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Fish Pedicure-induced *Aeromonas sobria* Superficial Necrotic Bullous Dermatitis in a Previously Undiagnosed Diabetes Patient. What are the Risks of Fish Pedicure for Public Health?

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Authors' contributions

This work was carried out in collaboration between all authors and they have no conflicts of interest, including specific financial interests and relationships relevant to the subject of this work. All authors have contributed significantly, and agree with the content of the manuscript.

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Case Study

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ABSTRACT

We describe a patient with previously undiagnosed diabetes who developed superficial necrotic bullous dermatitis due to *Aeromonas sobria* infection following a fish pedicure (also known as fish spa, fish therapy or Ichthyotherapy). A major concern regarding fish pedicure involves the transmission of viral and bacterial infections. It has been shown that fish tank water contains a wide variety of bacteria, including non-pathogenic as well as potentially pathogenic species. Commonly in fish spas the tank water is heated to a temperature of 25 to 30℃. Such temperatures favour overall bacterial growth and at the same time increase skin porosity upon immersion, hence indirectly promoting potential skin infections. The authors discuss three potential routes of transmission (from fish or tub surface to man, from water to man, and from man to man via the tub water) and analyse the potential risk of bacterial or viral transmission associated with fish pedicures. On the basis of the current case study and the consensus view of experts, the authors advise against fish pedicure, in particular for patients with diabetes or a compromised immune system.

Keywords: Bullous dermatitis; necrosis; infection; skin; Garra rufa; ichtyotherapy; fish pedicure; Aeromonas sobria.

1. CLINICAL CASE

A 64-year-old patient presented to the Dermatology Department because of warm, painful, erythematous and necrotic swelling of the skin over the right tibial crest (Fig. 1). The skin swelling had started to appear two weeks before as an erythematous purpuric wound that became more necrotic and slowly extended without abscess. The patient did not take chronic medication and had no significant medical history. His body temperature was 36.9℃. The patient's locomotor abilities were impeded and pain was palpable. No trauma was present at the site of the swelling. The patient had recently returned from a trip to Asia, and he noted that the problem started some hours after a fish pedicure. The condition was clinically diagnosed as a slowly developing case of superficial necrotic bullous dermatitis. The results of laboratory tests were: haemoglobin, 13.3 g/dL; platelet count, 49,000/lL; albumin, 1.6 g/dL; and serum creatinine, 0.9 mg/dL. The leukocyte count was 10,100 cells/mm³ with 48% segmented neutrophils, 1% myelocytes, 5% monocytes, 8% lymphocytes, and 20% band neutrophils.

Ultrasonography of soft tissue excluded phlebitis but confirmed the presence of a diffuse superficial dermatitis. Needle aspirates yielded purulent secretions. Intravenous ciprofloxacin 400 mg twice daily therapy was started to eradicate cutaneous and sub-cutaneous infection during the first week. Examination of the aspirate culture confirmed the presence of *Aeromonas sobria*. Antimicrobial testing determined a susceptibility to cefuroxime, cefotaxime, ciprofloxacin and gentamicin.

Fig. 1. Warm, painful, erythematous and necrotic swelling of the right tibia crest diagnosed as a superficial necrotic bullous dermatitis

Blood culture showed no bacterial growth. Following this result, the patient completed a total of 3 weeks oral ciprofloxacin 500 mg twice daily. Further investigation by an oral glucose tolerance test yielded a plasma glucose level of 280 mg/dl after two hours, accompanied by delayed insulin secretion. This result indicated the presence of latent diabetes (type 2 diabetes). The management consisted of neurologic and vascular assessments (electromyography of the lower limbs, electrocardiography, vascular Doppler of the lower limbs, echography of the heart, peak plantar pressures, vibration perception threshold, X-ray joint deformity, tendon reflexes, biothesiometry and ankle

reflexes), glycaemia monitoring, glycated haemoglobin a1c and serum creatinine levels. Total recovery was achieved four weeks after the onset of medical treatment without surgical wound debridement but with local gentamicin cream.

In conclusion, the patient had previously undiagnosed latent non-insulin dependent diabetes with *Aeromonas sobria*-induced superficial necrotic bullous dermatitis associated with fish pedicure.

2. DISCUSSION

Ichthyotherapy has its origins in a series of thermal springs at 1700 m altitude near the town of Kangal, situated 500 km east of Ankara, Turkey. It is a practice in which patients immerse their feet or their entire body into the water containing dozens of *Garra rufa* fish [1] that nibble away dead and thickened skin. It is claimed that the fish only eat dead skin, although there are some anecdotal reports that they can break the skin if they nibble too deeply. The use of *Garra rufa* fish, also called "Kangal fish therapy", "Doctor fish therapy" or fish spa, has been established for decades in Turkey and the Middle East, where it is claimed to control psoriasis, eczema or other skin conditions [2]. In the last decade, the use of Garra rufa fish for cosmetic reasons has become increasingly popular outside its native region and the number of establishments offering fish pedicures worldwide is rocketing. Since fish pedicures involve the use of living fish, conventional methods of sterilisation and disinfection of water and equipment are not applicable as they would kill the fish. This raised questions about the potential transmission of infections. Although to date there is little evidence in the scientific literature on the public health risk of fish pedicure, the practice has been banned in some countries on safety grounds. The current case is the first report of a fish pedicure-induced *Aeromonas sobria* superficial necrotic bullous dermatitis in a previously undiagnosed non-insulin dependent diabetes patient. Diabetes is known to facilitate wound infection. Abscess, erysipelas, cellulitis, fasciitis and osteomyelitis are amongst the major complications from bacterial infections in this population even when in latent non-insulin dependent diabetes patient The World Health Organisation has calculated that up to 200 million patients worldwide will be affected by diabetes in 2010, and 300 million will be affected in 2025 [3]. In the next 25 years, diabetes and latent non-insulin dependent diabetes will be the leading cause of disability and death. Some common infection like interdigital intertrigo, tinea pedis, and onychomycosis present as public health problems that could trigger serious deterioration in patient quality of life, due to complications induced by secondary bacterial infections [4,5]. In the current case, increased skin porosity on prolonged immersion in combination with skin nibbling by *Garra rufa* fish presumably facilitated bacterial infection during the fish spa treatment, leading to the observed clinical manifestations within two weeks following the fish pedicure.

Garra rufa is a small freshwater cyprinid fish species that naturally inhabits river basins in Central Eurasia. It is widely used in health and beauty industries in foot spas for ichthyotherapy. The species is known under the commercial name of Doctor Fish but is also referred to as *Discognathus crenulatus, Discognathus obtusus, Discognathus rufus, Garra rufa crenulata, Garra rufa gymnothorax and Garra rufus* [6,7].

Little is known about its biological cycle and ecological preferences, but it is most often reported to live in lotic environments (flowing water), feeding on periphyton (a complex mixture of algae, *Cyanobacteria*, heterotrophic microbes and detritus). The species appears to tolerate a wide range of temperatures as well as poor water quality but remains very vulnerable to human activity and environmental change [1]. To date, no population has been documented outside its native range. *Garra rufa* is one of the four Cyprinidae among the 73 known fish of the *Garra* genus showing a discoidal mouth [6,7]. This group has a modified lower lip in the form of a sticking disc independent from the chin area. The morphology of this chin disc is characterised by three rows of teeth in the throat. The fish cannot bite. Aquarium observations indicate that *Garra rufa* acts as a cleaner of ectoparasites of other fish. In the wild, *Garra rufa* is reported to feed on *Chrysophyceae* and phytoplankton, excluding some Rotifera and Protozoa [6,7].

Although the use of *Garra rufa* is established in some parts of the Middle and the Far East, few official publications address its therapeutic value. In addition, existing publications raise questions about the usefulness of *Garra rufa* in psoriasis treatment. Turkish authors published on the therapeutic role of this fish as early as 1989 and 1990 [8,9].

To our knowledge, only two scientific studies have been published regarding the medicinal / therapeutic use of *Garra rufa*.

A Turkish study describes prolonged immersion (approximately 10 days) of 87 psoriasis patients in the Kangal warm springs containing *Garra rufa* [10]. No information about side effects is provided. Patients' conditions improve, but the study does not report on the positive effects of being exposed to ultraviolet light at this altitude, the positive psychological effects of psoriasis patch improvement and the relaxing effect of baths.

An Austrian study reported on the treatment of 67 patients presenting with modest to severe patches of chronic psoriasis [11]. The patients underwent therapy (two hours a day for three weeks) in a tub containing *Garra rufa* combined with short-term ultraviolet A radiation treatment and application of moisturiser after each session. Each patient had his or her own tub for the duration of the treatment, and the fish were exclusively used for one patient. Bath waters were constantly filtered (700 l/h) and disinfected by a filter pump and a disinfectant machine powered by ultraviolet rays. Water was changed three to four times a day, and the temperature was maintained at 36-37℃. Although a water test was performed, no results were published. No abnormal reaction was reported although one patient was recorded with a "weak occasional bleeding".

Both short-term studies suggested that ichthyotherapy in a medical setting could have beneficial effects but these studies were uncontrolled and therefore their validity is suspect based on the deficiency. However, the treatment in both studies was combined with other medical therapies which exclude the possibility to assign any particular effect to the ichthyotherapy.

2.1 What are the Risks for Public Health?

The main concern about the use of fish spas involves the transmission of viral as well as bacterial infections. It has been demonstrated that the tank water and the fish contain a large variety of bacterial species [12] and in certain cases may act as a reservoir for multidrug-resistant bacteria [13]. In fish spas the water is commonly heated to maintain a temperature in the range of 25 to 30℃, which is necessary to keep the fish alive. Such temperatures also favour bacterial growth and increase skin porosity on prolonged immersion, thereby indirectly promoting potential skin infections.

Three routes of transmission are possible:

1. From fish (or tub surface) to man
2. From water to man
3. From man to man via the tub water

2.2 Transmission from Fish (or Tub Surface) to Man

Atypical mycobacteria, primarily *Mycobacterium marinum, M. fortuitum and M. chelonae,* provoke infections such as *"aquarium granuloma" or "pool granuloma"* [14,15]. *Mycobacterium* is altogether associated with the presence of fish and the presence of a biofilm (comparable to non-chlorinated pools). This group of organisms is typically transmitted through an open wound, scratch or cut [16]. Such *Atypical mycobacterial* infections have been reported especially from pedicure footbaths [17-19]. Leg shaving before a fish spa is considered to be a risk factor for developing a *Mycobacterial furunculosis.* These infections are particularly aggressive among immunosuppressed patients [20,21] or those taking immune modulating therapies (i.e., psoriasis patients) [22-24].

Aeromonas spp., a pathogen of *Garra rufa* responsible for increased fish mortality [25], is found in many water types (including potable water) associated with fish [26,27]. *Aeromonas* folliculitis type infections have been described in spas [28,29]. Some species may provoke infections in the case of invasive contacts with a prior traumatised skin [30-32]. Cases of serious infections are associated with immunodeficient patients [33-35] and with diabetic patients [36]. *Aeromonas* can provoke severe infections [37] and induce resistance to antibiotics used in human medicine [13].

Salmonellae can induce a pustular dermatitis [38], wound infection [39], abcess [40] cellulitis [41] or osteomyelytis [42], particularly in immunosuppressed patients. *Salmonellae* and non-toxigenic *Vibrio cholera*, identified in *Garra rufa* sets, commonly develop pathogenically when ingested with water [43]. Although *Escherichia coli and Salmonellae spp.* can survive in fish for a prolonged period, it is estimated that they play a rather secondary role in fish spa compared with oral infection.

Wound infections by *Klebsiella spp.* have been described in humans [44,45]. Among these enterobacteria, the species *Edwardsiella tarda* is particularly known for being transmissible from fish to humans and inducing severe skin infections [46-49] in immunosuppressed patients [50].

Bacterial infections by *Erysipelothrix rhusiopathiae* and *Streptococcus iniae* are both associated with fish handling out of the water, but zoonotic infections are rarely observed even in those who frequently manipulate fish [51]. Fish infected by *Streptococcus iniae* experience an increased mortality rate and most likely die quickly. In these conditions, both bacteria are considered as low-risk pathogens for humans. *Streptococcus agalactiae* (a group *B streptococcus*) has recently been identified in the United Kingdom as the cause of premature death in *Garra rufa* intended for use in fish spas [52]. The frequency of the link between Streptococcus and *Garra rufa* remains unknown; inspections and measures in fish population could provide more information in the future even when in a study *Streptococcus agalactiae* was found to be resistant to different/multiple antibiotics [53]. Although human infections by *Streptococcus agalactiae* are typically observed in new-borns or act as the cause of puerperal fevers, the organism is a well-known pathogen in patients suffering from diabetes [53,54]. This pathogen is generally considered as a low-risk pathogen in the context of fish spas.

2.3 Transmission from Water to Man

Rapidly developing *Atypical Mycobacteria* are omnipresent in water, including tap water [55]. Some of these environmental species have been associated with furunculosis following footbaths. Shaving and/or wax hair removal prior to the bath have been cited as risk factors for such infections. Many skin infections due to atypical mycobacteria have been described from warm water spas [56].

Pseudomonas aeruginosa can be present in water and is frequently associated with the colonisation of biofilms on immerged surfaces. In bath contexts and in particular in spas, it is demonstrated that an increased duration or frequency of exposure and the number of bathers may promote the development of *Pseudomonas* folliculitis [57-59]. The infection often manifests as a follicular rash, which is occasionally pustular and/or limited (60). Shaving prior to entering the spa is a risk factor. In a fish spa, the patient's position can provoke momentary contact with the bacterium. Most likely, planktonic *Pseudomonas aeruginosa* for which biofilms act as a breeding ground, as well as other bacteria species may be grazed off by the fish feeding on the biofilm, thereby limiting their concentrations.

2.4 Transmission from Man to Man (Via Water)

Whilst *Staphylococcus* is frequently observed on the skin, lower limbs and feet are non-favourite colonisation sites, except in patients with atopic dermatitis or psoriasis (61). Any problem caused by this organism most likely originates from skin contact with a contaminated surface out of the water (seats and towels). Secondary dilution of the water volume makes transmission proportionally improbable except in patients with a wound or immune problems. Nonetheless, two cases of Staphylococcus aureus infection following a fish spa have been described of which one including a Methicillin-resistant strain of *Staphylococcus aureus* [62,63]. An increased prevalence of Staphylococcus aureus has been shown in patients with psoriasis [64,65]. These patients are at higher risk of infection in fish spas especially if they undergo immune modulating therapies [66].

Blood-borne viruses (BBV), such as *hepatitis B virus* (HBV), *hepatitis C virus* (*HCV*) or *HIV*, can be transmitted by blood or other biological fluids from one person to another. In the United Kingdom, approximately 5% of the population is chronically infected with *HCV* and hence form a reservoir/source for contamination [67]. A low proportion (approximately 0.4%) is infected with *HBV*. It is estimated that 0.14% of the United Kingdom population is not aware of carrying a potentially contagious disease. In Belgium, 0.1% of the population is in the same state of ignorance some studies have documented survival of *HBV* outside of a contaminated needle, but only a weak risk of *HBV* transmission is associated with wounds due to sport contact, as in martial arts, boxing or rugby [68,69]. It is reported that HBV survives for seven days on dry surfaces but, to our knowledge, its survival capacity in water is not documented. HCV remains viable for some days in moist environment, although its infectiousness is reduced at ambient temperature.

Garra rufa is said to only nibble keratin, but some fish spa clients exhibit bleeding, indicating that the skin can be broken. *BBV* apparently cannot remain on the mouth of the fish to the point of provoking a subsequent contamination. Yet, transmission is theoretically possible if the blood of a contaminated patient passes through an open wound to a scratch or wound of another client using the same tub. Since the risk of transmitting *BBV* in this manner is likely minimised by the dilution factor, the risk of infection with *BBV* during a fish spa is considered low but cannot be excluded.

2.5 Transmission from Man to Man (via a Contact Surface)

Many pathogens, including *fungi*, such as dermatophytes, yeasts and other moulds, provoke tinea interdigitalis and/or tinea pedis and/or onychomycosis which frequently induce damage to the stratum corneum of the skin and facilitate secondary bacterial infection (4). Especially in fish spas damaged skin may facilitate bacterial proliferation, whereby immunosuppressed or diabetic patients are considered more vulnerable.

Human papillomaviruses (*HPV*) responsible for *Verruca vulgaris* are known to survive on dry surfaces for prolonged periods. Transmission from man to man may occur through contact with the floor where clients walk barefoot which is common practice in swimming pools or dressing rooms in sports facilities. Scratches are often described on *Verruca vulgaris* and are potentially leading to bacterial proliferation in case of fish spa especially in immunosuppressed or diabetic patients.

3. CONCLUSION

In the last decade, the use of *Garra rufa* fish for cosmetic reasons has become increasingly popular outside its native region. Since fish pedicures involve the use of living fish, conventional methods of sterilisation and disinfection of water and equipment are not applicable as they would kill the fish. Both tank water and fish have been shown to contain a wide variety of micro-organisms and can act as a reservoir for drug-resistant bacterial strains. This has raised questions about the potential transmission of infections in fish spas. Recently, the first evidence for an infection with Methicillin-resistant *Staphylococcus aureus* after fish pedicure was reported [63].

In this paper we document a first case of fish pedicure-induced *Aeromonas sobriae* superficial necrotic bullous dermatitis in a previously undiagnosed diabetic patient.

Depending on the route of transmission, bacterial, viral or parasitic infections may be transmitted through ichthyotherapy practices. On the basis of the available scientific literature revue and the consensus view of experts, the risk of infection as a result of fish pedicure is considered low, but cannot be excluded. The risk of infection will, however, increase if the client has (open) wounds, or if the patient has an underlying immunosuppressed condition, e.g. in immunosuppressed transplanted patients, in patients subject to chemotherapy and in diabetic patients. In addition, patients who take anticoagulant medication are more likely to have bleeding wounds and are therefore at higher risk of infection. Unless an efficient system for prevention and control of infection risks in fish spas is validated and supervised by a local health authority, the authors advise against fish pedicure, in particular for immunocompromised individuals.

CONSENT

All authors declare that 'written informed consent was obtained from the patient for publication of this case report and accompanying images.

ETHICAL APPROVAL

It is not applicable.

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DISCLOSURE

All authors (Olivier Vanhooteghem, Dieter Anseeuw, Christian Michel, Michel Penninckx, Anne-Madeleine Pironnet, Anne Simon, Filip Volckaert, Hilde Beele) certify that they have no conflicts of interest, including specific financial interests and relationships and affiliations relevant to the subject of this manuscript untitled "Fish pedicure-induced *Aeromonas sobria*

superficial necrotic bullous dermatitis in a previously undiagnosed diabetes patient. What are the risks of fish pedicure for public health?" The content of the manuscript has not been published or submitted for publication elsewhere. All authors have contributed significantly, and agree with the content of the manuscript. In keeping with the latest guidelines of the International Committee of Medical Journal Editors, each author's contribution to the paper is to be quantified.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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