydrophila*. *J Clin Pathol* 1983; 36:920-3.

44. Pitarangsi C, Echeverria P, Whitmire R, Tirapat C, Formal S, Dammin GJ, Tingtalapong M. Enteropathogenicity of *Aeromonas hydrophila* and *Plesiomonas shigelloides*: prevalence among individuals with and without diarrhea in Thailand. *Infect Immun* 1982; 35:666-73.

45. Ardehali B, Hand K, Nduka C, Holmes A, Wood S. Delayed leech-borne infection with *Aeromonas hydrophila* in escharotic flap wound. *J Plast Reconstr Aesth Surg* 2006; 59:94-5.

46. Fenollar F, Fournier PE, Legre R. Unusual case of *Aeromonas sobria* cellulitis associated with the use of leech-

es. *Eur J Clin Microbiol Infect Dis* 1999; 18:72-73.

47. Sartor C, Limouzin-Perotti F, Legré R, Casanova D, Bongrand M-C, Sambuc R, Drancourt M. Nosocomial infections with *Aeromonas hydrophila* from leeches. *Clin Infect Dis* 2002; 35:e1-5.

48. Hiransuthikul N, Tantisiriwat W, Lertutsahakul K, Vibhagool A, Boonma P. Skin and soft-tissue infections among tsunami survivors in southern Thailand. *Clin Infect Dis* 2005; 41:e93-6.

49. Abbott SL, Cheung WKW, Janda JM. The genus *Aeromonas*: biochemical characteristics, atypical reactions, and phenotypic identification schemes. *J Clin Microbiol* 2003; 41:2348-57.

50. Huddleston JR, Zak JC, Jeter RM. Sampling bias created by ampicillin in isolation media for *Aeromonas*. *Can J Microbiol* 2007; 53:39-44.

51. Palú AP, Gomes LM, Miguel MAL, Balassiano IT, Queiroz MLP, Freitas-Almeida AC, Oliveira SS. Antimicrobial resistance in food and clinical *Aeromonas* isolates. *Food Microbiol* 2006; 23:504-9.

52. Fosse T, Giraud-Morin C, Madinier I, Mantoux F, Lacour JP, Ortonne JP. *Aeromonas hydrophila* with plasmid-borne class A extended-spectrum β -lactamase TEM-24 and three chromosomal class B, C, and D β -lactamases, isolated from a patient with necrotizing fasciitis. *Antimicrob Agents Chemother* 2004; 48:2342-3.

53. Walsh TR, Stunt RA, Nabi JA, MacGowan AP, Bennett PM. Distribution and expression of β -lactamase genes among *Aeromonas* spp. *J Antimicrob Chemother* 1997; 40:171-8.

54. Marchandin H, Godreuil S, Darbas H, Jean-Pierre H, Jumas-Bilak E, Chanal C, Bonnet R. Extended-spectrum β -lactamase TEM-24 in an *Aeromonas* clinical strain: acquisition from the prevalent *Enterobacter aerogenes* clone in France. *Antimicrob Agents Chemother* 2003; 47:3994-5.

55. Subashkumar R, Thayumanavan T, Vivekanandhan G, Lakshmanaperumalsamy P. Occurrence of *Aeromonas hydrophila* in acute gastroenteritis among children. *Indian J Med Res* 2006; 123:61-6.

56. Goñi-Urriza M, Pineau L, Capdepuy M, Roques C, Caumette P, Quentin C. Antimicrobial resistance of mesophilic *Aeromonas* spp. isolated from two European rivers. *J Antimicrob Chemother* 2000; 46:297-301.

57. Kämpfer P, Christmann C, Swings J, Huys G. In vitro susceptibilities of *Aeromonas* genomic species to 69 antimicrobial agents. *Syst Appl Microbiol* 1999; 22:662-9.

58. Majumdar T, Ghosh S, Pal J, Mazumder S. Possible role of a plasmid in the pathogenesis of a fish disease caused by *Aeromonas hydrophila*. *Aquaculture* 2006; 256:95-104.

59. Rhodes G, Huys G, Swings J, McGann P, Hiney M, Smith P, Pickup RW. Distribution of oxytetracycline resistance plasmids between aeromonads in hospital and aquaculture environments: implication of Tn1721 in dissemination of the

tetracycline resistance determinant Tet A. *Appl Environ Microbiol* 2000; 66:3883-90.

60. Schmidt AS, Brunn MS, Dalsgaard I, Larsen JL. Incidence, distribution, and spread of tetracycline resistance determinants and integron-associated antibiotic resistance genes among motile aeromonads from a fish farming environment. *Appl Environ Microbiol* 2001; 67:5675-82.

61. Baddour LM. Extraintestinal *Aeromonas* infections—looking for Mr. Sandbar. *Mayo Clin Proc* 1992; 67:496-8.

62. Ko W-C, Lee H-C, Chuang Y-C, Liu C-C, Wu J-J. Clinical features and therapeutic implications of 104 episodes of monomicrobial *Aeromonas* bacteraemia. *J Infect* 2000; 40:267-73.

63. Murphey DK, Septimus EJ, Waagner DC. Catfish-related injury and infection: report of two cases and review of the literature. *Clin Infect Dis* 1992; 14:689-93.

64. Voss LM, K. Rhodes KH, Johnson KA. Musculoskeletal soft tissue *Aeromonas* infection: an environmental disease. *Mayo Clin Proc* 1992; 67:422-7.

65. Wolff RL, Wiseman SL, Kitchens CS. *Aeromonas hydrophila* bacteremia in ambulatory immunocompromised hosts. *Am J Med* 1980; 68:238-42.

66. Auerbach PS, Yajko DM, Nassos PS, Kizer KW, Morris Jr JA, Hadley WK. Bacteriology of the freshwater environment: implications for clinical therapy. *Ann Emerg Med* 1987; 16:1016-22.