NT Health Guideline

Approval Date: 05/01/2023

Water-Associated Skin & Soft Tissue Infection and Crocodile/Shark Bite (Adults)

Applicability

This guideline must be considered by:

- Medical Officers, Nursing and Midwifery Staff at Royal Darwin Hospital, Palmerston Hospital, Katherine Hospital, Gove Hospital

This guideline must be/must not be used for the following:

- Paediatric patients

Guideline statement

The purpose of this guideline is to provide clinicians advice regarding clinical features, diagnosis and management of adults with water-associated skin and soft tissue infections.

Relationship to other guidelines

For patients with or at risk of sepsis/septic shock, refer to the NT Adult Sepsis Recognition and Management Guideline. For evacuees with soft tissue or bone injuries from Neighbour countries, also refer to the Evacuees with Soft Tissue or Bone Injuries from Northern Neighbour Countries RDH Guideline. Refer to Melioidosis NT Health Guideline for advice on diagnosis and management of melioidosis (which can result from soil and water exposure).

This guideline contains information that can be also be found in the Therapeutic Guidelines (TG). This guideline has some variations from TG based on local susceptibility data, and has Infectious Diseases and Microbiology department consensus at RDPH.

Guideline

Water-associated skin and soft tissue infections can be mild, moderate or life-threatening. Prompt recognition of risk factors and collection of appropriate diagnostic specimens is required. Empiric therapy is often required, especially in patients with risk factors. Patients with sepsis or septic shock may require surgical consultation although all patients with features of necrotising fasciitis require urgent surgical consultation.

NORTHERN TERRITORY GOVERNMENT

Epidemiology

Skin and soft tissue infections (SSTIs) can follow minor and major injuries associated with water exposure. These infections can present across a spectrum of clinical manifestations such as impetigo, ecthyma, erysipelas, cutaneous abscess and necrotising infections [1], with features of sepsis and/or septic shock.

Water exposure may occur in fresh water (ponds, lakes), flowing fresh water (rivers), brackish water (where fresh and seawater meet), seawater, or treated water (swimming pools) with or without other contaminants such as mud, debris, sand or sewage [2,3]. Activities (such as handling and filleting of fish, coral cuts or abrasions, cleaning fish tanks, trauma from boating accidents, or shark/crocodile bites) can create a portal of entry for aquatic pathogens [4].

Water-associated SSTIs are often polymicrobial [5]. The infecting organisms can be either human skin bacteria, bacteria on marine organisms (including the mucous layer of the skin of fish) or bacteria living in fresh, brackish, sea or treated water. Pathogens that can cause water-associated SSTIs are often common human skin pathogens including *Streptococcus* spp. (*Streptococcus pyogenes*) and *Staphylococcus aureus* (including methicillin-resistant strains) [4]. Other typical pathogens are listed in Table 1. Mycobacterial infections (including *M. marinum* and rapidly growing mycobacteria such as *M. abscessus*, *M. fortuitum* and *M. chelonae*) should be considered, especially when conventional bacterial cultures remain inconclusive [2].

A review of the microbiology of crocodile attack wounds confirmed the potential diversity of organisms isolated as the bacteria originated from the crocodile's oral flora, the patient's skin or was acquired from the water or soil during the attack. [6] The oral and cloacal flora of the Australian crocodile includes *Aeromonas hydrophilia*, *Pseudomonas aeruginosa* and *Proteus* and *Salmonella* species [6], with *Aeromonas* the most common isolate in a NT series [6].

Table 1 – pathogens known to cause water-associated skin and soft tissue infections

	Common pathogens known to cause water-associated skin and soft tissue infections (not in order of frequency)
1	*Staphylococcus aureus*
2	*Streptococcus* spp. (including *Streptococcus pyogenes*)
3	*Vibrio* spp.
4	*Aeromonas* spp.
5	*Chromobacterium violaceum*
6	*Shewanella* spp.
7	*Erysipelothrix* spp.
8	*Edwardsiella tarda*
9	*Mycobacterium marinum* and other mycobacterial infections

A review of 468 *Vibrio* spp., *Aeromonas* spp., *Chromobacterium violaceum* and *Shewanella* spp. (VACS) isolates from 2000-2013 in the Northern Territory identified *Aeromonas* spp. as the most commonly isolated organism (67%), followed by *Vibrio* spp. (15%), *Shewanella* spp. (13%) and *C. violaceum* (5%) [5]. Co-isolation of other bacteria was present in 60% of the samples and included *S. aureus* (29%), enterobacterales (24%), β-haemolytic streptococci (16%), other Gram-negative and Gram-positive bacteria (9%), anaerobes (5%) and other VACS organisms (8.9%) [5].

Epidemiology, incubation periods and typical clinical characteristics of some of the above pathogens are summarised in Table 2 [3].

Table 2 – epidemiology, incubation and typical clinical characteristics of common pathogens that cause SSTIs (original table modified for this guideline) [2,4]

Pathogen	Epidemiology	Incubation	Typical clinical characteristics
Aeromonas spp.	Fresh and brackish water, associated with near-drowning	24-48 hours	Cellulitis, pyodema, furuncles, necrotising infection
Chromobacterium violaceum	Wet tropical soils, brackish and stagnant water, associated with immunosuppression	24-48 hours	Cellulitis, pustules, ulcers with necrotic base, bluish purulent discharge, more common in patients with chronic granulomatous disease
Edwardsiella tarda	Fresh and brackish water, associated with catfish spine puncture and immunosuppression	24-48 hours	Pyoderma, necrotising infection (myonecrosis); can cause hepatic disease
Erysipelothrix rhusiopathiae	Environmental commensal on exterior slime of fish	24-48 hours (4-7 days for erysipeloid lesions)	Erysipelas, erysipeloid lesions, bacteraemia, endocarditis, septic arthritis and osteomyelitis
Mycobacterium marinum	Saltwater, aquarium or fishtank, injury from crustacean bite / trauma	1 week to months (mean 21 days)	Localised red-violet verrucous patches, lymphadenopathy, ulceration, deep infection possible
Shewanella spp.	Saltwater, contaminates shellfish, associated with near-drowning, ingestion of raw shellfish, exposure of pre-existing wound to saltwater, associated with immunosuppression	3-49 days	Cellulitis, pyoderma, deep ulcers, bacteraemia, haemorrhagic bullae, necrotising infection and compartment syndrome
Vibrio spp.	Saltwater, coastal waterways, associated with puncture wounds sustained in saltwater, ingestion of raw/undercooked oysters	3-7 days	Cellulitis, bacteraemia, haemorrhagic bullae, ulcers, necrotising infection and compartment syndrome - high case fatality

Diagnosis

Any specimen sent for culture should have clinical notes stating “water-associated infection”. Investigations that should be performed in patients with water-associated SSTIs include:

- Blood cultures
- Wound exudate for microscopy, culture and sensitivities (MCS)
- Tissue sample of infected tissue for MCS
  - If *M. marinum* is suspected on epidemiological and clinical factors, tissue should be sent for acid fast bacilli microscopy and mycobacterial cultures
- Throat, rectal swabs and other cultures for *Burkholderia pseudomallei* if Melioidosis is suspected (refer to TEHS Melioid guideline) or if there is soil/mud contamination of wounds

Diagnostic imaging (such as X-Rays, ultrasound, Computed Tomography (CT) and/or Magnetic Resonance Imaging (MRI)) may be required dependent on the patient’s clinical features and to ensure there are no retained foreign bodies.

Management of water-associated infections

For patients with or at risk of sepsis or septic shock, please refer to the NT Adult Sepsis Recognition and Management Guideline. Water-associated wound infections can progress rapidly; even localised infections require close monitoring. Skin and soft infections particularly with *Vibrio* spp., *Shewanella* spp., or with features of necrotising fasciitis require immediate surgical consultation (for surgical source control). The risk-benefit ratio favours rapid administration of antimicrobials in patients with sepsis or septic shock if it is not logistically possible to obtain the above investigations promptly.

General management principles

Emphasis should be on patient education and strategies to prevent water-associated infections. Patients, especially with co-morbidities (such as diabetes, chronic kidney disease, chronic liver disease, hazardous alcohol use, immunocompromised) should be cautioned about the risks of exposure of open wounds to water sources.

Careful cleaning (and debridement, if necessary) of wounds immersed in water is important to prevent infection. Ensure that tetanus immunisation is up-to-date – see the Australian Immunisation Handbook for details. Antibiotic prophylaxis is not routinely required for wounds immersed in water if there are no risk factors for moderate to severe infection (see below). Antibiotic prophylaxis is required for traumatic water-associated wounds that require surgical management or are significantly contaminated. Early empiric therapy is required for marine animal bite or penetration wounds at high risk of infection and in patients with moderate to severe risk for developing severe infections (Table 3).

Table 3 – risk factors for moderate to severe SSTIs

Risk factors for moderate to severe infections
Presentation to medical care delayed by 8 hours or more
Wound is a puncture wound that cannot be debrided adequately
Wound involves hands, feet, groin or face
Wound involves deeper tissue (such as bones, tendons, joints)
Wound involves an open fracture (refer to Surgical Antibiotic Prophylaxis TEHS Guideline)
Patient is immunocompromised (e.g. asplenia, immunosuppressive therapy, liver disease, iron overload, diabetes, malignancy)

Empiric antibiotic therapy of water-associated infections

The doses below may require modification based on the patient's renal function. Table 4 shows suggested empiric treatment options for mild, moderate and severe water-associated infections. Given the clear diversity of moderate presentations, either oral or intravenous empiric treatment options can be given at the discretion of the treating clinician and/or the Infectious Diseases (IFD) team.

Contact IFD in **any** patient with immediate or delayed severe penicillin hypersensitivity, **any** patient with a confirmed VACS infection or **any** moderate or severe infections.

For patients with moderate infections and no systemic features of sepsis being managed in remote centres with infectious diseases input, where ciprofloxacin is not available: doxycycline may be used as an alternative.

Table 4 – empiric treatment option for mild, moderate and severe infections

Severity	Criteria	Empiric treatment options
Mild (Sea-Water)	**NONE OF THE FOLLOWING** - risk factors as listed in Table 3 - infection with systemic features - infection involving deeper tissues - shark or crocodile bite	1. Doxycycline 100mg orally, 12-hourly **AND** Dicloxacillin 500mg orally, 6-hourly **OR** 2. Doxycycline 100mg orally, 12-hourly **AND** Cefalexin 500mg orally, 6-hourly (if delayed, non-severe penicillin hypersensitivity) **<u>If sewage or soil or mud contaminated wound</u>** 1. Amoxicillin/clavunate 875/125mg orally, 12-hourly **AND** Doxycycline 100mg orally, 12-hourly
Mild (Fresh/brackish or aquarium)	**NONE OF THE FOLLOWING** - risk factors as listed in Table 3 - infection with systemic features - infection involving deeper tissues - shark or crocodile bite	1. Trimethoprim+sulfamethoxazole 320+1600mg orally, 12-hourly (monotherapy) **OR** 1. Doxycycline 100mg orally, 12-hourly **AND** Dicloxacillin 500mg orally, 6-hourly **OR** 2. Doxycycline 100mg orally, 12-hourly **AND** Cefalexin 500mg orally, 6-hourly (if delayed, non-severe penicillin hypersensitivity) **<u>If sewage or soil or mud contaminated wound</u>** 1. Amoxicillin/clavunate 875/125mg orally, 12-hourly AND Doxycycline 100mg orally, 12-hourly
Moderate	**ANY OF THE FOLLOWING** - Risk factors as listed in Table 3 - Infection involving deeper tissues - Shark or crocodile bite	**<u>No systemic features, reliable for clinical follow up</u>** 1. Ciprofloxacin 750mg orally, 12-hourly **AND** Dicloxacillin 500mg orally, 6-hourly **OR** 2. Ciprofloxacin 750mg orally, 12-hourly **AND** Cefalexin 500mg orally, 6-hourly (if delayed, non-severe penicillin hypersensitivity) If sewage OR soil OR mud contaminated wound OR shark or crocodile bite, ADD Clindamycin 450mg orally, 8-hourly - IF extensive wounds or delay beyond 24 hours from time of bite --- **<u>Any systemic features (but not sepsis or septic shock)</u>** 1. Ciprofloxacin 400mg IV, 8-hourly **AND** Flucloxacillin 2g IV, 6-hourly **OR** Ciprofloxacin 400mg IV, 8-hourly **AND** Cefazolin 2g IV, 8-hourly (if delayed, non-severe penicillin hypersensitivity) If sewage **OR** soil **OR** mud contaminated wound **OR** shark or crocodile bite, **ADD** Clindamycin 450mg orally, 8-hourly * Consider de-escalation from IV to oral regimen after 24-48 hours if clear improvement. Refer to Directed therapy in guideline
Severe infection (including sepsis and septic shock)	**ANY OF THE ABOVE**	1. Ciprofloxacin 400mg IV, 8-hourly **AND** Meropenem 1g IV, 8-hourly (wet season) **OR** Piperacillin-tazobactam 4.5g IV, 6-hourly (dry season) **AND** Vancomycin (loading dose 25 to 30mg/kg IV; also chart regular vancomycin IV) If shark **OR** crocodile bite **OR** necrotising infection, **ADD** Clindamycin 600mg IV, 8-hourly

Directed therapy

Antibiotic therapy should be guided by antimicrobial susceptibility. If alternate regimens are required, discuss with IFD. Table 5 shows suggested treatment options for directed, **step down** therapy (to be discussed with IFD) for VACS organisms.

Table 5 – treatment options for directed, step down therapy

Pathogen	Treatment options for directed, step down therapy
Aeromonas spp.	1. Trimethoprim+sulfamethoxazole 320+1600mg orally, 12-hourly **OR** 2. Doxycycline 100mg orally, 12-hourly **OR** 3. Ciprofloxacin 500mg orally, 12-hourly
Chromobacterium violaceum	1. Trimethoprim+sulfamethoxazole 320+1600mg orally, 12-hourly **OR** 2. Doxycycline 100mg orally, 12-hourly **OR** 3. Ciprofloxacin 500mg orally, 12-hourly (resistant to ampicillin and most cephalosporins)
Shewanella spp.	1. Ciprofloxacin 500mg orally, 12-hourly **OR** 2. Trimethoprim+sulfamethoxazole 320+1600mg orally, 12-hourly
Vibrio spp.	1. Ciprofloxacin 500mg orally, 12-hourly **OR** 2. Doxycycline 100mg orally, 12-hourly

Duration and modification of therapy

Modification of empiric therapy may be required based on the patient's clinical progress, renal function, allergy status and results of culture and susceptibility testing. IV to oral switch can be safely done with IFD input in the appropriate clinical context (e.g. with clinical improvement, after source control), particularly if the patient has moderate infection and is clearly improving.

A duration of 5 days is likely to be appropriate for mild infections, provided VACS organisms are not cultured. If any VACS organisms are cultured, a longer duration may be required - discuss with IFD. A duration of 7 to 14 days (IV + oral) is likely to be appropriate for moderate infections, although a longer course may be required for wounds involving deeper tissues or if any VACS organisms are cultured – discuss with IFD. For those with severe infections, the total duration will be determined by the IFD team.

Document History

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National Safety and Quality Health Service standards

National Safety and Quality Health Service standards							
Clinical Governance	Partnering with Consumers	Preventing and Controlling Healthcare Associated Infection	Medication Safety	Comprehensive Care	Communicating for Safety	Blood Management	Recognising & Responding to Acute Deterioration
☐	☐	☒	☐	☐	☐	☐	☒

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