Review

Aquatic Sports Dematoses. Part 2 – In the Water: Saltwater Dermatoses

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Abstract

The second part of this three-part series on water-related dermatoses will discuss dermatologic conditions seen in athletes exposed to saltwater. The vast majority of the following dermatoses result from contact with organisms that inhabit saltwater, including bacteria, cnidarians, and echinoderms. This review also will include other dermatoses affecting saltwater athletes and should serve as a guide for dermatologists, sports medicine physicians, and other medical practitioners in recognition and treatment of these dermatoses.

Introduction

The second part of this three-part series on water-related dermatoses will discuss dermatologic conditions seen in athletes exposed to saltwater. The vast majority of the following dermatoses result from contact with organisms that inhabit saltwater, including bacteria, cnidarians, and echinodermata (Table 1). This review will also include other dermatoses affecting saltwater athletes.

Organism-related dermatoses

Vibrio vulnificus infections

Background: Vibrio vulnificus, a gram-negative, motile, curved bacterium, resides in ocean filter feeders (e.g. oysters and clams). The organism lives in warm seawater and can cause two distinct syndromes in swimmers.

Clinical: A primary septicemia results from consumption of undercooked seafood, especially raw oysters.[1] Patients experience fever, diarrhea, nausea, vomiting, and even septic shock soon after consumption.[2] Typically, within 24 h of the onset of symptoms, patients experience the characteristic skin lesions, which consist of severe cellulitis with ecchymoses and bullae.[2]

The second syndrome, a necrotizing wound infection secondary to direct inoculation, causes athletes to develop a painful, rapidly progressive cellulitis along with systemic symptoms and a mortality rate > 50%. Severe local tissue swelling with hemorrhagic bullae occurs commonly.[3] The infection affects males more frequently than females as a result of the female hormone estrogen, which provides protection against the *V. vulnificus* endotoxin via an unknown mechanism.[4]

Treatment: Infections with *V. vulnificus* require doxycycline 100 mg intravenously or orally twice daily along with ceftazidime 2 g intravenously every 8 h. Therapy includes wound care, with possible debridement and even amputation.[4]

Protothecosis

Background: Prototheca wickerhamii and *Prototheca zopfii*, achlorophyllic algae, inhabit both streams and lakes, but commonly dwell in sewage, slime flux, and animal waste.[5] Reports of approximately one hundred human cases of protothecosis exist world-wide, with cases in Europe, Asia, Australia, and the United States. Most reports describe cutaneous infections; olecranon bursitis as well as disseminated or systemic manifestations may occur.[6]

Clinical: Patients present with non-tender, pyoderma-like lesions or infiltrating papules and plaques on exposed sites. However, reports of both herpetiform[7] and verrucous[8] variants also exist in the literature.

Table 1 Summary of organism-related saltwater dermatoses

Dermatosis	Causative organism	Clinical Presentation
Vibrio vulnificus infection	*Vibrio vulnificus* (Bacterium: Gram negative, motile, curved rod)	1. Primary septicemia followed by cellulitis after consumption of undercooked seafood 2. Necrotizing wound infection with rapidly progressive cellulitis after direct inoculation
Protothecosis	*Prototheca wickerhamii*, *Prototheca zopfii* (Achlorophyllic algae)	Nontender, pyoderma-like lesions or infiltrating papules and plaques on exposed sites
Staphylococcal impetigo	*Staphylococcus aureus* (Bacterium: Gram positive cocci in clusters)	Erythematous papules, plaques, and pustules with associated honey-colored crust and sometimes vesicles or bullae
Portuguese man-of-war sting	*Physalia physalis*, *Physalia utriculus* (Cnidaria: Hydrozoa)	Pruritic, erythematous, patterned, urticarial plaques that may become violaceous and develop vesicles or necrosis
Fire coral dermatitis sting	*Millepora dichotoma, Millepora platyphylla* (Cnidaria: Hydrozoa)	Erythematous, burning lesions (caused by formic acid) at sites of contact
Jellyfish sting	*Pelagia*, *Chrisaora*, *Stomolophus*, *Cyanea*, and *Linuche* genera (Cnidaria: Scyphozoa)	Stinging sensation initially followed by urticarial or papulovesicular lesions distributed linearly
Irukandji syndrome	*Carukia barnesi* (Cnidaria: Cubozoa)	Painless, erythematous patch with papules at the sting site with prominent systemic symptoms
Irukandji-like syndromes	*Carybdeid* genus (Cnidaria: Cubozoa)	Painless, erythematous patch initially with increasing pain and papules developing at the sting site and with possible subsequent systemic symptoms
Sea anemone dermatitis	*Actinodendron plumosum*, *Triactis producta*, and others (Cnidaria: Anthozoa)	Stinging sensation followed by swelling, erythema, petechial hemorrhages, and ecchymoses
Seabather's eruption	Larvae of adult sea anemone *Edwardsiella lineata* and the thimble jellyfish *Linuche unguiculata* (Cnidaria: Anthozoa)	Stinging sensation and pruritus followed by vesicles, papules, and pustules with or without urticaria occurring in areas beneath the swimming suit
Sponge diver's dermatitis	Small sea anemones attached to sponges (Cnidaria: Anthozoa)	Erythematous wheals that may become vesicular and ulcerate
Ghost anemone dermatitis	*Haloclava producta* (Cnidaria: Anthozoa)	Delayed stinging sensation followed by pruritic, erythematous, edematous, necrotic plaques at points of contact
Red sea coral dermatitis	*Dendronephthya nipponica* (Cnidaria: Anthozoa)	Urticarial plaques followed by a vesiculobullous eruption and chronic dermatitis, usually of the hands and arms
Starfish dermatitis	Starfish; usually *Acanthaster planci*, the "crown of thorns starfish" (Echinodermata: Stelleroidea)	Immediate, intense, burning sensation with occasional embedding of spines in the skin
Sea urchin dermatitis	Sea urchins, such as *Diadema antillarum* (Echinodermata: Echinoidea)	Painful erythema and edema usually on palms or soles with occasional embedding of spines in the skin
Sea cucumber dermatitis	Sea cucumbers, such as *Parastichopus californicus* (Echinodermata: Holothuroidea)	Burning, irritant dermatitis on exposed skin caused by holothurin
Sponge dermatitis	Phylum *Porifera*	Minor abrasions or stinging sensation followed by pain, pruritus, and swelling caused by crinitoxins
Seaweed dermatitis	*Lyngbya majuscula* (Blue-green algae)	Stinging, burning, or itching sensation followed by a blistering erythematous desquamative dermatitis most commonly in areas covered by bathing suits (perineal and perianal areas)
Red tide dermatitis	Unicellular phytoplankton, such as *Ptychodiscus brevis*	Erythematous, urticarial eruption on exposed skin

Treatment: Treatment consists of antimycotic agents such as ketoconazole,[9,10] itraconazole,[11] fluconazole,[12] and amphotericin B.[13]

Staphylococcal impetigo

Background: Authors have reported a strong association between marine water contact and staphylococcal skin infections.[14,15] One study found that those with contact with marine water experience staphylococcal skin infection 18.1 times more commonly than those without marine contact.[15]

Clinical: Early in the disease process, well-defined, erythematous papules develop. Later, lesions appear as erythematous papules and plaques with honey-colored crusts with or without pustules. Rarely, patients may present with discrete vesicles and bullae (Fig. 1); coexistent regional adenopathy and pharyngitis may occur.[16]

Treatment: Focal and limited infections only require topical mupirocin. Extensive lesions may necessitate oral antibiotics such as dicloxacillin or cephalexin. Patients with MRSA respond to topical mupirocin, but may require oral doxycycline, trimethoprim/sulfamethoxazole

Figure 1 Bullous staphylococcal impetigo is characterized by collarettes of scale, superficial vesicles, and honey colored crust

or clindamycin. As a result of the increasing prevalence of MRSA, practitioners should consider prescribing these antibiotics at the onset of infection in athletes affected by staphylococcal impetigo.[17]

Cnidarial dermatoses

The phylum Cnidaria, formerly known as Coelenterates, divides into four classes: hydrozoa, scyphozoa, cubozoa, and anthozoa. All members of this phylum possess organelles (nematocysts) located on tentacles that pierce the skin and release toxin when in contact with skin. The stings from cnidarians constitute the most frequent envenomations encountered by humans in the marine environment.[18] Typically, the sting initially causes pain, followed by the development of erythema and then a pruritic, papular eruption that persists for approximately 3–7 d. In general, affected swimmers should immediately apply vinegar and cold packs to the wound. Some authors believe that applying sand to the area may help in removing unfired nematocysts. Clinicians must also consider pain management and tetanus prophylaxis. Warm compresses, antihistamines, and topical steroids may assuage symptoms. Swimmers with circulatory or respiratory collapse require epinephrine.

Hydrozoa

Portuguese man-of-war

Background: This organism possesses a gas-filled bag composed entirely of carbon monoxide that floats on the water; the motion of the water and wind carries this chamber. Large men-of-war may possess tentacles that hang down as far as one-hundred feet.

Clinical: The sting from a Portuguese man-of-war results in pruritic, erythematous, patterned, urticarial plaques that persist 3–7 d. This area may become violaceous and develop vesicles or necrosis. On rare occasions, athletes may also experience dizziness, nausea, weakness, and possibly death.[16]

Treatment: Please refer to the "Cnidarial Dermatoses" introductory paragraph for management. Swimmers should wear a diving suit upon entering high-risk waters to prevent skin contact with the organism.[16]

Fire coral

Background: The fire coral, *Millepora dichotoma*, does not belong to the true coral family, but rather represents another type of a hydrozoan.[19] Accidental contact by water athletes commonly occurs because fire coral may look like seaweed.

Clinical: Athletes present with deeply erythematous, burning lesions caused by the formic acid on the fire coral's outer shell.

Treatment: Treatment of the affected areas with ammonium neutralizes the formic acid. For additional management, please refer to the "Cnidarial Dermatoses" introductory paragraph.

Scyphozoa

Jellyfish

Background: Unlike the Portuguese man-of-war, a jellyfish propels itself as a result of rhythmic contractions in its hood (Fig. 2).[20] The tentacles of a jellyfish may dangle as far as thirty feet. These tentacles sometimes detach from the organism and become tangled in seaweed. Greater than 100 toxic jellyfish exist and their stings may produce a multitude of symptoms, including stinging, burning, pruritus, or death.[21]

Figure 2 The whip-like tentacles of the jellyfish may be short or extend up to 10 yards. (Photo courtesy of Barbara Van Eeckhout)

Figure 3 Jellyfish stings cause an initial stinging sensation followed by linear erythematous plaques, which may be urticarial or vesicular

Clinical: Most commonly, jellyfish stings provoke an initial stinging sensation followed by urticarial or papulovesicular lesions in a linear distribution (Fig. 3).[22] Delayed reactions may also develop and may recur days or weeks after stings by jellyfish.[23] These changes may consist of hyperpigmentation, fat atrophy, keloid-like scars, and erythema nodosum.[20]

While rare, jellyfish stings can cause severe effects. Acute respiratory distress, severe parasympathetic dysfunction, cyanosis, syncope, hemolysis, arrhythmias, and cardiac arrest may occur.[24]

Treatment: Once in contact with tentacles, swimmers should not immerse themselves in freshwater, which may cause activation and firing of the nematocysts. The proteolytic enzymes in meat tenderizers may help inactivate the toxins if applied shortly after contact.[25] Please refer to the ''Cnidarial Dermatoses'' introductory paragraph for additional management information.

Cubozoa

Members of the class, Cubozoa, cause some of the most severe reactions in aquatic athletes. Contact with these organisms usually constitutes a medical emergency. Box jellyfish, including *Chironex fleckeri*, *Carukia barnesi*, and other cnidarians belonging to the *Carybdeid* genus are included in this classification.

Irukandji syndrome

Background: The stings from the almost invisible, yet extremely toxic Australian Irukandji jellyfish, also known as the *Carukia barnesi* box jellyfish, can result in death. These organisms cause the Irukandji syndrome, a syndrome described by Flecker in 1952 and named after an Aboriginal tribe who lived in the Cairns region of Australia, north Queensland.[26]

Clinical: The initial sting induces no symptoms, but shortly thereafter, pain develops and rapidly intensifies.[27] Cutaneously, the syndrome begins as a patch of erythema with papules at the sting site.[28] Patients then may experience myriad extracutaneous symptoms including intense abdominal, back and limb pain as well as hypertension, arrhythmia, and pulmonary edema.[29] The symptoms generally persist for 4–30 h, but may not resolve completely for 1 week.[30]

Treatment: Affected athletes should remove adherent tentacles, apply cold seawater compresses, and irrigate the wound with vinegar to inactivate unfired nematocysts. Refer to the ''Cnidarial Dermatoses'' introductory paragraph for additional management.

Irukandji-like syndromes

Background: The Irukandji-like syndrome occurs after other small *Carybdeid* genus envenomations, and appears similar to the actual Irukandji syndrome. Numerous reports of Irukandji-like syndromes exist worldwide, including the Pacific basin,[27] Hawaii,[31] and, most recently, the Florida Keys.[32]

Clinical: Athletes experience a painless or mildly painful sting which becomes increasingly painful during the next hour with subsequent erythematous patches and papules developing at the sting site. Affected swimmers may also develop severe systemic manifestations.[32]

Treatment: Please refer to the ''Cnidarial Dermatoses'' introductory paragraph as well as the Irukandji syndrome treatment section for management.

Anthozoa

Sea anemone: sea anemone dermatitis

Background: Anthozoa, the fourth class of coelenterates, contains the true corals (Fig. 4) and anemones. Sea anemones contain several long cylindrical projections whose stings tend to cause localized effects (Fig. 5).

Clinical: Swimmers experience an initial stinging or burning sensation surrounding the sting site along with swelling, erythema, petechial hemorrhages, and ecchymoses. Bathing or showering exacerbates the stinging sensation. Shortly thereafter, a pruritic, erythematous, vesiculopapular eruption occurs on skin which contacts the ocean's bottom sediment (knees, legs, feet, hands, and forearms). Usually, the eruption resolves within 1–2 weeks but local necrosis, ulceration, and severe sloughing of the tissues can ensue.[33] Occasionally, a sea anemone's sting causes systemic symptoms, including acute renal failure[34] and fulminant hepatic failure.[35]

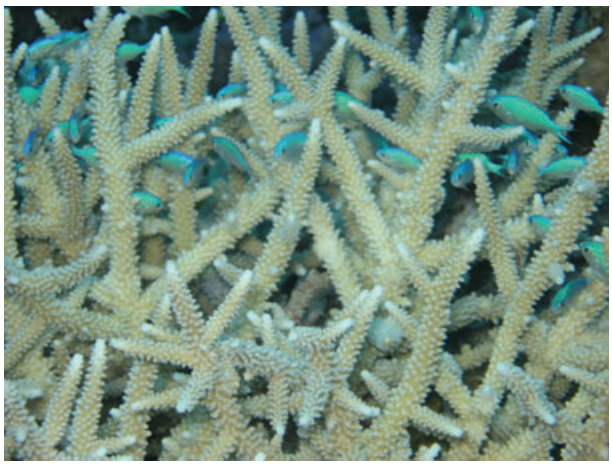

Figure 4 True corals, like the one pictured here, are members of the class Anthozoa, along with sea anemones. (Photo courtesy of Analourdes and Mercedes Gonzalez)

Figure 5 The long cylindrical projections of the sea anemone usually cause localized cutaneous injury. (Photo courtesy of Analourdes and Mercedes Gonzalez)

Treatment: Please refer to the ''Cnidarial Dermatoses'' introductory paragraph for management.

Sea anemone: seabather's eruption

Background: The first case of ''seabather's eruption,'' described by Sams in 1949, occurred in swimmers off the southeast coast of Florida.[36] The areas of highest prevalence include Florida, the Caribbean, Bermuda, and the northeast coast.[37] The larvae of the adult sea anemone, *Edwardsiella lineata*,[37] and the thimble jellyfish, *Linuche unguiculata*,[38] both cause seabather's eruption. Each larva contains approximately 200 nematocysts that inject toxins directly into the skin. Physical or chemical stimuli, such as external pressure on the larvae or a change in osmotic pressure caused by evaporation of seawater or showering in fresh water, can activate the nematocysts.[39]

Clinical: Affected athletes typically experience pruritus beneath the swimsuit, especially in areas where clothing lies tightest against the skin, such as the waist and bathing-suit straps.[37] Generally, a stinging sensation precedes the development of the eruption, which consists of vesicles, papules, and macules with or without urticaria that typically resolve within 1 week. Systemic symptoms, such as malaise, headache, chills, fever, and nausea, occur in up to 10% of cases.[37]

Treatment: Prompt removal of the swimming suit constitutes the most important treatment. Swimmers should not remove their suit while taking a shower, however, because tap water may cause nematocyst activation. Other treatment options include topical corticosteroids and oral antihistamines.[38]

Sea anemone: sponge diver's dermatitis

Background: The stinging tentacles of small sea anemones attached to the bases of sponges cause ''sponge diver's dermatitis''.[33]

Clinical: Erythematous wheals may vesiculate and ulcerate; headache, nausea, vomiting, and chills may also occur.

Treatment: Please refer to the ''Cnidarial Dermatoses'' introductory paragraph for management.

Sea anemone: ghost anemone dermatitis

Background: Haloclava producta, the highly contractile white ''ghost anemone,'' inhabits the eastern shore of the United States and the northeast Gulf of Mexico.[40]

Clinical: Affected swimmers experience a stinging sensation within 2 h after exiting the water followed by pruritic, erythematous, edematous, necrotic plaques at points of contact.

Treatment: Please refer to the ''Cnidarial Dermatoses'' introductory paragraph for management.

Red sea coral dermatitis

Background: Red soft coral (*Dendronephthya nipponica*), a type of marine cnidarian, has affected spiny lobster fishermen along the Pacific coast of Miyazaka Prefecture in Japan for years. The organism purportedly releases a toxin that causes conjunctivitis, rhinitis and asthma in addition to dermatitis of the hands and arms. These symptoms generally affect fishermen during the fishing season between September and April.[41] Nonetheless, swimmers also develop this eruption.[42–44]

Clinical: The eruption begins as acute urticaria, and follows with acute vesiculobullous lesions and chronic dermatitis.[45]

Treatment: Please refer to the "Cnidarial Dermatoses" introductory paragraph for management.

Echinodermata

Members of the phylum Echinodermata, another large group of invertebrates, are capable of causing significant injury to athletes and recreational swimmers. Four divisions comprise the phylum: Stelleroidea (sea stars), Echinoidea (sea urchins, heart urchins, and sand dollars), Holothuroidea (sea cucumbers), and Crinoidea (sea lilies, feather stars). Crinoidea species do not cause injury to humans, so they warrant no discussion here.

Sea stars/starfish

Background: Usually, contact with sea stars does not harm humans, but occasionally contact, especially contact with the "crown of thorns starfish," commonly found off the Great Barrier Reef, can cause puncture wounds that produce significant injury. These spines can even puncture neoprene suits.[46]

Clinical: Patients experience an immediate, intense burning sensation that may last for up to a month. Occasionally, spines may break off and become embedded in skin, causing a foreign body reaction. Rarely, systemic symptoms develop, including nausea, vomiting, and paresthesia.

Treatment: Refer to "Cnidarial Dermatoses" introductory paragraph.

Sea urchins

Background: Sea urchins typically creep along the bottom of deep seas (Fig. 6) and along the continental coast line and have surface spines with blunt or sharp tips that may contain venom glands (Fig. 7).[47]

Clinical: Painful wounds with surrounding erythema and edema usually occur on the hands after a swimmer attempts to pick up a sea urchin or on the soles after walking on the sea bottom in shallow water. Fragile, broken spines may remain in the skin (Fig. 8). Black species may cause a spotted macular discoloration caused by the residual pigment. If the spines penetrate through the skin, one may see immediate redness, swelling, and pain suggestive of tenosynovitis. Furthermore, systemic reactions, including nausea, syncope, and respiratory distress may occur.

Treatment: Refer to "Cnidarial Dermatoses" introductory paragraph.

Sea cucumbers

Background: Sea cucumbers, bottom-dwelling, sausage-shaped echinoderms produce a toxin called holothurin on their surface; this substance causes an acute irritant dermatitis. Contact with the eyes can cause a painful chemical conjunctivitis, possibly resulting in blindness. Finally, ingestion of the holothurin, a potent cardiac glycoside, may result in death.

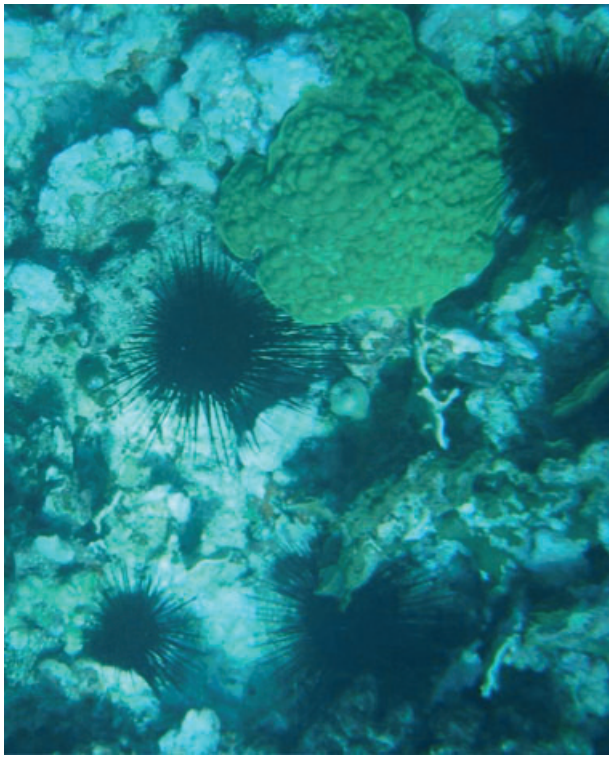

Figure 6 Sea urchins exhibit characteristic surface spines, which can lodge in a swimmer's skin

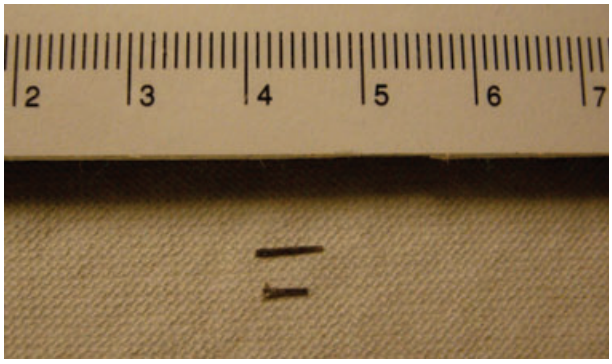

Figure 7 The surface spines can be sharp or blunt-ended

Clinical: Athletes present with a burning irritant dermatitis on exposed skin. Additionally, they may develop conjunctivitis.

Treatment: Athletes should rinse off the holothurin immediately with warm water, soap, vinegar, or isopropyl alcohol. Practitioners should treat ocular injury with topical anesthesia followed by copious irrigation with ophthal-

Figure 8 A sea urchin spine has punctured the skin

mologic consultation. For prevention, swimmers and divers ought to wear gloves while handling sea cucumbers.

Sponges dermatitis

Background: Marine sponges may have sharp calciferus or siliceous spicules that provoke an irritant dermatitis. Contact with sponges (phylum *Porifera*) typically results in minor abrasions. However, some species produce crinitoxins and are capable of affecting the skin both locally and systemically.[48] Sponges with sharp spicules can cause a pruritic, irritant fiberglass-like dermatitis when in contact with human skin.[49]

Clinical: Swimmers experience a stinging sensation followed by pain, pruritus, and swelling within minutes to hours because of crinitoxins. In severe envenomations, the swelling may produce vesiculations, bullae, and even joint symptoms. Later, patients may demonstrate desquamation. Additionally, reports of delayed allergic contact reactions, erythema multiforme, and anaphylaxis exist.[49]

Treatment: Refer to "Cnidarial Dermatoses" introductory paragraph.

Contact dermatoses

Seaweed dermatitis

Background: "Seaweed dermatitis" presents with blisters and deep desquamation in areas covered by bathing suits.[50] *Lyngbya majuscula*, a common blue-green alga found throughout the Pacific, Indian, and Caribbean oceans, causes seaweed dermatitis.[51] These organisms produce active irritants that result in acute dermatitis.[52]

Clinical: Swimmers generally experience a stinging, burning, or itching sensation within 24 h of contact.[53] Shortly thereafter, an erythematous dermatitis appears, most commonly surrounding the perineal and perianal areas that lasts for approximately 1 week. Patients may also experience respiratory irritation[54] and burning of the upper gastrointestinal tract on ingestion.[55]

Treatment: In general, treatment consists of symptomatic relief with cool compresses, topical steroids, antihistamines, and analgesics.[53]

Red tide dermatitis

Background: "Red tide dermatitis," a type of irritant contact dermatitis, occurs after exposure to unicellular phytoplankton (e.g. *Ptychodiscus brevis*), which exist in red tides.[56]

Clinical: The toxins released from these organisms cause an erythematous, urticarial eruption on exposed skin. Athletes may also develop conjunctivitis and pulmonary symptoms.

Treatment: Refer to "Cnidarial Dermatoses" introductory paragraph.

Miscellaneous dermatoses

Diver's hand

Background: Saturation diving occurred extensively in the past for the inspection and maintenance of subsea oil installations in the North Sea. Typically, these divers undergo compression for 1–3 h, bottom time (working period) for 12–16 d, and decompression for 4–7 d.[57] These divers may develop extensive peeling of the upper skin layers of the palms and occasionally the soles, a condition known as "diver's hand" by the divers themselves.[58]

Clinical: Some divers experience only mild scaling of their palms while most experience peeling of large, 3–6 cm areas. In general, scaling and fissuring begins at the distal fingers and progresses proximally.[57]

Treatment: This condition usually resolves spontaneously within 2–4 weeks if patients refrain from further saturation diving. Medium-potency steroids provide symptomatic relief.

Decompression sickness

Background: Decompression sickness, a dangerous and possibly deadly syndrome, occurs when a diver surfaces too rapidly. Importantly, early manifestations of decompression sickness may present in the diver's skin.

Clinical: These changes include mottling, erythema, or pallor. Additionally, pruritus, hypothermia, fever, and sweating are systemic signs that may accompany the skin manifestations. In particular, mottling is an important sign to recognize, and should prompt routine decompression chamber therapy.[59]

Treatment: Affected divers should undergo prompt decompression chamber therapy.

Nitrogen rash

Background: A diver who remains submerged at a given depth for an excessive amount of time may experience a rare, transient condition known as ''Nitrogen rash'' or ''skin bends''.[58] Nitrogen supersaturates the blood and dissolves in the subcutaneous tissue.

Clinical: This eruption consists of tender, pruritic, erythematous lesions that mainly affect the elbows and flanks. The area may also be cyanotic or purpuric.

Treatment: The rash resolves spontaneously, but the athlete should not dive until the eruption clears. In addition, divers should avoid flying for a minimum of 12 h after a single no-decompression dive and a minimum of 18 h after multiple dives per day or multiple days of diving.

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