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Review

Burn wounds infected by contaminated water: Case reports, review of the literature and recommendations for treatment

Noel F.F. Ribeiro [a], Christopher H. Heath [b,c,*], Jessica Kierath [c], Suzanne Rea [d,e], Mark Duncan-Smith [d,e], Fiona M. Wood [a,d,e,f,g]

[a] Department of Plastic Surgery, Royal Perth Hospital, Perth, Western Australia (WA), Australia
[b] Department of Microbiology & Infectious Diseases, Royal Perth Hospital, Perth, WA, Australia
[c] School of Medicine and Pharmacology, University of Western Australia, Stirling Highway, Crawley, WA, Australia
[d] State Burns Unit, Royal Perth Hospital, Perth, WA, Australia
[e] McComb Foundation, Royal Perth Hospital, Perth, WA, Australia
[f] School of Paediatrics and Child Health & School of Surgery, University of Western Australia, WA, Australia
[g] The State Burns Unit, Royal Perth Hospital and Princess Margaret Hospital for Children, Perth, WA, Australia

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ABSTRACT

First-aid education for the management of burns advocates cool running water over burnt skin to limit soft tissue damage. However, the water used may itself constitute a risk.

We report three cases of severe invasive and necrotizing infection in patients who used or immersed themselves in contaminated water in an attempt to extinguish the fire following acute major burns. Wound cultures from all patients yielded *Aeromonas hydrophila* and two yielded *Bacillus cereus*. One patient had a complex polymicrobial infection, including zygomycosis with *Rhizomucor variabilis*. All patients were treated aggressively with wound débridement, including one patient who required bilateral lower limb amputations to control progressive infection. All infections were successfully treated and all patients survived their burn injuries.

We review the management of burns complicated by exposure to contaminated water leading to burn wound infections. We describe commonly reported organisms from various water sources, the appropriate initial empirical antimicrobial chemotherapy and present the clinician with a proposed algorithm for managing these serious infections.

Contents

* *Corresponding author at*: Department of Microbiology & Infectious Diseases, Royal Perth Hospital, Perth, WA, Australia. Tel.: +61 8 92242807; fax: +61 8 92241989.
E-mail addresses: noel_ribeiro@doctors.org.uk, noel_ribeiro@hotmail.com (Noel F.F. Ribeiro), chris.heath@health.wa.gov.au (C.H. Heath), kieraj01@student.uwa.edu.au (J. Kierath), suzierea@bigpond.net.au (S. Rea), markduncansmith@bigpond.com.au (M. Duncan-Smith), fionaw@mccomb.org.au (F.M. Wood).
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1. Introduction

Changes in many aspects of burn care, in particular intensive care management, have led to increased survival for patients with major burns. As a result burns related deaths have halved over the past 40 years [1]. Infection, however, remains a leading cause of death among this group of patients. Much is known about burns wound infections following most forms of thermal injury [1]. Conversely, relatively little is known about the diagnosis and management of burns infections, following exposure of wounds to contaminated water [2,3]. We report three such cases, with major burns wounds exposed to various water sources used to extinguish flames, which were subsequently complicated by severe invasive and necrotizing deep wound infections. All three patients were managed at The Royal Perth Hospital (RPH) Burns Unit between the February 2005 and March 2007.

Thermal injury to skin causes a massive release of humoral factors including cytokines, prostaglandins, vasoactive prostanoids, and leukotrienes. Accumulation of these factors at the site of injury results in spillover into the systemic circulation, giving rise to immunosuppression involving all facets of the immune system [1,4]. In addition to the loss of the natural cutaneous barrier to burns, coagulated proteins and other nutrients in the burns wound lead to microbial colonization. In some patients colonization is followed by tissue invasion by microorganisms causing burn wound infection [1,4]. This process is partly influenced by the inoculum and innate virulence of the organism.

Numerous microorganisms can cause soft tissue infection after exposure to either fresh or salt-water, particularly if there is associated trauma. The likely organisms associated with contaminated water exposure, should be considered when managing burns patients. Whilst common organisms associated with marine or freshwater contaminated wounds are *Staphylococcus aureus* and *Streptococcus pyogenes*, often from the individual's skin [5], there are a large number of organisms present in aquatic environments, which need to be considered. The organisms most commonly responsible for soft tissue infection from water sources include: *Aeromonas* species (spp.), *Pseudomonas* spp., *Plesiomonas* spp. and *Edwardsiella tarda* from fresh-to-brackish water [5]; *Vibrio* spp. including *Vibrio vulnificus and V. cholerae* [6], *Shewanella algae* and *S. putrefaciens*, *Erysipelothrix rhusiopathiae* from salty (sea) water, and *Mycobacterium marinum* [7] from both marine and freshwater environments. In addition, soil contaminated water contains ubiquitous organisms like *Bacillus* spp. and fungi including zygomycetes. Infection with these organisms can produce a variety of skin and soft tissue infections including cellulitis, abscess formation, wound infection, ecthyma gangrenosum and necrotizing soft tissue infections. It is not possible to determine the etiology of these infections based upon clinical features alone, as other common organisms including beta-hemolytic streptococci and *S. aureus* cause similar manifestations. However, rapidly progressive soft tissue infections with sepsis syndrome, particularly in high-risk individuals, are often associated with *Aeromonas* spp. and *Vibrio* spp. infections. *V. vulnificus* is frequently linked with bullae formation and soft tissue necrosis. In contrast, *M. marinum* and *E. rhusiopathiae* cause indolent soft tissue infections, which are not usually associated with systemic toxicity [7].

2. Case reports

2.1. Case 1

A 35-year-old individual presented to RPH following explosion of a diesel can used to start a fire, which resulted in 61% Total Body Surface Area (TBSA) full-thickness burns, including an