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Direct Possessions of Insect Arthropods on Humans Owing to Allergen, Bloodsucking, Biting, Envenomation and Stinging Side By Side Case Diagnosis and Treating

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Abstract

The purpose of this paper is to present the readers with a basic yet sound understanding of the dangerous types of insect invertebrates that may be encountered during daily life operations worldwide. The class Insecta belongs to the superclass Hexapoda (six-legged arthropods) of the phylum Arthropoda (joint-legged animals). This huge biodiversity is a natural treasure to humans as many species are important natural enemies of pests, pollinators and provide useful compounds (honey, silk and lac). However, some insects have negative impacts on human's health because they are vectors of diseases that affect millions of peoples globally. In addition, insects can cause allergic or adverse reactions in humans. The adverse actions have been noted in the subsequent insect orders, Thysanura (silverfish), Dictyoptera (cockroaches), Phasmatodea (stick insects), Orthoptera (locusts, crickets), Siphunculata (lice), Hemiptera (true bugs, cicadas), Coleoptera (beetles), Diptera (flies, mosquitoes), Siphonaptera (fleas), Lepidoptera (butterflies, moths) and Hymenoptera (bees, wasps, ants). There are several types of potentially negative interactions associated with invertebrates including physical pain, disease, envenomation, myiasis, allergic reactions, psychological disorders and occasionally death. The cause of allergic reactions may be due to the bites of lice, fleas and bedbugs, or by way of the stings of bees or wasps. Symptoms of allergic reactions along with other possessions include itching, hives, swelling, vomiting, diarrhoea and shock. The diagnosis and treatment of allergic reactions are dependent on species of insects and diseases involved. But sometimes an insect bite or sting causes generalized reaction symptoms of which are often mild, or in other cases symptoms are more severe, such as difficulty in breathing or a sudden drop in blood pressure, and this potentially life-threatening reaction is known as anaphylaxis. Other signs of anaphylaxis include noisy breathing, swelling of tongue or throat, persistent cough or wheeze, difficulty in talking or hoarse voice, dizziness or collapse, pale and floppy, which is a case of medical emergency. First aid for bites and stings should include bandaging the wound and keeping the person immobile until medical help arrives. Emergency service might be called and apply cardiopulmonary resuscitation if a person collapses or stops breathing. Use insect repellents, particularly repellents can be applied to clothing, shoes, tents, mosquito nets and other stuffs to enhance protection. Currently, primary prevention by avoidance of stings and bites, and adequate instruction of sensitized individuals in the use of emergency drugs are mandatory.

Keywords

Allergen, Antigen, Hematophagous, Venom, Sting, Bite

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1. Introduction

In addition to disease transmissions, insect arthropods can cause direct injuries to man. The bites, stings and allergic reactions are three major categories of injuries caused by arthropods. The problems of arthropod's injury and the exaggerated fear of arthropods can even result in psychiatric problems. There are very few types of insects that carry venom or poison, and there is none whose venom is extremely dangerous. However, it is possible by an insect bite or sting to cause an allergic reaction that can range from a mild local reaction to something like a severe asthma attack. In extreme allergic reactions, the airways of victim can close up and somebody can even stop breathing (Sarwar et al., 2014; Sarwar, 2015 a; 2015 b; 2015 c). Some insects having negative impacts on human's health are given under:-

2. Biting Insects

Biting and bloodsucking insects are flies (black flies, sand flies, deer flies and horse flies), mosquitoes, bedbugs and fleas. Actually, none of them are essentially severe poisonous, but some have saliva that can irritate or provoke a reaction, and others can introduce infections when they bite. Black flies, for example, leave bites around the head, neck and ears, while fleas often bite repeatedly around the feet and lower legs. Bedbugs tend to leave lines of bites, usually on the torso. While their bites can be extremely itchy, these insects do not cause serious diseases or reactions except mosquitoes. Arthropods bite to feed, probe (taste), or defend themselves. Most penetrations of human skin are made by mouthparts that are developed for ingesting blood, tissue and tissue fluids of animals or plants. These bites usually result in the arthropod injecting salivary fluids or regurgitating its digestive tract products into the man or animal. Some biting arthropods can also produce skin injuries. Each individual's reaction to arthropod bites can be very different (Golden, 2003).

Most of the encounters with biting and stinging insects result in more or less pronounced localized reactions. Typically, urticarial wheals and papular reactions are observed. Less often local bullous or hemorrhagic or disseminated papular reactions, particularly in children and immunologically naive adults, may be seen. With the exception of bee and wasp venom allergies, immediate-type allergic reactions to arthropod stings and bites are rare. Systemic IgE-mediated hypersensitivity has also been reported from additional hymenoptera species e.g., hornets, bumble bees and ants. Rare are systemic reactions to mosquitoes, flies or kissing bugs and exceptional from ticks, bed bugs, moths, caterpillars and spiders. A major problem is the often lacking standardization of extracts for skin testing and for the determination of specific IgE. Some of the allergens have been characterized and few of them synthesized using recombinant techniques. Most investigations have been made with whole-body extracts or extracts from salivary glands, while desensitization has rarely been attempted (Bircher, 2005). Biting arthropods are grouped according to the duration of host contact as short-term or prolonged (long-term) (Sarwar, 2014 a; 2014 b; 2014 c; 2014 d; Sarwar et al., 2015).

2.1. Short-Term Host Contact

Most arthropods that bite man have only short-term host contact. Bloodsucking arthropods are frequently winged or highly mobile. This accounts for their ability to quickly attack and escape capture or detection. Some arthropods hide in structures close to the host and only feed when the host is nearby. Others that bite may not have intended to attack, but did so in defense or by mistake. Arthropods can bite in several stages of their development; that is adult, larvae, or nymph stages. Their mouthparts are generally classified into chewing or sucking types. Chewing mouthparts are generally not used for skin penetration. Usually, injuries of this type are not reported, but secondary infections may occur due to bacterial contamination. Sucking mouthparts are structured for skin penetration.

2.1.1. Bloodsucking (Hematophagous) Insects

Blood, normally from warm blooded animals (including man), is used both for life suppor, growth and egg development of arthropods. The mouthparts of sucking arthropods vary greatly in structure from arthropod to arthropod. For example, adults of the order Diptera (two-winged insects) have the most diverse mouthparts. Only the females of the mosquitoes, black flies, biting midges, horseflies and deer flies are bloodsuckers, while both males and females of tsetse flies and stable flies are bloodsuckers. The mouthparts are different within each of these families of Diptera, but the goal of a blood meal is the same. Other examples of arthropods that are short-term are fleas, true bugs (conenose bugs and bedbugs) and soft ticks.

2.1.2. Non-bloodsucking (Non-hematophagous) Insects

Some plant-feeding arthropods and some arthropod predators have piercing or sucking mouthparts, which are capable of penetrating the human skin. Bites from these arthropods can be as painful as bloodsuckers, if not more so. Bites from these arthropods are usually an act of defense.

2.2. Long-Term Host Contact

Some biting arthropods require a considerable time on the host to complete a normal life cycle. Since a continuous food supply is available on one host, the search for another host is reduced. Most of these arthropods are categorized as parasites. They are classified as either ecto-parasites or endo-parasites. Ecto-parasites (those living outside the host body) may be flat (fleas) or thin (lice) which allows them to travel easily through a hairy environment. Their feet are specialized for holding on to hair. The mouthparts of ticks and mites are designed to anchor their bodies to the host. Endo-parasites (those living inside the host body) are usually soft-bodied (fly larvae, mites) without legs or with very short legs; their bodies usually have specially arranged spines or hairs.

3. Stinging Insects

Some arthropods affect man by injecting venom (insect toxins) through stingers, fangs, modified front legs, or spines. An arthropod, injection of poison is in defense or to kill prey. Usually, man is envenomed by arthropods in defense of themselves and their nest or eggs. Stinging insects are primarily honeybees and bumblebees, wasps (yellow jackets) and hornets, and fire ants. All three have different kinds of venom, but none is likely to be dangerous in small doses unless someone is allergic to the poison. The insect responsible for the largest number of severe allergic reactions is the yellow jacket wasp. Considering both multiple stings and allergic reactions to single sting, insects actually harm or even kill to host in rare cases (Cho et al., 2002; Greenen, 2005; Potter, 2005).

4. Allergy Insects

Allergic reactions are caused by both the bites and stings of arthropods. Additionally, arthropod parts (live or dead) and their body fluids can cause allergic reactions. Allergic reactions are extremely variable in different peoples ranging from very mild to severe reactions. Highly sensitive persons should be prepared to deal with their problems in case they are bitten, stung, or exposed to other arthropod allergens (McDermott et al., 2000; Arruda and Chapman, 2001; Arlian, 2002; Auerswald and Lopata, 2005; Jeebhay et al., 2005).

Horsefly bite can cause allergic reactions in humans; there have been identified two new allergens from the salivary glands of the horsefly, *Tabanus yao* as an antigen 5-related (Ag 5) protein and hyaluronidase, respectively. ELISA inhibitions of serum IgE reactivity to the horsefly salivary gland extract (SGE) using purified Tab a 1 and Tab a 2 are significant (about 45%). In addition, these proteins showed some IgE-binding capacity to sera of subjects with wasp sting allergy. They appear to be of importance for the allergic reactions induced by horsefly bite. These allergens are thus not only found in stinging but also found in hematophagous insects. These results also provide support for the presence of the so-called wasp-horsefly syndrome (Ma et al., 2011).

A major allergic reaction that interferes with breathing is called anaphylaxis or anaphylactic shock. Histamine, a chemical released by the body during most allergic reactions, is released into the skin after any insect bite and is responsible for the redness and itching. In anaphylaxis, histamine causes major itching and redness of the skin (hives), and may also be released in the airways, lungs, and other vital organs. It causes tissue to swell, can close the airways (causing breathing to stop), and can drop blood pressure to dangerously low levels. Anaphylaxis can occur after a single bite, but this is rare, and more typically fatal anaphylaxis occurs when somebody gets stung many times (50 to 100), still nowhere near enough times to kill a non-allergic person. A sharp pain is followed by a burning sensation that soon resolves into a major itch. A red ring or bump appears at the site of the sting. The important thing to remember is that bees' stingers are barbed and usually remain in the skin. In its haste to get away, the bee literally tears the stinger and the attached poison sac out of its abdomen, killing itself in the process. Wasps and hornets lack barbs on their stingers and can attack again and again (Klotz et al., 2009 a; 2009 b).

5. Envenomation Insects

Envenomation (injury from venoms produced by insects and other animals) is a common public health hazard. Globally, millions of peoples in various states are stung by venomous arthropods each year. About thousands of these envenomations result in severe injury, and about few of them result in deaths from bees, spiders, wasps, yellow jackets, hornets and scorpions, and about from ants. This mortality contrasts markedly to the usual deaths per year that are caused by venomous snakes. Probably many deaths that are caused by venomous animals are never reported as so caused (Service, 2012). Venoms that are produced by arthropods are mixtures of four toxin types:-

5.1. Vesicating Toxins

The vesicating toxins produce blisters on the body of victim resulting in common public health hazard.

5.2. Neurotoxins

These toxins attack the central nervous system (and which may cause death through respiratory paralysis).

5.3. Cytolytic Toxins

That destroy tissue of victim and there are few types of potential negative interactions associated with these toxins.

5.4. Haemorrhagic Toxins

Those prevent the blood's normal clotting of the victim and can cause allergic or adverse reactions in humans.

The diagnosis and identification of venom reactions are dependent on the species of insects and the diseases involved. The venom of blister beetles is strongly vesicating and that of black widow spiders is strongly neurotoxic. The venom of brown spiders is strongly haemolytic and that of horse flies is strongly haemorrhagic. The toxicity of venom varies with several factors, geographic source, the seasons of the year, the individual arthropod and the individual human being. All envenomations should be treated by a physician under particular care (Cloudsley-Thompson, 1995).

Members of several groups of arthropods can inject venom when they bite or sting. Most notable are bees, wasps, ants, spiders and scorpions. Others, such as blister beetles and certain caterpillars, produce toxins that can cause problems when they are touched or ingested. In general, envenomation results in medical or veterinary conditions ranging from mild itch to intense debilitating pain or even to life-threatening encounters due to allergic reactions. Envenomation sites on the skin usually appear as reddened, painful, more or less circular lesions surrounding the bite, sting, or point of venom contact. These areas may become raised and can persist for several days, often causing inflammation of adjacent tissues. Caterpillars that cause envenomation typically secrete toxins from specialized setae so that a relatively wide spectrum of allergic reactions can occur in humans or animals exposed to certain arthropods. Many of the species involved also cause envenomation by biting or stinging, with the allergic reaction resulting from an over responsive host immune system. Bites or stings from arthropods such as lice, bedbugs, fleas, bees, ants, wasps, mosquitoes and chiggers all can result in allergic host reactions. Contact allergies can occur when certain beetles or caterpillars touch the skin. Respiratory allergies can result from inhaling allergenic air-borne particles from cockroaches, fleas, or other arthropods. The recirculation of air by modern air-handling systems in buildings tends to exacerbate inhalation of insect allergens (Burns, 1987; Bircher, 2005).

Humans and animals usually react to repeated exposure to bites or stings from the same or antigenically related arthropods in two possible ways, depending on the nature of the antigen or venom inoculated and the sensitivity of the host, 1) desensitization to the bites or stings with repeated exposure and 2) allergic reactions which, in extreme cases, can develop into life-threatening anaphylactic shock. However, a distinct five-stage sequence of reactions typically occurs in most humans when they are repeatedly bitten or stung by the same, or related, species of arthropod over time. Stage-1 involves no skin reaction, but leads to development of hypersensitivity. Stage-2 is a delayed-hypersensitivity reaction. Stage-3 is an immediate sensitivity reaction followed by a delayed hypersensitivity reaction. Stage-4 is immediate reaction only, whereas Stage-5 again involves no reaction (i.e., the victim becomes desensitized). These changes reflect the changing host immune response to prolonged and frequent exposure to the same arthropod or to cross-reactive allergens or venoms (King and Spangfort, 2000).

6. Invasion of Host Tissues

Some insects invade the body tissues of their host, and various degrees of invasion occur, ranging from subcutaneous infestations to invasion of organs such as the lungs and intestine. Invasion of tissues allows arthropods to exploit different host niches and usually involves the immature stages of parasitic arthropods. The invasion of host tissues by fly larvae called myiasis, is the most widespread form of host invasion by arthropods. Larvae of many myiasis causing flies move extensively through the host tissues. As they mature, they select characteristic host sites (e.g., stomach, throat, nasal passages, or various subdermal sites) in which to complete the parasitic phase of their development. Certain mites also invade the slid or associated hair follicles and dermal glands. Others infest nasal passages, lungs and air sacs or stomach, intestines, and other parts of the alimentary tract of their hosts. Examples include scabies mites, follicle mites, nasal mites, lung mites, and a variety of other mites that infest both domestic and wild birds, and mammals (Burns, 1987; Cloudsley-Thompson, 1995).

7. Diagnosing of Insect Bites and Stings

The consultant might perform a physical examination to look for effects of the bite or sting on various parts of the body of victim. If anybody can safely provide an example of what bit or stung, it can be very helpful to the medical care giver to determine both diagnosis and treatment. Normally, tests are not required to diagnose bee stings and insect bites. Diagnostic tests are only likely to be of use if someone finds a mite or tick on their skin and wants to know if it is carrying anything dangerous. Another diagnostic test that might be valuable is an insect venom allergy test. This involves scratching the skin with tiny doses of various insect venoms and looking for the size of the hive that results to measure the

allergic reaction to the individual insect venom. The diagnosis of a reaction to a bite or sting is usually obvious from the victim's history. Examination of the skin, respiratory system, cardiovascular system, and oral cavity are particularly important to determine both diagnosis and treatments. For identifying the disease that is transmitted by biting or stinging bugs or insects, blood tests are usually required and once the definitive diagnosis is made, specific treatments then can be started (Potter, 2005; Goddard, 2012).

8. Treating and Preventing Insect Bites and Stings

If the stinger has been left in the skin, it should be removed as soon as possible. The most often suggested method of removing stingers is to scrape the skin with a thin, dull edge, such as the edge of a credit card or a thin dull table knife. Using tweezers to remove bee stingers may result in more venom being introduced into the wound due to unintentionally squeezing the poison sac. Some specialists say that since the poison sac of a bee sting is still attached after the bee is gone, so care should be taken not to squeeze it as this can force the remaining poison into the wound. Others maintain that it does not matter how it is removed. Either way can be used, but it should be removed as quickly as possible to minimize the poison dose and the risk of infection (Mullen. and Durden, 2002; Eldridge and Edman, 2004; Goddard, 2012).

8.1. Wash the Affected Area

For bites and stings from insects, wash the affected area with soap and water, and applying an icepack to prevent the venom from spreading and applying a paste of baking soda and water may also help to relieve welt formation. With most bites and stings, the best treatment is to wait for the itching to go away. Ice cubes, acetylsalicylic acid, antihistamines and calamine lotion can help in better for treatment. If victim is at risk of a major anaphylactic reaction (anyone who has a severe allergic reaction in the past is at risk), some Physicians recommend carrying a syringe filled with epinephrine. This naturally occurring hormone will open breathing tubes closed by anaphylaxis. Peoples who are allergic to insect stings may also undergo desensitization. This is only useful for peoples who have tested positive in the skin-scratch allergy test. By being exposed to small and harmless amounts of venom on a regular basis for a few years, the body's response to the venom is changed, hopefully lowering the risk of anaphylaxis from future stings to almost nothing.

8.2. Changing in Patterns of Activities

Public can minimize exposure to insect bites and stings by changing in patterns of activity or behavior. There should have a professional exterminator or hive keeper, to remove or destroy nest or hives of biting or stinging insects or bugs and do not attempt such actions by personally. Some vector mosquitoes are most active in twilight periods at dawn and dusk or in the evening, so avoid outdoor activity during these periods. To avoid insects and insect bites, do not wear brightly-colored clothing or strong, flowery perfumes. Do not carry overripe fruit or walk through clover fields. Peoples with allergies to stings should wear identification bracelets. Applying insect repellents may also be useful to avoid insect bites. Wear long-sleeve shirts, long pants, socks and hats to minimize the areas of exposed skin, and shirts should be tucked in for body protection. Permethrin-containing repellents are recommended for use on clothing, shoes, bed nets and camping gear. Permethrin is highly effective as an insecticide or acaricide and as a repellent. Permethrin-treated clothing repels and kills mosquitoes and other arthropods and retains this effect after repeated laundering. Such treated clothing is thought to pose little danger for poisoning to humans wearing it. Repellents containing N, N-diethylmetatoluamide as an active ingredient are recommended by most authorities or researchers. Follow the directions on the bottle or spray container to avoid toxicity to children and adults.

8.3. First Aid

The first aid for bites and stings from land creatures can depend on what type of creature it is. In case of bee sting, remove the sting by sliding or scraping finger nail across it, rather than pulling at it. Wash the area and apply ice to reduce the swelling or soothe the pain with icepacks or iced water. If the person has an allergy to bee stings, they can fall into a life-threatening state of anaphylactic shock. The only treatment is an injection of adrenaline or antivenomous that is necessarily required. Immobilize the person, apply pressure to the bite and seek immediate medical help. Under certain conditions bandage the wound firmly with a pressure immobilization bandage. Use a second bandage to wrap the arm or leg and splint the affected limb.

8.4. Treatment for Serious Reactions

Treatment for serious reactions to stings or bites should be done in the emergency department. Treatment may begin with epinephrine (subcutaneous), diphenhydramine (Benadryl) and steroids (drugs in the cortisone family) are also usually given intra- veinal. Oral antibiotics may be given for infected bite wounds. For seriously ill peoples, an intra-venial might be started, oxygen given, and a heart monitor be used until the symptoms have improved with medications. For those bites and stings that lead to transmission of

pathogenic organisms, the next step is to see health care professionals to obtain a definitive diagnosis so appropriate treatments may be done. The treatments for diseases that are transmitted are designed for each disease; the reader should go to health care for diagnosing of disease, for example, dengue, malaria, yellow fever, tularemia, plague, typhus and many others for specific treatment plans.

9. Treatment of Anaphylaxis

Physicians treating allergies can offer their patients three options, 1) medications, 2) immunotherapy, and 3) avoidance of the allergen (Fireman, 1999; Klotz et al, 2009 a; 2009 b; Sarwar et al., 2015; Sarwar, 2015 d; 2015 e; 2015 f).

9.1. Medications

Given the speed of an allergic reaction to a bite or sting, immediate medical attention is critical. Epinephrine and antihistamines may be life-saving when administered early during an anaphylactic reaction. A prescription from a physician for self-injected epinephrine is advisable for sensitized individuals who are at risk of life-threatening reactions. They should carry and know how to administer a preloaded syringe containing two doses; the second dose may be needed in some severe reactions. The antihistamines act by binding to the receptor sites on target cells, thereby blocking the effects of histamine. Epinephrine has multiple anti-inflammatory effects. Methylprednisolone, a corticosteroid with broad anti-inflammatory properties, is often administered and is long-acting, but it requires hours before reaching to maximum effectiveness. Its short-term benefit is questionable.

9.2. Immunotherapy

For the more common causes of insect sting allergy (yellow jackets, honey bees and imported fire ants), immunotherapy is available and involves repeated injections of increasing doses of the venom extract, or in the case of imported fire ants, whole body extract. Possible mechanisms for the beneficial effects of immunotherapy include activation of lymphocytes to produce IgG blocking antibodies, which have a high affinity for the allergen and can prevent it from binding to mast cells, and production of suppressor T lymphocytes, which suppress IgE production of B lymphocytes. Unfortunately, for less common causes of allergic reactions to bites and stings, commercial extracts for immunotherapy are not available. Nevertheless, some allergists have developed immunotherapy for these so-called ‘orphan insects’. These are not generally available and involve only a small segment of the population, usually only their own patients.

9.3. Avoidance of Allergen

Correct identification of the offending arthropod is critical for understanding its biology, which may provide useful information in preventing future accidental contacts. It is often helpful to the healthcare provider to contact an entomologist or pest management professional for help in identification and elimination or avoidance of the offending arthropod insects.

10. Conclusion

A human’s first line of defense against invasion or external stimuli is the body skin. It may react in a variety of ways against all kinds of stimuli, physical or chemical, including arthropods and their emanations. Skin lesions may result from arthropod exposure, although not all lesions have the same pathological origin, some are due to mechanical trauma, some due to infectious disease processes and some result from sensitization processes. Physicians and other health care providers are frequently confronted with patients having skin lesions attributed to a mysterious arthropod bite. Diagnosis is difficult, but may be aided by asking to the patient some numerous questions about the event and any recent activity which might has led to arthropod exposure. Physician can questions like, do victim see the offending arthropod, is it worm-like, does it fly, where is victim when these lesions occurred, which might provide useful information for diagnosis. Most treatments (except in cases of infectious diseases) involve counteracting immune responses to venoms, salivary secretions, or body parts using various combinations of antihistamines and corticosteroids. Infectious diseases may require aggressive antibiotic or supportive care. With ever-increasing urban development and sprawl into natural habitats, there is a growing problem of bites and stings by a variety of arthropods with the potential to induce allergic reactions. It is important that the causative agents be identified and reported to state or local poison control centers so that a record is maintained. Physicians, entomologists, pest management professionals and the general public need to be made aware of these potential problems to facilitate rapid treatment of such emergency condition to potentially saving lives.

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