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Review

Impact of climate change on dermatological conditions related to flooding: update from the International Society of Dermatology Climate Change Committee

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Abstract

Climate change contributes to the increase in severity and frequency of flooding, which is the most frequent and deadly disaster worldwide. Flood-related damage can be very severe and include health effects. Among those health impacts, dermatological diseases are one of the most frequently encountered. Both infectious and noninfectious dermatological conditions are increasing after flooding. We searched PubMed using the search term climate change OR global warming OR rainfall OR flooding OR skin. Articles published in the English-language literature were included. We also searched the International Society of Dermatology website library on climate change for additional articles. There is an increased risk of trauma during the course of a natural disaster. The majority of post-tsunami wound infections were polymicrobial, but gram-negative bacteria were the leading causes. Infectious diseases with dermatological manifestations, such as impetigo, leptospirosis, measles, dengue fever, tinea corporis, malaria, and leishmaniasis, are important causes of morbidity among flood-afflicted individuals. Insect bites and stings, and parasite infestations such as scabies and cutaneous larva migrans are also frequently observed. Inflammatory conditions including irritant contact dermatitis are among the leading dermatological conditions. Dermatological conditions such as alopecia areata, vitiligo, psoriasis, and urticaria can be induced or exacerbated by psychological conditions post disaster. Prevention is essential in the management of skin diseases because of flooding. Avoiding exposure to contaminated environments, wearing protective devices, rapid provision of clean water and sanitation facilities, prompt vector controls, and education about disease risk and prevention are important.

Introduction

Global alteration of climate, also known as climate change, has been taking place over the past few decades.[1,2] It has been perceived as a challenge to humans because of its association with various undesirable environmental changes.[2,3] Sustained alteration of climate results in elevated temperature and sea levels, alteration in humidity, and occurrence of unusual weather events like extreme precipitation.[3,4] These changes contribute to the increase in severity and frequency of flooding.[4]

Flooding has been recognized as the most frequent and deadly disaster worldwide, accountable for nearly 50% of all casualties caused by a natural disaster.[4] It may ensue after heavy precipitation, hurricanes/storms, tidal surge, or other possible causes such as melting of snow or ice caps.[5] Flood-related damage can be divided into tangible and intangible losses. The latter can be very severe and include health effects, stress and anxiety, loss of school hours, lack of sleep, and other uncountable inconvenience and losses.[6] Flood-related health impacts can be further divided into short-term – including death, trauma, toxic exposure, and communicable diseases; and long-term, including noncommunicable diseases, psychosocial health problems, malnutrition, and poor birth outcomes.[7] Among those health impacts of flooding, dermatological diseases are one of the most frequently encountered conditions along with gastrointestinal and respiratory illnesses.[8–11] Both infectious and noninfectious dermatological conditions are noted to increase after flooding by approximately 20%.[12–15]

We present an update of the existing knowledge on flood-related dermatological conditions, which are believed to be a consequence of climate change.

Materials and methods

We searched PubMed using the search term climate change OR global warming OR rainfall OR flooding OR skin. Articles published in the English-language literature were included. We also searched the International Society of Dermatology website library (http://www. Intsocderm.org) on climate change for additional articles. For this review, we included skin diseases related to (i) trauma, (ii) infections, (iii) infestations, bites, and stings, and (iv) inflammatory and psychodermatological conditions.

Results

Most of the references gathered to evaluate the postulated effects of climate change and flooding on the epidemiology of skin diseases have been extracted from limited published reports on major environmental disasters such as the tsunamis in Indonesia and Thailand and Hurricane Katrina in the United States (summarized in Table 1).

Flood-related dermatological conditions (Table 1)

Disasters including flooding generally consist of three phases: impact phase (day 0–4), post-impact phase (4 days to 4 weeks), and recovery phase (beyond 4 weeks). Distinctive circumstances in each phase allow the development of different health problems including skin diseases. In the impact phase, trauma is commonly encountered. In the postimpact phase, wound infections or spread of pathogens in crowded shelters predominate. In the recovery phase, uncommon infections appear as a result of exposure to contaminated surroundings. Vector-borne diseases also increase because of the return of stagnant water bodies.[16] This paper grouped flood-related dermatological conditions based on their nature: (i) trauma and related wound infection; (ii) infections and infestations; (iii) inflammatory or other noninfectious conditions; and (iv) psychodermatological conditions.

Trauma and related wound infection

There is an increased risk of trauma and mortality during the course of a natural disaster.[17] It is commonly seen immediately or during clean up or restorative works after a disaster.[18,19] It accounted for nearly 22–38% of health visits during Hurricane Katrina in 2005.[20,21] Trauma ranked third among all dermatologic conditions seen 10 days after the tsunami in Banda Aceh in 2005.[18] Laceration was reported as the most common type of trauma, predominantly involving the feet and hands.[18,22] The proportion of lacerations decreased, while that of sprain and strain increased with time.[21]

Infection has been reported in two-thirds of trauma patients after the tsunami in Thailand. Most of them suffered from crush injuries of the legs.[23,24] Contamination of wounds with water, soil, and debris, improper cleansing or treatment of wounds, and previous skin disorders are predisposing factors for postdisaster wound infections.[25,26] Individuals who sustained minor injuries in post-disaster tasks may also develop soft tissue infections.[26]

The majority of post-tsunami wound infections were polymicrobial, but gram-negative bacteria were the leading causes. Gram-negative bacilli *Aeromonas* was the most frequent cause of wound infections. It presents as streptococcal cellulitis-like edema, erythema, and purulent discharge associated with fever and chills. It may develop into necrotizing fasciitis, necrotizing myositis, and osteomyelitis. Other reported gram-negative infections were caused by *Klebsiella*, *Escherichia coli*, *Pseudomonas aeruginosa,* and *Proteus*. Most of these gram-negative bacteria were susceptible to third and fourth generations of cephalosporins, aminoglycosides, fluoroquinolones, and imipenem.[23,24,26]

Gram-positive bacterial infections were less frequent (4.5%) and mostly caused by *Staphylococcus sp*.[23] A cluster of tetanus cases caused by *Clostridium tetani* were recorded after the tsunami in Aceh. These bacteria produce tetanolysin and tetanospasmin toxins causing signs and symptoms most commonly 5–10 days after injury. Unvaccinated populations are especially at risk for morbidity and mortality.[27,28]

Other unusual bacteria have also been documented in flooding-associated wound infections. One PCR (polymerase chain reaction)-confirmed case of cutaneous melioidosis was reported in a tsunami survivor. The causative agent, *Burkholderia pseudomallei,* is frequently found in rice fields in Southeast Asia and Northern Australia. It enters the human body through skin exposure, aspiration of soiled water, or inhalation of aerosols. Cutaneous melioidosis presents as chronic, debilitating, or recurrent nonhealing nodules, ulcers, or abscesses and is more frequent in children. A small abscess on the right foot was the presentation in the post-tsunami case.[29,30]

Cases of *Vibrio vulnificus and parahaemolyticus* wound infections were observed after hurricanes and tsunamis.[10,24] *Vibrio vulnificus* dwell in warm coastal aquatic environments, and wound exposure after coastal flooding may lead to infection. Immunocompromised individuals or those with chronic liver diseases are particularly susceptible to this bacteria. Infected wounds show increased erythema, edema, pain, and hemorrhagic bullae. Fever, chills, hypotension, and septic shock may also develop.[31,32]

Outbreaks of Buruli ulcer following flooding were seen in Australia, Uganda, and Togo. Buruli ulcer is caused by *Mycobacterium ulcerans*. It is transmitted by direct inoculation via preceding trauma or abrasion, and it has an incubation period of less than 3 months. Preceding flooding or disaster displaced the mycobacteria from their normal habitat into those water bodies. The temperature of 27 °C to 33 °C, low salinity, low pH, stream stagnation, and sufficient nutrients support the survival and expansion of the mycobacteria. Buruli ulcer mostly affects children aged 2–14 years old. It starts as indurated erythema, develops into indolent necrotizing ulcers, and resolves into scar in 4–6 months (Fig. 1a). It can be complicated by deformity, joint contracture, subluxation, disuse atrophy, stunted limb

Table 1 Flood-associated dermatologic conditions

Dermatologic conditions	Effects	Source
Trauma and related wound infection		
Trauma	21.8–38.4%	CDC[20,21]
	3rd most common (29.4%)	Lee *et al.*[18]
	Most frequent: laceration	
	Laceration (20–24%)	CDC[22]
Wound infection		
Bacterial infection		
Polymicrobial	71.8%	Diaz[23]
Gram-negative infection	Aeromonas sp. (22.6%)	Diaz[23]
	Escherichia coli (18.1%)	
	Klebsiella pneumoniae (14.5%)	
	Pseudomonas aeruginosa (12.0%)	
	Proteus sp. (7.3%)	
Gram-positive infection	4.5%	Diaz[23]
	Mostly *Staphylococcus sp*	
Tetanus	106 cases, 20 deaths	Watson *et al.*[27]
Burkholderia pseudomallei (melioidosis)	1 case	Svensson *et al.*[29]
Vibrio vulnificus and *parahaemolyticus*	24 cases, 6 deaths	CDC[A10]
	9 cases	Hiransuthikul *et al.*[24]
Mycobacterium ulcerans (Buruli ulcer)	Outbreaks	Dobos *et al.*[33]
Fungal Infection		
Cladophialophora bantiana	2 cases, coinfection with *M. abscessus*	Petrini *et al.*[36]
Mucormycosis	Isolated cases	Benedict *et al.*[26]
Blastomycosis	Potential problem	CDC[35]
Infections and infestations		
Infection	Most common (32.5%)	Lee *et al.*[18]
Bacterial infection		
Impetigo	2nd most common (16%)	Moreno *et al*[87]
Methicillin-resistant *Staphylococcus aureus* (MRSA)	30 cases	CDC[10]
Leptospira (leptospirosis)	9 cases	Smith *et al.*[38]
	11 cases	Thaipadungpanit *et al.*[39]
Viral infection		
Measles	8–12× increase	Howard *et al.*[19]
	35 cases	Watson *et al.*[27]
Dengue fever	Increased number	Saeed *et al.*[43]
Hepatitis A virus infection	Cluster of cases	Watson *et al.*[27]
	Increased incidence	Gao *et al.*[42]
Fungal infection		
Superficial fungal infection	Most common skin infection Predominantly tinea corporis	Lee *et al.*[18]
	Tinea corporis (10 cases)	CDC[10]
	Tinea pedis	Tempark *et al.*[15]
Protozoal infection		
Malaria	3.6%	CDC[12]
	Increased incidence (OR = 3.67, 95% CI = 1.77–7.61)	Gao *et al.*[42]
	Increase in positively tested individuals by 30%	Boyce *et al.*[44]
Tegumentary leishmaniasis	Increased transmission	Salomon *et al.*[45]
	Above-average number of cases	
Bites and stings		
Black fly bite	Increased density and biting-activity of adult vectors	Zarroug *et al*[48]
Mosquito bite	Increase in number	Gao *et al.*[42]Saeed *et al.*[43]
Fire ants sting	Related	Tempark *et al.*[15]
Hymenoptera sting	Increased	Diaz[A47]
Paederus dermatitis	Outbreak (33 cases)	Claborn *et al.*[52]
Mite bite	97 cases	CDC[10]
Centipede bites	Related	Tempark *et al.*[15]
Dog bite	>700	Bandino *et al.*[14]

Table 1 Continued

Dermatologic conditions	Effects	Source
Snake bite	Baluchistan (61 cases) Punjab (61 cases) Sindh (20 cases)	WHO[53]
Infestations		
Scabies	Leading cause of morbidity (19%)	WHO[53]
Pediculosis capitis	Most frequent (36%)	Moreno *et al*[37]
Hookworm larvae (cutaneous larva migrans)	Increased (58.2%)	Kannathasan *et al.*[55]
Schistoma spindale cercaria (cercarial dermatitis)	Outbreak (58 cases)	Kullavanijaya *et al.*[56]
Inflammatory and other noninfectious conditions		
Eczema	2nd most common: 29.8% Contact dermatitis: 75% (mostly irritant contact dermatitis)	Lee *et al.*[18]
Parthenium dermatitis	Spread of cases	Mitchell *et al.*[58]
Immersion foot	Related	CDC[10]
Psychodermatological conditions		
Acute urticaria	3 cases	Lee *et al.*[18]
Atopic dermatitis	4 cases	Lee *et al.*[18]
Others (alopecia areata, angioedema, vitiligo, psoriasis)	Related	Tempark *et al*[15]

Figure 1 Flood-associated dermatologic conditions: (a) Buruli ulcer, (b) Methicillin-resistant *Staphylococcus aureus* (MRSA) infection

growth, and distal lymphedema. It is rarely associated with fever or weight loss.[33,34]

Continuous climate change may also increase disaster-associated fungal infections.[26] Natural disasters such as tsunami, major floods, and hurricanes disperse pathogenic fungi from their natural habitats. This leads to fungal contamination of the environment and buildings and causes infection of the injured individuals.[26,35] Several fungi were identified in wound infections during the Indian Ocean tsunami, namely *Cladophialophora bantiana, Mucor sp., Apophysomyces elegans,* and *Fusarium sp*. Early stage of these fungal infections can be difficult to differentiate from bacterial infections.[26]

Two cases of *Cladophialophora bantiana* and *Mycobacterium abscessus* coinfection were isolated in two tsunami-related trauma patients. *Cladophialophora bantiana* causes brain abscess or spinal myelitis in immunosuppressed individuals. Soft-tissue infection may result from cutaneous dissemination or rarely from exogenous inoculation by trauma or presence of

foreign bodies. In post-tsunami cases, this infection manifests as blue-red, slow-growing lesions with tiny purulent discharge in the intact, noninjured skin beyond the graft area, without associated fever or lymphadenopathy.[36]

Mucormycosis is usually acquired from exposure to reservoir water and organic matter. The risk for infection rises with penetrating trauma and increasing number of wounds. It may present as necrotizing fasciitis.[26]

Blastomycosis is caused by *Blastomyces dermatitidis*, most commonly found in moist soil along water or streams polluted with decaying vegetation. This infection may be problematic, particularly in endemic areas after floods. Blastomycosis ranges from asymptomatic infection, pneumonia, to disseminated form appearing as cutaneous ulcers with multiple necroses of the skull, vertebrae, or long bones. Direct scraping of pus or skin lesions revealing broad-based thick-walled budding yeast cells supports a presumptive diagnosis. Histopathologic examination or culture is required for diagnosis. Immunodiffusion test revealing a precipitin band with Blastomyces A antigen is highly specific but not sensitive for this condition.[35]

Infections and infestations

Most disasters do not directly cause an increase in infectious diseases. However, they bring about lack of safe water supply, destruction of healthcare services, population displacement, overcrowding, and other disruptions in infection control and sanitation. These conditions along with other factors such as nutritional and immunity status of affected population may result in increased infectious diseases.[19,27]

Bacterial infections

Bacterial infections remain an important cause of morbidity among flood-afflicted individuals. Impetigo was the second most frequent dermatological condition among pediatric patients at a post-flood shelter in Paraguay.[37] A cluster of 30 cases of methicillin-resistant *Staphylococcus aureus* (MRSA) (Fig. 1b) was also found among hurricane evacuees.[10]

Cases and outbreaks of leptospirosis have been reported in Australia, Thailand, India, Taiwan, and other countries, in which an increased number of rodents and their closer contact with humans as a result of flooding were implicated.[27,38,39] Leptospirosis, which is caused by *Leptospira* is transmitted through ingestion of or contact with urine of the infected rodents, pets, or livestock, and urine-contaminated water or soil.[38] Following an incubation period of up to 14 days, fever, chills, headache, myalgia, nausea, vomiting, and abdominal pain appear. Hepatosplenomegaly, edema, hemorrhage, and conjunctival suffusion can be seen. Dermatologic manifestations include jaundice, nonspecific macules, papules, petechiae, and urticaria. One to five centimeter, tender erythematous plaques on the pretibial area abating after 4–7 days is a typical manifestation of Fort Bragg fever caused by *L. interrogans* serovar *autumnalis*. Diagnosis is made by dark-field microscopy, serology, or PCR. Treatment consists of oral amoxicillin or doxycycline, or intravenous penicillin or ceftriaxone.[14]

Viral infection

Measles carries a very high fatality rate among children and may lead to severe complications such as diarrhea, pneumonia, and blindness.[40,41] Increased cases of measles during flooding have been reported in several countries, such as in the Dominican Republic and Indonesia. Increased transmission in overcrowded situations and initial immunization coverage of the populations may be responsible for this.[19,27] Vaccination of infants and children is a vital measure to prevent post-disaster measles outbreak, which was successfully applied during Kosi Floods in Bihar, India.[40,41]

Viral infections associated with contamination of drinking water and food and proliferation of insect breeding sites also showed an increase in incidence with flooding.[27,42] Dengue fever transmitted by *Aedes* mosquitoes displayed an increased number of cases after flooding in India and Pakistan.[1,43] Dengue infection manifests as fever, headache, retroorbital pain, severe bone pain, nausea, and petechial lesions. Other viral infections such as hepatitis A also showed association with flooding and tsunami.[27,42]

Fungal infection

Superficial fungal infection, particularly tinea corporis, was the most prevalent infectious disease observed after a tsunami. It was associated with immersion and humid temperature during and after the disaster.[18] Cases of tinea corporis were also reported among rescuers working in wet environments during hurricanes.[10]

Tinea pedis is another superficial dermatophytosis presenting with pruritic erythematous lesions on the interdigital web spaces or lateral aspects of the feet (Fig. 2a). Likewise, this condition may develop after protracted exposure and immersion of feet in floodwater.[15]

Protozoal infections

Cases of malaria were observed after flooding in China, Uganda and Pakistan.[12,42,44] This post-flooding period is notorious for malaria outbreak because of damaged environmental ecosystem, increased population of mosquitoes, and altered human behavior and living condition. Villages along flooded rivers were more affected because of proximity to the largest breeding sites and greater densities of adult mosquitoes. There may also be delay between the flood and the peak of malaria epidemic because of flushing of existing breeding sites during heavy rainfall and creation of new ones as floodwaters regressed.[44]

Leishmaniasis is caused by *Leishmania* genus and transmitted by phlebotomine sandflies. Tegumentary (cutaneous and mucocutaneous) leishmaniasis was known to be endemic in Las Lomitas, Argentina, and the main risk factor for increased

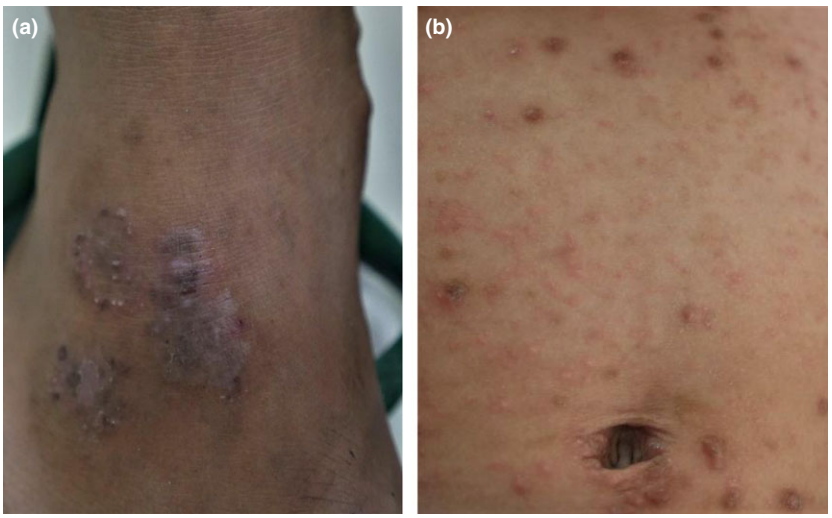

Figure 2 Flood-associated dermatologic conditions: (a) Tinea pedis, (b) Scabies

cases between 1992 and 2001 is fishing or any activity during the flooding period along the Bermejo River. The overflow at a particular fishing point might gather human hosts, reservoirs, and vectors, hence the increased transmission and the above-average number of cases in 2002.[45] Tegumentary leishmaniasis starts as a pruritic erythematous papule or nodule on the bite site, which may heal spontaneously or grow and evolve into ulcers with crusts. Mucosal sites such as oral-nasal and pharyngeal can be affected.[46]

Bites and stings

Insect bites and stings are frequently observed after flooding because of increased breeding of mosquitoes and flies or fleeing of centipedes, ants, and fire ants.[15,27,47] In Sudan, high precipitation and flooding swept away the breeding place and diminished the population of black flies, *Simulium damnosum senso lato*. However, they may add oxygen content and nutrition to the river resulting in an increased population of larvae, maturation, density, and biting activity of adult vectors.[48] Similar effects are also seen on mosquitoes where standing water as a result of river overflow provides new breeding places, allowing an increased population of mosquitoes.[42,43] Bites from mosquitoes and flies carry consequences of insect-borne illnesses such as malaria, dengue, and leishmaniasis.[42,44,46] Insect-borne diseases are rarely the primary concern during the onset of floods. They become significant in the mid-term (1–4 weeks) to long-term (after 4 weeks) phases when receding water turns into new breeding places for vectors.[49]

Fire ants and Hymenoptera stings also increase after flooding. These stings by bees, wasps, and ants may result in anaphylactic reactions and unexpected fatality.[47] They can also be secondarily infected by community-acquired MRSA.[50]

Paederus dermatitis is an irritant contact dermatitis to paederin in the hemolymph of Paederus beetles. This vesicant is released upon brushing or crushing of the beetles. An outbreak of Paederus dermatitis has been reported during high rainfall and flooding in a military unit training in Arizona, USA.[51,52] This condition is characterized by erythema and painful vesicles in linear or "kissing" configuration, frequently on the exposed body parts. Lesions will desquamate within 8–10 days, leaving hypopigmentation or hyperpigmentation which may last for 6–12 months. Prevention involves covering holes on the house, turning off lamps at night, applying insect repellant, blowing off the landing beetles and washing the area with water and soap, and control of beetles swarm. Cold wet compress, topical corticosteroids, and antibiotics, oral analgesics, and antihistamines can be given.[51]

Bite reactions from other arthropods after flooding have also been reported. Mite bites account for 97 dermatological cases after a hurricane.[10] Centipede bites present as painful erythema and edema with two punctate bite marks or more severe Wells syndrome. Systemic reactions include hypotension and respiratory distress because of envenomation, and rhabdomyolysis with renal failure.[15]

Other animal bites are also expected to increase during flooding. Both wild and domestic animals may relocate to higher grounds during flooding and interact with humans to occupy available spaces. Household pets are more common than wild animals as the cause of animal bites. Snake bites and more than 700 dog bites were reported in a Pakistan flood.[14,53]

Infestations

Scabies infestation by *Sarcoptes scabiei* is transmitted via direct skin-to-skin contact and was the leading cause of morbidity in the flooding in Baluchistan, Pakistan.[53,54] Scabies appears as multiple pruritic erythematous papules with excoriations with predilection on the interdigital web spaces of hands and feet, volar wrists, umbilicus, areolae, and genital areas (Fig. 2b). Linear burrows are classic lesions.[14]

Pediculosis capitis was the most common dermatological condition among children at a particular post-flood shelter in Paraguay. The majority of the patients lived together with other children suffering from similar conditions. Most of the dermatologic cases among the pediatric subjects were linked to their stay at the shelter.[37]

Cutaneous larva migrans or creeping eruption is cutaneous infestation by larvae of hookworms *Ancylostoma caninum* and *A. braziliense*. An increase in the prevalence of CLM was observed among devotees performing side roll at Nallur Temple, Sri Lanka. The side roll sites were sprinkled with sands from temple ground. The previous flooding may have carried fecal material with hookworm eggs and facilitated survival and spread of larvae into the sands of the temple grounds. The eruption appears as pruritic serpiginous erythematous lesions over the body part in contact with infested soil or sand, mostly the buttocks, thighs, and feet.[55]

Cercarial dermatitis or swimmer's itch is a hypersensitivity reaction of the skin to the penetrating cercaria of *Schistosoma spindale* and *Trichobilharzia*. An epidemic of swimmer's itch occurred in Thailand among rice farmers. The prior severe and prolonged flooding increased the number of intermediate hosts – Indoplanorbis exustus snails – and the dispersal of Schistosomal eggs in the paddy field, which were eventually responsible for the outbreak. Cercarial dermatitis presents with immediate pruritus after submerging in contaminated water. This is caused by release of histolytic enzyme upon cercarial penetration. Erythematous papules developed 10–15 hours after exposure corresponding to delayed-type hypersensitivity to cercarial proteins in the epidermis and may be excoriated and secondarily infected. Lesions resolved with postinflammatory hyperpigmentation within 1–2 weeks. Blood eosinophilia may be found, and histopathologic examination resembles insect bite. Treatment includes topical corticosteroid, antihistamines, and antibiotics for the secondary bacterial infection.[56,57]

Inflammatory and other noninfectious conditions

Eczema was the second leading dermatological condition found in tsunami survivors in Banda Aceh, Indonesia. The predominant type was irritant contact dermatitis involving the arms and legs. Predisposing factors include exposure to soiled items and detergents and macerated skin from immersion, friction, or humid environments.[18] Prolonged immersion in flood water injured keratinocytes leading to inflammation.[15] Irritant contact dermatitis can be secondarily infected with bacteria or fungi.[15]

Parthenium dermatitis is an allergic contact dermatitis to sesquiterpene lactone called parthenin. Exposure occurred by contact with hairs or with airborne pollen of *Parthenium hysterophorus* weed. Expansion of cases in India occurred after a severe flood scattered seeds vastly beyond Poona area, where the plants first grew. Clinical manifestation resembles photodermatitis. However, it can become generalized into fatal erythrodermic form. It is treatment-resistant, and affected individuals must be relocated away from weed ridden places.[58]

Immersion foot or trench foot cases were reported after a hurricane.[10] It stems from prolonged exposure to wet conditions. It presents as pruritic, painful, tingling, numb, swollen, and cold feet. Upon warming, the feet will became erythematous, tender, and dry. Vesicles and blisters may also develop. Trench foot may be avoided by keeping the feet dry and clean and by wearing a clean and dry sock.[59]

Psychodermatological conditions

Several dermatological disorders can be induced or exacerbated by psychological conditions post disaster, such as alopecia areata, vitiligo, urticaria, angioedema, psoriasis, and atopic dermatitis.[15] Acute urticaria and exacerbated atopic dermatitis were found among survivors of tsunami in Banda Aceh and may be associated with psychological factors post tsunami.[18]

Management

Prevention is an essential part in the management of skin diseases caused by flooding. One should refrain from wading in the water or wear protective clothing and devices such as footwear, gloves, masks or respirators, and eye protectors which are critical to prevent injury and minimize exposure to contaminated environments.[16] Center for Disease Control has listed recommendations on personal protective equipment (PPE) selection based on hazard types.[25]

Infectious diseases are rarely a direct result of flooding but are due to secondary effects such as contaminated water supply, population overcrowding and disruption of vector controls. Rapid provision of clean water and sanitation facilities, prompt vector controls, and proper assignment of the victim to avoid overcrowded shelters are important. These methods have been successful in achieving absence or low number of infectious diseases following flooding in the United States.[19] Measles and tetanus vaccination is beneficial in the acute phase of a disaster.[19] Avoiding outdoor exposure at dusk and dawn, wearing protective clothing, and application of insect repellant and nets are examples of strategies to limit arthropod-borne infections.[15] Furthermore, education of healthcare workers and the public about disease risk and prevention after flooding would also benefit.

Questions (answers provided after references)

(1) Which dermatological conditions are noted to increase after flooding?

a Infectious dermatological conditions
b Noninfectious dermatological conditions
c All of the above
d None of the above.

(2) In which phase of a disaster is the incidence of vector-borne diseases increased?

a Impact phase
b Post-impact phase
c Recovery phase
d All of the above

(3) The impact phase of the disaster ranges from:

a Day 0 to day 3
b Day 0 to day 4
c Day 0 to day 7
d Day 0 to day 14

(4) The leading cause of post-tsunami wound infections are:

a Gram-positive bacteria
b Gram-negative bacteria
c *Mycobacteria*
d Deep fungal infections

(5) The most frequent infectious disease observed after a tsunami:

a Superficial fungal infections
b Measles
c Impetigo
d Malaria

(6) A typical manifestation of Fort Bragg fever is:

a Jaundice
b Petechiae
c Urticaria
d Tender erythematous plaques on pretibial area

(7) Paederus dermatitis is characterized by the following feature:

a It is caused by bite of *Paederus* beetles
b It presents as urticarial papules on the exposed body parts
c Lesions will desquamate within 3 days
d Hypopigmentation and hyperpigmentation may last for 6 to 12 months

(8) Swimmer's itch is a hypersensitivity reaction of the skin caused by:

a Cercaria of *Schistosoma spindale* and *Trichobilharzia*
b Jellyfish
c Larva of *Ancylostoma caninum* and *A. braziliense*
d *Sarcoptes scabiei*

(9) Clinical presentation of Parthenium dermatitis resembles:

a Photodermatitis
b Acute urticaria
c Tinea manuum et pedis
d Atopic dermatitis

(10) The etiologic agent of Buruli ulcer:

a *Cladophialophora bantiana*
b *Mycobacterium ulcerans*
c *Burkholderia pseudomallei*
d *Vibrio vulnificus*

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Answers

1, c; 2, c; 3, b; 4, b; 5, a; 6, d; 7, d; 8, a; 9, a; 10, b

