Bacteremia With Oral *Prevotella salivae* in an 18-Year-Old After a Water Skiing Fall Into a Freshwater Lake

Victoria A. Avanzato, DPhilⁱ, John D’Angelo, MDⁱ, Jacqueline Okolie, MDⁱ, and Annie Massart, MDⁱ

Abstract

Freshwater exposure is associated with a diverse range of infections from pathogens present in soil and water. This includes skin and soft tissue infections and wound infections, gastrointestinal infections, and central nervous system infections acquired through recreational exposure or trauma. Case reports of freshwater-associated infections typically focus on waterborne pathogens as the cause of illness; however, patients who experience significant physical trauma during freshwater exposure may also be at increased risk for infection with their own flora if the nature of the injury allows entry of bacteria through a mechanism such as mucosal injury. Here, we present a case of a healthy 18-year-old man who rapidly developed bacteremia with oral flora following several falls submerging his face into lake water while water skiing, as well as acute polymicrobial sinusitis and subsequent pre-septal cellulitis. Shortly after his water skiing falls, the patient developed sinusitis that rapidly progressed to headaches, emesis, and significant periorbital swelling. Blood cultures grew *Prevotella salivae*, a bacterium naturally found in the oral cavity. Sinus cultures grew *Klebsiella aerogenes* and *Listeria monocytogenes*, which may be associated with lake water. The infection improved with antibiotic therapy, and the patient was discharged on a regimen of amoxicillin/clavulanic acid and trimethoprim-sulfamethoxazole. Reports of bacteremia with oral flora following freshwater injury are not typically reported, and to our knowledge, this is the first report describing bacteremia with *P. salivae*.

Keywords

*Prevotella salivae*, water skiing, lake, bacteremia, sinusitis, pre-septal cellulitis

Introduction

Freshwater and saltwater exposure can lead to various infections via exposure to pathogens in the water and soil through infection of skin or wounds, inhalation, or ingestion through recreation or trauma. Manifestations include skin and soft tissue infections (SSTIs), ocular infections such as keratitis and conjunctivitis, urinary tract infections, gastrointestinal infections, pneumonia, central nervous system (CNS) infections, and disseminated infections. Bacterial species implicated in water-associated illness include *Aeromonas hydrophila*, *Chromobacterium violaceum*, *Edwardsiella tarda*, *Erysipelothrix rhusiopathiae*, *Plesiomonas shigelloides*, *Pseudomonas aeruginosa*, *Leptospira*, *Mycobacterium* spp, *Shewanella* spp, and *Vibrio* spp, as well as *Escherichia coli*, *Shigella*, and *Staphylococcus aureus* and *Streptococcus* spp. Other pathogens, such as *Cryptosporidium*, *Giardia*, and norovirus also lead to gastrointestinal infections, and the amoeba *Naegleria fowleri* is associated with devastating meningoencephalitis.²³

Reports of water-associated illness in the literature usually focus on waterborne pathogens as the cause of disease. However, depending on the nature of the injury and resulting exposure, patients may also be at risk for serious infections with their own flora, such as oropharyngeal flora. In this report, we present a case of an 18-year-old man who rapidly developed bacteremia with oral flora and polymicrobial sinusitis leading to pre-septal cellulitis, shortly after exposure to lake water after several high-speed falls into the water while water skiing.

¹Emory University, Atlanta, GA, USA


Corresponding Author:

Annie Massart, MD, Division of Hospital Medicine, School of Medicine, Emory University, 1364 Clifton Road Northeast, Box M7, Atlanta, GA 30322, USA.

Email: Amassa2@emory.edu

Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (https://creativecommons.org/licenses/by-nc/4.0/) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access pages (https://us.sagepub.com/en-us/nam/open-access-at-sage).
A healthy 18-year-old man presented to the hospital with purulent nasal drainage and swelling around his left eye following freshwater exposure. Five days prior to presentation (hospital day –5; see Table 1), the patient went water skiing in West Point Lake in Georgia and fell face-first into the water several times at high speeds. He initially felt fine, but developed left sinus pain and congestion with yellow nasal discharge the following day (day –4). He presented to the ED of Facility 1 with left sinus pain and pressure.

Prescribed amoxicillin

Day –3

Returned to Facility 1’s ED with worsening pain and mild left eyelid swelling

Blood cultures performed

Day –1

Presented to Facility 2 urgent care with worsening periorbital pain/swelling

Prescribed cefdinir

Blood cultures observed to be growing GNRs; patient asked to return to ED

Day 0

Returned to Facility 1’s ED

Computed tomography scan performed, consistent with pre-septal cellulitis

Received dose of vancomycin and piperacillin-tazobactam

Facility 1 blood cultures Gram-stain positive for GNRs and gram-positive cocci in pairs

Transferred to Facility 3 for evaluation by ophthalmology and otolaryngology

Day 1

Received ceftriaxone IV in ED

Otolaryngologist performs bedside nasal endoscopy and culture

Antibiotics switched to cefepime IV, vancomycin IV; ceftriaxone discontinued

Day 2

Nasal culture grows K. aerogenes, blood culture from Facility 1 growing anaerobes

Antibiotics administered: cefepime IV, vancomycin IV, metronidazole PO, meropenem IV

Day 3

Blood cultures from Facility 1 speciate to P. salivae

Antibiotics administered: vancomycin IV, meropenem IV; metronidazole was discontinued

Day 4

Nasal culture grows L. monocytogenes

Antibiotics were switched to amoxicillin/clavulanic acid PO, trimethoprim-sulfamethoxazole PO

Day 5

Patient discharged on amoxicillin/clavulanic acid PO and trimethoprim-sulfamethoxazole PO for total 10-day course

Abbreviations: ED, emergency department; GNR, gram-negative rod; IV, intravenously; PO, by mouth.

### Table 1. Overview and Timeline of Illness, Hospitalization, and Antibiotics.

<table>
<thead>
<tr>
<th>Hospital day</th>
<th>Significant events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day –5</td>
<td>Patient experienced multiple falls with impact to his face while water skiing at West Point Lake in Georgia</td>
</tr>
<tr>
<td>Day –4</td>
<td>Presented to the ED of Facility 1 with left sinus pain and pressure</td>
</tr>
<tr>
<td></td>
<td>Prescribed amoxicillin</td>
</tr>
<tr>
<td>Day –3</td>
<td>Returned to Facility 1’s ED with worsening pain and mild left eyelid swelling</td>
</tr>
<tr>
<td></td>
<td>Blood cultures performed</td>
</tr>
<tr>
<td>Day –1</td>
<td>Presented to Facility 2 urgent care with worsening periorbital pain/swelling</td>
</tr>
<tr>
<td></td>
<td>Prescribed cefdinir</td>
</tr>
<tr>
<td></td>
<td>Blood cultures observed to be growing GNRs; patient asked to return to ED</td>
</tr>
<tr>
<td>Day 0</td>
<td>Returned to Facility 1’s ED</td>
</tr>
<tr>
<td></td>
<td>Computed tomography scan performed, consistent with pre-septal cellulitis</td>
</tr>
<tr>
<td></td>
<td>Received dose of vancomycin and piperacillin-tazobactam</td>
</tr>
<tr>
<td></td>
<td>Facility 1 blood cultures Gram-stain positive for GNRs and gram-positive cocci in pairs</td>
</tr>
<tr>
<td></td>
<td>Transferred to Facility 3 for evaluation by ophthalmology and otolaryngology</td>
</tr>
<tr>
<td>Day 1</td>
<td>Received ceftriaxone IV in ED</td>
</tr>
<tr>
<td></td>
<td>Otolaryngologist performs bedside nasal endoscopy and culture</td>
</tr>
<tr>
<td></td>
<td>Antibiotics switched to cefepime IV, vancomycin IV; ceftriaxone discontinued</td>
</tr>
<tr>
<td>Day 2</td>
<td>Nasal culture grows K. aerogenes, blood culture from Facility 1 growing anaerobes</td>
</tr>
<tr>
<td></td>
<td>Antibiotics administered: cefepime IV, vancomycin IV, metronidazole PO, meropenem IV</td>
</tr>
<tr>
<td>Day 3</td>
<td>Blood cultures from Facility 1 speciate to P. salivae</td>
</tr>
<tr>
<td></td>
<td>Antibiotics administered: vancomycin IV, meropenem IV; metronidazole was discontinued</td>
</tr>
<tr>
<td>Day 4</td>
<td>Nasal culture grows L. monocytogenes</td>
</tr>
<tr>
<td></td>
<td>Antibiotics were switched to amoxicillin/clavulanic acid PO, trimethoprim-sulfamethoxazole PO</td>
</tr>
<tr>
<td>Day 5</td>
<td>Patient discharged on amoxicillin/clavulanic acid PO and trimethoprim-sulfamethoxazole PO for total 10-day course</td>
</tr>
</tbody>
</table>

On arrival, vital signs were normal, and the patient was afibrile. Laboratory testing revealed leukocytosis to 16 100/ mL with an absolute neutrophil count of 1216/mL and elevated creatinine to 1.43 mg/dL. Physical examination was significant for marked left periorbital swelling and tenderness with minimal to no opening of the eye, tenderness to palpation over the left maxillary sinus, and purulent drainage from the left nare. Extraocular movements were intact, and the patient did not report any pain with eye movement. He had no visual deficits. A bedside nasal endoscopy was performed by otolaryngology for sinus cultures. The outside hospital confirmed their blood culture Gram stains demonstrated GNRs and gram-positive cocci in pairs, and he was given cefepime intravenously (IV) and vancomycin IV and isotonic IV resuscitation (day 1).

The following day (day 2), the nasal culture from the previous day grew Klebsiella aerogenes. His creatinine was elevated to 1.34 mg/dL, suggesting acute kidney injury (AKI); the vancomycin was renal-dosed, and he received another 1 L of Lactated Ringer’s solution. The cefepime was switched to meropenem. He also received metronidazole, as the outside hospital reported the blood cultures were growing anaerobes. Otherwise, the patient’s condition remained stable, still with significant pain and left periorbital swelling, and left nasal drainage. The next day (day 3), blood cultures from the outside hospital further speciated to Prevotella salivae, and the patient was continued on vancomycin and meropenem. His AKI resolved, with a creatinine of 1.08 mg/dL. The next day
Table 2. Sensitivities of *K. aerogenes* Sinus Culture Isolate.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Minimum inhibitory concentration interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amikacin</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Cefazolin</td>
<td>Resistant</td>
</tr>
<tr>
<td>Cefepime</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Cefoxitin</td>
<td>Resistant</td>
</tr>
<tr>
<td>Ceftazidime</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Ceftriaxone</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Levofoxacin</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Meropenem</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Piperacillin/Tazobactam</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Trimethoprim/Sulfa</td>
<td>Susceptible</td>
</tr>
</tbody>
</table>

(day 4), the nasal cultures additionally grew *Listeria monocytogenes*. The sensitivities of the *K. aerogenes* cultured are shown in Table 2; sensitivities of the *P. salivae* and *L. monocytogenes* were not performed by the microlab. The gram-positive cocci noted on the Gram stain of the outside hospital blood culture ultimately did not grow. The patient was switched to amoxicillin/clavulanic acid by mouth (PO) and trimethoprim-sulfamethoxazole PO per recommendations from infectious disease consultation, as all recovered pathogens and other common bacterial causes were covered by this broad regimen. By this time, his pain and periorbital swelling were much improved, and the patient was able to fully open his eye. He was discharged home the following day (day 5) to complete a total 10-day course of antibiotics with a plan to follow up in the otolaryngology, ophthalmology, and infectious disease clinics. An overview of his illness and hospitalization is presented in Table 1.

**Discussion/Conclusions**

Exposure to freshwater and saltwater can lead to a variety of infections from pathogens present in the water, sand, and soil. Many bacteria associated with such infections are naturally present in aquatic environments, and certain species may be introduced into freshwater environments through fecal matter from humans and animals, such as geese, agricultural runoff, and weather events. The presence of swimmers has also been suggested to stir up sand, soil, and sediment, which may re-suspend pathogens in sediment layers into the water, leading to increased human exposure through recreational activities.6

Water skiing can lead to injury and infection, although there are currently fewer case reports in the literature specific to infections than injuries. Typical cases include injuries from the tow rope and from falling, such as muscle, tendon, or ligament sprains and tears, abrasions, and lacerations.9 In addition, hydrostatic injuries to the vagina and rectum have been described,10-13 which result from the high pressure of water entering these orifices that occurs when participants fall backward. Water skiing accidents can also lead to infections from water exposure. The literature includes case reports describing a necrotizing foot infection in a diabetic patient following a water skiing fall,14 a wound infection with *A. hydrophila* following a water skiing accident involving a tow rope,15 a case of *V. parahaemolyticus* septicemia after water skiing in a patient with acute myelogenous leukemia,16 as well as a fatal case of *N. fowleri* meningoencephalitis after a previously healthy patient fell and hit his head on the water.17 In these cases, as well as most cases describing freshwater injury, the pathogen responsible is associated with the water source.

Interestingly, this patient rapidly developed bacteremia with an oral bacterium, *P. salivae*, and not a waterborne pathogen classically associated with freshwater exposure. As the patient experienced several falls at high speed submerging his face into lake water, it is plausible that the associated trauma to the oropharyngeal mucosa created a portal of entry for the bacteria, rapidly leading to bacteremia. *Prevotella* is a diverse genus of anaerobic GNRS with a prominence in the oral cavity and gastrointestinal tract, although it is also found in the respiratory tract, vagina, and skin. *Prevotella* spp can cause both local and systemic infections and are most commonly associated with periodontal and endodontic infections within the oral cavity.18 *Prevotella* spp have also been grown from patients with orbital complications of acute sinusitis.19 *Prevotella* spp have been implicated in various disease states, including bacteremia, SSTIs, brain abscesses, Lemierre’s syndrome, head and neck infections, genitourinary infections, respiratory infections, and even descending necrotizing mediastinitis from an odontogenic infection.20 *Prevotella* spp bacteremia has been documented following dental procedures and dentoalveolar abscesses, an infected decubitus ulcer, and in a patient with heart failure.21-28 To our knowledge, this is the first report identifying *P. salivae* in blood cultures in a case of clinically significant bacteremia.

The patient also developed a polymicrobial sinusitis and pre-septal cellulitis that grew *K. aerogenes* and *L. monocytogenes* in the nasal culture. *K. aerogenes* (formerly *Enterobacter aerogenes*) is associated with nosocomial bloodstream infections and antibiotic resistance. This species is typically found in the human gastrointestinal tract, but can also be found in soil, human and animal waste, and aquatic environments.29,30 *L. monocytogenes* is classically a foodborne pathogen that causes gastrointestinal disease as well as meningitis in the pregnant, elderly, and immunocompromised. Less frequently, it can cause pulmonary infections, endophthalmitis, necrotizing fasciitis, and focal infections such as joint sepsis.31-33 However, *Listeria* spp, including *L. monocytogenes*, have been routinely isolated from soil and water, including lakes and rivers, demonstrating that this environmental pathogen can use water sources for dispersion.34,35 It is plausible that exposure to lake water
from water skiing led to the polymicrobial sinusitis in the patient, especially given the acute timing of symptom development after exposure. Subsequent spread from the sinus likely resulted in the patient’s pre-septal cellulitis and bacteremia. While orbital cellulitis was initially a concern, this became less likely in the setting of no pain with eye movements and the lack of orbital involvement on imaging.

Of note, the repeat blood cultures drawn at our facility remained negative, and *P. salivae* did not grow in the nasal sinus culture. This makes it difficult to definitively link the patient’s bacteremia to the sinusitis. We believe this is because the patient had already received multiple antibiotics in the days prior to transfer. It is difficult to know whether *P. salivae* contributed to the pansinusitis, as nasal cultures did not grow this species, or if the bacteria were directly inoculated into the patient’s bloodstream through mucosal injury during the trauma of the falls. However, we believe this distinction is not significant to discern regarding management as this clinical scenario should prompt clinicians to pursue broad empiric antibiotic coverage. As the patient was healthy without any symptoms before water skiing, denied any sick contacts, and displayed rapid symptom development beginning shortly after his freshwater exposure, it is likely these events originated from the same incident.

This case—bacteremia with oral flora and polymicrobial sinusitis leading to pre-septal cellulitis in a previously healthy 18-year-old man shortly following exposure to lake water—is unique in that the bacteremia was caused by naturally occurring oral flora rather than bacterial species typically associated with freshwater exposure. Furthermore, while *Prevotella* spp have been shown to cause sepsis, this is the first report that identifies *P. salivae* as the cause of bacteremia. This case adds to the literature of serious infections following lake water exposure and highlights that the variety of pathogens involved in such cases extends beyond the typical culprits in the water itself. It is important to discuss potential water exposure while gathering patient history in such cases to ensure antibiotic treatments have appropriate coverage.

### Acknowledgments
The authors would like to thank Mary Ann Kirkconnell Hall, MPH, for assistance preparing this manuscript. They also thank all members of teams involved in the care of this patient.

### Declaration of Conflicting Interests
The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding
The author(s) received no financial support for the research, authorship, and/or publication of this article.

### Ethics Approval
Our institution does not require ethical approval for reporting individual cases or case series.

### Informed Consent
Verbal informed consent was obtained from the patient for their anonymized information to be published in this article.

### ORCID iD
Annie Massart https://orcid.org/0000-0001-6790-589X

### References