



Review Article

Flood dermatoses: A literature review

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ARTICLE INFO

Article history:

Received 17-10-2022

Accepted 01-11-2022

Available online 26-11-2022

Keywords:

Floods

Tinea

ABSTRACT

The most frequent calamity in the world, flooding has killed around 53,000 people in just the previous ten years. Prior to 2011, flooding was the most frequent type of disaster on the planet, accounting for about half of all natural disaster victims and nearly US \$185 trillion in economic losses. Flood dermatoses can be divided into four categories: (i) Inflammatory skin diseases (such as irritant contact dermatitis); (ii) Fungal and bacterial infections; (iii) Traumatic skin diseases; and (iv) Other miscellaneous skin diseases (such as an allergic reaction to an insect bite and psycho-emotionally aggravating primary skin diseases). Here we review and summarise a number of articles on flood related skin diseases in an effort to improve knowledge and recognition of these conditions for both dermatologists and general practitioners in order to provide the best and most appropriate management of these particular skin diseases in emergency situations.

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1. Introduction

The most frequent calamity in the world, flooding has killed around 53,000 people in just the previous ten years. Prior to 2011, flooding was the most frequent type of disaster on the planet, accounting for about half of all natural disaster victims and nearly US \$185 trillion in economic losses.¹

As a result of hydrometeorological and geophysical disasters like the flood in Bangladesh in 2004, Hurricane Katrina in the United States in 2005, the earthquake in Haiti in 2010, the great eastern Japan earthquake and tsunami in 2011, and the floods in Thailand in 2013, a flood is defined as an overflow of water expansion (2011). One of the most frequent disasters, it accounts for 40% of all natural disasters worldwide²⁻⁴ and has a number of negative effects on the environment and healthcare, including direct harm to people, animals and other living things, contaminating food and chemical supplies, causing infectious and water-borne disease outbreaks and causes psychological health issues.

Due to increasing sea levels and more frequent and severe precipitation events, flooding events are predicted to become more regular and intense.⁵ Additionally, as urbanization levels rise, more individuals will be susceptible to flooding incidents.⁶

Floods are predicted to raise the burden of disease, morbidity, mortality and social and economic disruptions on a worldwide scale. They are also predicted to continue to strain health services, particularly in low-resource nations. These nations are the most vulnerable and the ones that experience the majority of big floods.⁷ The effects of floods on people's health depend on a variety of geographic and socioeconomic conditions as well as based on how vulnerable the affected populations already are.⁵

Flooding also affects the ability of local healthcare providers to provide essential services, as well as the needs of evacuees and clinic settlement. These issues necessitate emergency disaster response in order to provide patients with prompt treatment, including immediate wound care, antibiotics, pain relief, tetanus toxoid and also effective management of flood-related skin diseases. When

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extreme weather conditions, such as severe floods, occur, the skin is the organ system that is most susceptible to direct damage. Skin penetration from an injury can cause persistent morbidity and significantly raise the risk of secondary bacterial infection. One of these problems is skin disease caused by flooding, which can appear as cutaneous and/or systemic symptoms as a result of prolonged exposure to contaminated water and unsanitary surroundings. The authors divided these conditions into four categories: (i) Inflammatory skin diseases (such as irritant contact dermatitis); (ii) Fungal and bacterial infections; (iii) Traumatic skin diseases; and (iv) Other miscellaneous skin diseases (such as an allergic reaction to an insect bite and psycho-emotionally aggravating primary skin diseases).

We reviewed and summarized a number of articles on flood-related skin diseases in an effort to improve knowledge and recognition of these conditions for both dermatologists and general practitioners in order to provide the best and most appropriate management of these particular skin diseases in emergency situations.

2. Inflammatory Skin Conditions

2.1. Inflammatory contact dermatitis

The permeability barrier is breached by chemicals or irritants to start the acute phase of irritant contact dermatitis, which results in minor keratinocyte destruction and the release of inflammatory mediators. One of the risk factors for keratinocyte damage leading to inflammation and irritation without activating the immune cascade is prolonged immersion in the inundated water.⁸ Depending on the intensity of the irritants and the length of exposure, the time it takes for symptoms to appear might range from minutes to days. The hand and foot are the typical areas of irritation from flooding. The area of exposure is typically represented by erythematous patches in the clinical presentations. Inflammatory contact dermatitis signs and symptoms include burning, stinging, and discomfort. Compared to pruritus, these symptoms are more frequently observed.⁹ The primary skin condition is typically irritant contact dermatitis, which is occasionally followed by secondary infections from bacteria or fungi, secondary skin conditions caused by defects in the skin barrier, persistent irritation, and trauma. Avoiding irritants and keeping the exposed skin dry are the optimum therapies to stop secondary skin disorders. It is sufficient to receive supportive care that includes oral antihistamines to address itching sensations and topical corticosteroids to treat inflamed skin. Chronic eczema, as well as secondary bacterial and fungal infections, can all result from persistent irritation; all of these should be identified so that the appropriate medication can be provided.

2.2. Infections

Specific endemic diseases (such as leptospirosis, melioidosis, dengue hemorrhagic fever in South Asia and Southeast Asia, or malaria in Africa, South America, and Asia), the natural course of the disaster (such as flood from seawater or contaminated water), and the severity of the disaster are the associated factors with regard to flood-related disaster and infection. Public health policies typically bear responsibility for the management and resolution of these resulting issues. However, in these dire circumstances, there are typically few viable medicines and lab investigations, such as the culture of pathogenic organisms. The risk of soft tissue, ophthalmology, respiratory, gastrointestinal and vector-borne infections from pathogen inoculations, as well as the overcrowding of the displaced survivors, the removal of water sources, changes to vector breeding, and zoonotic reservoir, are among the infections brought on by the flood.¹⁰

2.3. Fungus-induced skin infection

As a result, exposure to floodwater for an extended period of time increases the risk of a superficial fungal skin infection. The most typical body part to be submerged in contaminated water is the foot. The appearance of erythematous skin maceration and stinging in the intervals between interconnected digital networks.

The interdigital variant of tinea pedis, which frequently affects the foot, is another name for it. On the plantar surface and the lateral sides of the foot, vesicles and pustules of the vesicular type and moccasin type may also appear as isolated dry scaly, erythematous hyperkeratotic papules.

In typical circumstances, non-dermatophyte molds (*Scytallidium dimidiatum*, *Scytallidium hyalinum*, and *Fusarium* spp.) are usually cited as the origin of tinea pedis.^{11–13} Even though the clinical manifestations of non-dermatophyte molds are identical to those of real dermatophytes, the fungus can typically be identified using a fungal culture on Sabouraud's dextrose agar (without cycloheximide), leading to more targeted and effective therapies.¹⁴ Due to the slight susceptibility to the oral medications griseofulvin and ketoconazole, the patients should be ruled out for this mold infection before therapy.¹⁵ Additionally, non-dermatophyte molds may contribute to the etiology of illnesses in non-flooding settings. To better understand the predominance of these species, more research is necessary. Broad spectrum topical antifungal medicines can be used for at least 2-4 weeks as an example of a generalized treatment to address potential infections.

A combination of topical treatments could be used as the goal of treatment in cases where the specific fungal pathogen(s) causing the inflammatory lesions and/or the probable polymicrobial agent(s) are unknown.

2.4. Multi-microbe infection

Skin maceration on the interdigital web of the foot can be both a sign of a bacterial colonization as well as a persistent irritating dermatitis of the foot. In spite of the Gram negative bacilli, *Corynebacterium* spp. and *Staphylococcal* spp. were found in 87.5% (14/16), 25% (4/16), and 25% (4/16) of the specimens, respectively. Vachiramon et al. studied fungal culture results taken from interdigital webs of 16 cases of foot maceration from flooding in Thailand and found only 12.5% positive fungal growth (2/16; *Trichosporon mucoides*).¹⁶

Topical anti-inflammatory, antibacterial, and antifungal medications work best as a combination to treat these mixed organisms.¹⁶ Combining anti-inflammatory effects of corticosteroids can treat troubling symptoms more quickly than treatment alone in patients with healthy hosts.¹⁷ The brief course of treatment may cause patients to misinterpret the clearance, which then results in drug withdrawal before the targeted antifungal drugs have had a chance to effectively combat the infections.¹⁷

3. Comparing *Tinea pedis* and *Tinea corporis*

According to a prior study, *tinea pedis* was the most prevalent superficial fungal skin illness following an earthquake. As a result of submersion during the tsunami, hot weather and other factors, Lee et al. reported that *tinea corporis* was more prevalent than *tinea pedis*. This is attributed to humid and unsanitary conditions.¹⁸ But it's important to understand that *tinea corporis* is a secondary ailment.

3.1. Wounds

Traumatic wounds are frequently the first sign of a skin problem, with bacterial infection coming later. Increased redness, swelling that quickly transforms into vesicles, and hemorrhagic bullae are the earliest symptoms of wound infections. Large-scale infections such as cellulitis, gangrene, necrotizing fasciitis, pyomyositis, and septicemia can occasionally happen. The pathogens *Streptococcal pyogenes* and *Staphylococcus aureus* are typically to blame for secondary bacterial infections. *Aeromonas* spp. is one of the unique diseases found in contaminated water.^{19–21} Despite exposure to seawater, doctors should be mindful of atypical mycobacteria and *Vibrio* spp. after major storm surges (*Mycobacterium marinum*).^{22,23} Sea and fresh water contamination is linked to tetanus from *Clostridium tetani* infections and gas gangrene from *Clostridium perfringens* infections, both of which are found in wound infections.²⁴ However, wound infections from soil, fresh water and mixed contamination from the sea are most frequently caused by polymicrobial species. The kind of pathogens, healing time, therapy and prognosis of these wounds are all influenced by the underlying conditions of the patients as well, including

diabetes mellitus, chronic venous insufficiency, peripheral nerve damage, and immunocompromised state. One of the best remedies for infected wounds is wound dressing. In situations where there is a high chance of a severe infection from a contaminated or unclean wound, prophylactic antibiotics are frequently administered. Depending on the specific hosts, the selective antibiotic regimens are supposed to cover the suspected infections. Additionally crucial are tetanus antitoxin, toxoid and/or immunoglobulin, especially in cases of insufficient immunization or in regions with low immunization coverage rates. In addition, it's important to keep an eye on systemic sickness symptoms and wound care.

4. Traumatic Skin Conditions

It should come as no surprise that traumatic skin illnesses frequently develop during and after the recovery from a disaster. The prevalence of this syndrome depends on the severity of natural disasters, the start and length of research, and ranges from 2.9% in flood survivors to 29% in tsunami survivors.²⁴ In men, this happened about three more times than in women.²⁴ Cuts, lacerations, punctures, and penetration wounds are the most common presentation types for dermatological lesions. The most usually impacted areas are the hands and feet.²⁴ Traumatic open wounds may develop a subsequent bacterial infection. The kind, length of the wound, presence of a foreign body, initial dressing, and treatments all affect which pathogens are responsible for subsequent infection. 71.8% of the mixed organisms found in wound cultures from tsunami survivors in Thailand were Gram-negative bacilli, with a preponderance of 95.5%. These organisms included *Aeromonas* spp. (22.6%), *Escherichia coli* (18.1%), and *Klebsiella pneumoniae* (14.5%).

5. Miscellaneous

5.1. Response to an insect bite

A stagnant body of contaminated water encourages mosquito reproduction and increases the amount of ants, fire ants, and centipedes that emerge from floodwater. Especially in areas of persistent flooding, reactions to insect bites are becoming more common.

5.2. Mosquitoes

In addition to being carriers of systemically transmitted illnesses like malaria and dengue hemorrhagic fever, mosquitoes also negatively impact the quality of life for flood victims. The generation of carbon dioxide, odors, and estrogen near human skin are what attract mosquitoes.²⁵ When a person gets bitten by a mosquito, their immune system becomes hypersensitive to the saliva protein, which triggers an inflammatory response.²⁵ Immunoglobulin E

(IgE) specific for saliva, IgG antibodies, and T cell-mediated delayed-type hypersensitivity reactions make up the pathogenesis.^{25,26} Mosquito bites can cause a variety of skin reactions and clinical manifestations. While the delayed reaction manifests as indurated erythematous papules that peak at 24-36 hours and eventually disappear within days or weeks, the immediate reaction manifests as a wheal and flare 2-10 mm in diameter that peaks within 20 minutes.^{27,28} Vesicles, bullae, ecchymosis, and a localized inflammatory reaction that resembles cellulitis are additional mosquito bite presentations (Skeeter syndrome).²⁸ When it comes to a severe allergic reaction, it may show up as hemorrhagic bullae, necrosis, or an ulcer that heals with lingering scars.²⁹ Patients with underlying illnesses such as hematological malignancies usually experienced more severe reactions to mosquito bites.^{30,31} Erythematous papules (68.6%) and acute wheals (67.1%) were the most prevalent cutaneous lesions identified by Kulthanan et al. when they examined and evaluated the clinical characteristics of mosquito allergy patients in Thailand. The leg is the most typical place to be affected.³² Avoiding mosquito bites is perhaps the best preventative measure. Limiting exposure time at dawn and dusk, wearing protective clothing, using mosquito nets and insect repellents, and other measures will help you achieve this. Effective treatments include topical corticosteroids and oral anti-pruritic medications for symptoms. The most popular and effective insect repellent is N, N-diethyl-m-toluamide (DEET), also known as N, N-diethyl-3-methylbenzamide. DEET repellents provide protection for about two to three hours.^{33,34} DEET in concentrations ranging from 5 to 30% is sold over the counter. The concentration of DEET directly correlates with the most effective time for bug protection.³³ However, one should also take into account the negative effects of systemic absorption. The average duration of protection for botanical insect repellents, such as 5-15% citronella, is less than 20 minutes. When compared to medicines that contain DEET, they do not offer sufficient protection.³³

5.3. Fire ants

In the Order Hymenoptera, the red and black fire ants are designated as *Solenopsis richteri* and *Solenopsis invicta*, respectively. Most of these species may be found in Thailand. Their lengths range from 2 to 6 mm. They have dug subterranean tunnels in the ground and tree roots to dwell in.^{33,34} They assault the victims repeatedly and generally in swarms. Bites, stings, and injection of venom into the outermost layer of the skin are the first two stages of fire ant attacks.³⁵ Following an initial increase in plasma membrane permeability caused by these poisonous alkaloid venoms, mast cells release histamine.^{36,37} While the delayed-type reaction manifests as surface vesicles holding clear fluid and tissue edema over the course of several hours, the rapid reactions upon envenomation

manifest as wheals and flares of 1-2 mm up to 10 cm in size within seconds. As a result, 8-10 hours later, the clear fluid turns hazy and develops pustules and an umbilicus.³⁸ These sterile pustules are typically dispersed or arranged in a pattern that is referred to as a rosette.³⁹ Vesiculopustular lesions are frequent and last for a few days to a few weeks. The intensity of the local response depends on the victims' sensitized immunity and venom exposure. Within 20 minutes of stings, itchy sensations are common.³⁶ Approximately 16% of fire ant sting cases are thought to result in a systemic reaction, and 0.6% to 2% of those cases result in life-threatening anaphylaxis.^{38,39} Ten cases of anaphylaxis brought on by the sting of *S. richteri* were documented by Khan et al.⁴⁰ There were numerous deadly anaphylactic cases in works of English literature.^{41,42} There have been few reports of other systemic symptoms, such as nephrotic syndrome and neurological conditions such as mononeuropathy, seizures, optic neuritis and demyelination of the brain. The most frequent complication of these stings is subsequent bacterial infection, so additional supportive care includes symptomatic therapies including washing the lesion with mild detergent, local compression with ice pack, calming preparations, and scratch avoidance. Antibiotic usage as a preventative measure is not typically advised. For the pain and itching sensations, topical corticosteroids and systemic antihistamines are acceptable therapies.⁴³

5.4. Centipedes

Arthropods known as centipedes are found all over the world. They are nocturnal species who favor damp, gloomy environments. The majority of bites take place indoors. They have one pair of legs for each section of the body and range in size from 3 to 250 mm.⁴⁴ According to the reported instances of immunogenic properties and fatality (severe hypotension and respiratory distress syndrome from type IV or delayed-type hypersensitivity), Balit et al. hypothesized that centipedes may produce a venom that induces local inflammatory reactions similar to bee and wasp stings as well as potentially more generalized hypersensitivity reactions.⁴⁴ A painful erythematous swelling patch with two-bite puncta is the typical presentation. Itchiness and bullae are also present.⁴⁵ An unmistakable sign of definitive bites is pain, the intensity of which varies depending on the species. Greater pain and more swelling are caused by large species. The period of pain lasts between 30 to 120 minutes (median time 30 minutes).⁴⁴ The symptoms and signs most likely last longer than 48 hours. The resulting secondary bacterial infection is rare, though. Rarely does a centipede bite cause a severe reaction.

Wells syndrome and rhabdomyolysis with renal failure are just a couple of the described cases in the literature.^{46,47} The discomfort of envenomation is reduced with supportive care, pain management, and use of ice packs, hot water immersion, and systemic analgesics. The use of ice packs

is secure and appropriate for pre-hospital care. Topical corticosteroids are also useful for reducing edema and inflammation.

6. Psycho-emotion

6.1. Chronic primary skin conditions

Due to the impact of psycho-emotional elements that exacerbate the primary underlying disorders, such as atopic dermatitis, urticaria, alopecia areata, angioedema, psoriasis, and vitiligo, stress can cause psychodermatological diseases.⁴⁸ Urticaria that appeared right after an earthquake was documented by Stewart and Goodman.⁴⁹ 12 patients with worsened psoriasis, atopic dermatitis, or urticaria following a tsunami disaster were described by Lee et al. in their study. Kodama et al. claimed that stress following an earthquake can exacerbate atopic dermatitis.⁵⁰ According to Amano et al., mice subjected to the water avoidance stress test had skin lesions resembling atopic dermatitis and had higher serum levels of immunoglobulin E. A likely explanation for the exacerbation was corticotropin-releasing factor's inhibitory impact.⁵¹ According to Kim et al., modification of immune system cells that attack skin appendages and the peripheral corticotropin-releasing hormone-proopiomelanocortin axis is the etiology of psychological stress-aggravated psoriasis.⁵²

According to the available data, type 2 beta corticotropin-releasing hormone (CRH) receptors that are overexpressed in the vicinity of the hair follicles might cause acute emotional stress to trigger alopecia areata. The hair roots may be destroyed locally as a result of the pro-inflammatory effects of CRH or similar peptides.⁵³ Katsarou-Katsari et al. used a scalp skin biopsy for in situ CRH receptor hybridization in order to validate this notion.⁵³ Stressful situations have a major impact on aggravating vitiligo in both children and adults, as Manolache et al. have shown.^{54,55} Poor hygienic circumstances, insufficient systemic to topical treatment compliance, and uncontrollable environmental factors are among the causes of this illness.

Skin conditions caused by flooding cover a wide clinical spectrum. There are many elements connected to these types, including environmental ones (endemic region, natural course, and disaster intensity) and individual ones (medical and dermatological underlying diseases). The major issues in the public health system could be caused by psycho-emotional disorders, traumatic skin diseases, vector-borne diseases, infectious diseases, and inflammatory skin diseases. Loss-related psychological health problems should be identified and treated. In order to achieve effective and optimum treatment outcomes, dermatologists and general practitioners should fully improve with the fundamental knowledge of these disorders.

7. Source of Funding

None.

8. Conflicts of Interest

There is no conflict of interest.


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Cite this article: Roy J, Das K, Kurien AJ. Flood dermatoses: A literature review. *IP Indian J Clin Exp Dermatol* 2022;8(4):217–222.