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Review Article

Considerations on Bat-related Allergy in Humans -

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ABSTRACT

Historically, bats had been incriminated of transmitting a number of serious diseases to man. In spite of the huge number of published work on the role of bats in the epidemiology of these diseases, meager information has thus far been published regarding the role of bats in causing allergy in humans. In the present article we throw some light on the possible role of bats in causing allergy in humans.

Keywords: Bat-related allergy; Bats; Bat allergens

INTRODUCTION

Some information about bats would be of interest before discussing their role in the allergy that they cause in humans. Such information includes their nature, global existence, classification, habitat, their roosts, feeding behavior and any property that can aid in understanding their role in causing allergy in humans. One of the most important information about bats, regarding the present study, is their proximity to humans. In this concept, it is of great interest to know their habitat-and-roosts and their feeding behavior [1].

Bats are flying mammals of the order Chiroptera; with two suborders; *Megachiroptera* (megabats) and *Microchiroptera* (microbats/echolocating bats). Bats constitute the second largest order (24%) in the mammalian kingdom, with 1400 species [2]. The flying foxes (*Acerodon jubatus*) are the largest bats; with a wingspan of 1.7 meters and weighing 1.6 kg. The smallest bat is 150 mm across the wings [3,4].

Bats can be found in almost every type of habitat and almost all parts of the world (internationally ubiquitous), except the poles. They prefer warm weather. In winter, bats either hibernate or migrate to warmer areas. Bats live in different ecological and social conditions. Some bats live in colonies; others live solitary [5-7].

The feeding behavior of bats can enable their allergens to have access to humans. According to their feeding behavior, bats are classified into: Vampire bats, Insectivorous bats, Fruit-eater bats and bats of prey.

BLOOD SUCKING BATS (VAMPIRE BATS)

These bats feed, solely, on blood. They are found in Central and South America [8,9]. The feeding behavior of Vampire bats varies to their species. For instance, the common vampire bat (*Desmodus Spp.*) is not fastidious and will attack any warm-blooded animal (including humans).

THE FRUIT-EATING BATS (FLYING FOXES)

They feed on fruits, flowers & pollen. They are classified under the suborder Megachiroptera, family Pteropodidae [10], genus *Pterous*. They are the largest bats in the world. The geographical distribution and movement of members of the family Pteropodidae range from Africa, the eastern Mediterranean, Madagascar and the Indian Ocean islands in the west, across mainland southern Asia, throughout the islands of the west Pacific from the Ryukyu Archipelago and Ogasawara-shato in the north, to coastal eastern Australia, new Caledonia and the Loyalty Islands in the South, and East to Fiji, Tonga, Samoa and the Cook Islands. Many species are restricted to islands, while a number of them are widespread. Fruit bats are known to travel over considerable distances [11,12].

INSECT-EATER BATS (INSECTIVORES)

Insectivorous bats predominantly belong to the microbats' group. As their name implies, they are predators, prying on insects such as flies, mosquitoes, beetles, moth, grasshoppers, termites, bees, wasps etc. [1]. Of these insectivorous bats are the Mexican free-tailed bats, (*Tadarida brasiliensis*), the little brown bat (*Myotis lucifugus*), the brown long-eared bat (*Plecotus auritus*) and many horseshoe bat species.

BATS FEEDING ON SMALL VERTEBRATES (PREDATORS)

These bats feed on birds, lizards, frogs, small mammals and fish. The bat (*Nyctalus lasiopterus*) uses its large teeth to catch birds. Those bats take their preys to their roosts and consume them. These roosts may be in human lodges. From our personal experience [13], we saw feather and remains of birds in roosts of bats in air-coolers in human lodges.

CONTACTS BETWEEN HUMANS AND BATS IN NATURE

Understanding the nature of contacts between humans and bats under natural conditions, is worthwhile. Indeed, this will help in understanding the exact interactions that may lead to allergic conditions in humans. Contacts between humans and bats can be direct or indirect. Bats rarely come in direct contact with humans, though they may roost nearby human lodges. Direct contact can only happen when vampire bats do not find cattle to suck blood, then humans can be their target for blood sucking. However, there are certain conditions that can aid in indirect contacts between bats and humans; exposing humans to their allergens. These conditions have been summarized by Abuelzein E [1] as follows:

- Humans can be exposed to bat allergens, when they change the ecological conditions, where bats used to roost, such as by removing agricultural range and expand to build their lodges, then bats can come closer to these human lodges.
- Bats as wild animals, can react, defensively, against any handling by humans. The reaction can be serious biting or scratching, exposing the human to the bat's allergens.
- Humans can be exposed to bat's allergens when the fruit bats partially feed on fruits, contaminated with their saliva.
- One of the most important contact between bats and humans is when researchers go to caves, to collect some research samples from bats or their roosts. Those researchers, can be exposed to bat's allergens through their inhalation from the atmosphere of these caves, or direct contact with bats.

- Laboratory workers handling bats can be exposed to bat's allergens.
- Since early days, bats have been hunted in some parts of the world, for reasons including food, perceived medical value, for hide or teeth, or for sport.
- Historically, bats have been consumed for their meat in several regions, including Oceania, Australia, Southeast Asia, China, and West- and- Central Africa.
- The ability of some bats (e.g. the *Microchiroptera*) to echolocate to produce laryngeal vocalization for navigation purposes; may cause production of aerosols with allergens from the naso-pharyngeal mucosa and saliva. Indeed this behavior will enhance transmission of the allergens to humans [14].

THE BAT ALLERGENS

Very scanty data is available in the literature regarding bats'-related allergens. However, in small laboratory animals (e.g. rats, mice, Guinea pigs, mice, rabbits hamsters etc...), it was reported that 20-30% of individuals working with them will develop allergic reactions to their allergens. The allergens may be present in the animal's hair, skin, urine, saliva, serum, droppings and contaminated feed or bedding material [15].

In a study by EL-Ansary EH, et al. [15], who investigated seven atopic patients with bat-related case-histories, found that extracts of both yellow hairy bat, black bat, and bat's guano were allergens that had positive skin prick test and Radioallergosorbent specific IgE antibodies Test (RAST) in the patients. All seven patients had positive skin prick test and RAST for specific IgE antibodies, to bat droppings (guano). Three patients had a positive RAST to both black and yellow bats and one patient to yellow bat. They concluded that bat's guano, are probably the major allergen source in bat-related respiratory allergy.

Bat's guano is always mixed with urine, in a dry form, accumulating underneath the bat's roosts. This accumulated material can crumble easily creating dust which can be inhaled by individuals, causing allergic reactions.

EXPECTED CLINICAL FEATURES OF BAT-RELATED ALLERGY

When handling a suspected case of allergy at a specific locality, where bat population is remarkably dense, then bat-related allergy is to be considered. Also it is particularly important to learn whether individuals suffering from allergy, in the locality, suspect that bats are probably the cause of their allergy? This was the situation in Al-Ansari EH, et al [15], who found that bat allergens were the causative agents of allergy in the patients who were living in close contact with bats. In such a case, thorough investigation has to be carried out. This includes identification of the bat species available in the area and the proximity of their roosts to the human lodges and their guano.

The clinical features caused by bat-related allergy, in humans, are not expected to be that different from other allergy conditions caused by other allergens from other sources. Exposure of individuals to bat allergens, may involve the cutaneous, respiratory, cardiovascular,

and the gastrointestinal systems. Flushing and pruritis are usually the initial signs. Exposure to the ocular systems leads to conjunctival injection, tearing, eye itching. It is not excluded that exposure to bat allergens may cause severe and sudden allergic reaction (anaphylaxis).

If the Cardiovascular system is involved manifestations of dizziness, palpitation and chest pain may be observed.

Involvement of the gastrointestinal tract leads to dysphagia, nausea, vomiting, cramps, bloating and diarrhea.

In published data related to bat-related allergy [15], no neurologic involvement in the patients was reported. However, in case of neurologic symptoms, these may be manifested by headache, dizziness and blurred vision.

TREATMENT OF BAT-RELATED ALLERGY

Treatment of bat-related allergy is not that different from treatment of other allergic conditions. The general concept of allergy treatment can be followed:

- To identify, remove and avoid contact with the bats' allergens.
- By medications: This will reduce the symptoms and prevent allergic reactions. The initial strategy of treatment of suspected bat-related allergy, is the immediate care for any case of anaphylaxis. This requires admission at hospital for observations and managing airway passages, giving high-flow oxygen, support blood pressure with intravenous fluids and immediate adrenaline/antihistamine/hydrocortisone.

Generally speaking, a number of various drugs are used for medication of allergic conditions, these include systemic and/or topical prescriptions such as: antihistamines, mast cell stabilizers, corticosteroids, monoclonal antibodies and immunotherapy (desensitization).

Acute allergy can be relieved by prescribing antihistamines; which reduce symptoms by competitively and reversibly block histamine receptors for a short time.

The use of Mast cell stabilizers can decrease degranulation of mast cells, which prevent release of histamine and other chemotactic factors that are present in the preformed and newly formed state.

When allergy takes a chronic form, then Corticosteroids remain among the most potent pharmacologic agents used in its treatment. They block both cyclooxygenase and lipoxygenase pathways to prevent the formation of arachidonic acid, thus act as anti-inflammatory and immunosuppressants. Corticosteroids do have limitations so, they should be used under supervision.

In cases of atopic and asthmatic patients, monoclonal antibodies (MABs), e.g. omalizumab can be used. They are highly specific for the IgE receptors, thus blocking binding of high serum levels of IgE in those individuals.

Treatment can also be achieved through Immunotherapy [16]: Immunotherapy (desensitization) is a mainstay in the systemic management of allergies. The sequential gradual exposure to allergen switches the CD4+ T-cell response from Th2 to Th1, reducing IgE production and the levels of pro- allergic cytokines IL4 and IL5. This



treatment, is usually given over a period of time as needed, and has to be carried out in hospitals with emergency facilities. Highly purified bat allergens can be used via injections or sublingual routes. Pre-treatment with antihistamine reduces risk of local reaction.

For safety purposes, patients who have had severe reactions should be trained to self-administer adrenaline using a self-injection aid and should carry a Medical –Alert bracelet. Carrying a supply of antihistamines may also be helpful.

LABORATORY DIAGNOSIS

When handling a suspected case of allergy in a patient, at a specific locality, where bat population is remarkably dense, then bat-related allergy is to be considered. In such a case, thorough investigation has to be carried out. This includes proximity of the bats' roosts to the human lodges and the degree of contact with the bats and their guano. The species of bats in the locality and preparation of allergens from them. It is also important to learn whether the individuals suffering from allergy, in the locality, suspect that bats are probably the cause of their allergy? This was the situation in Al-Ansari EH, et al. [15], who found that bat allergens were the causative agents of allergy in the patients who were living in close contact with bats.

Laboratory diagnosis of bat - related allergy follows the general procedure for allergy caused by other causes. These tests are:

- Skin test: In this procedure bat's allergens are include if bat-related allergy is suspected. The skin is pricked with small amounts of bat allergens. If the reaction is positive, a raised hive will develop on the site of the pricks on the skin.
- Testing of specific serum IgE (sIgE) antibodies against the bat allergens, employing the Radioallergosorbent Test (RAST) or ImmunoCAP testing. ELISA tests were also developed and used to detect sIgE antibodies against other allergens [17].

DISCUSSION

Bat-related allergy has been reported in the literature several times [14,17,18]. However, in spite of the global ubiquity of bats in large numbers, still scanty published data is thus far, available regarding information on bat-related allergy. So, in the present article it is intended to through some light on this subject, which seems to have been rather overlooked; though it can be a serious health hazard. We also discussed its peculiarities and significance in the differential diagnosis and treatment of allergies (with reference to bat-related allergy).

Published data on bats-related allergy [15,18,19] stressed that proximity of bat roosts to human lodges or living of bats within human lodges, expose people to their allergens. Some bats roost in the attics, ceilings, and roofs, at the point of entry of air coolers, in near-by trees, old buildings, churches, and other empty premises.

Studies to elucidate the role of bats in causing allergy in humans, should include identification of the bat species, preparation of allergens from their guano, bodies and excreta.

Preparation of allergens from each bat species, in a specific locality, includes allergens from the body of the bat itself, its secretions and excretions and the dust in their roosts. The dust available in the bats' roosts is usually a combination of their urine and guano in a

dried form. This usually breaks down into small pieces forming dust that can be inhaled when cleaning the roosts. The bat allergens are to be fully characterized in a pure form, employing standard techniques [15,19] with the development of new methods. In this concept, post-graduate students can be given scholarships to conduct comprehensive research on the topics related to bat-related allergy.

The prepared pure bat allergens can be used in the following:

- They can be included among other allergens that are used routinely in the differential diagnosis of the allergic conditions in patients. This is particularly important if the locality in which the patients live, is infested with bats.

Some patients may test negative in the routine allergy tests against the common environmental allergens found in their locality. Those patients may not recall that they live in an area infested with bats and their roosts and they have not come in touch with them. In such a case, testing against bat allergens becomes vital [15].

- They can be used in immunotherapy which probably requires the use of the allergen for a long period.

It is felt that bat-related allergy should have more international attention, as it can be a serious health problem if it is over-looked.

Bearing in mind that bat-allergens, to be used for diagnosis and treatment of bat-related allergies in a specific geographical locality, e.g. in developing countries, cannot practically, be supplied by international health organizations; because they have to be prepared from the local bat species. Then the expected strategy for international health organizations is to encourage local health authorities to prepare bat allergens from the local species of bats, so as to cater for any problem of bat-related allergies. Such an exercise is expected to be aided by the supply of the technical-knowhow and experts in this field for training the local health personnel. Indeed, such a situation will save lives from severe and serious effects of bat-related allergies. To remove bats from the houses or other human lodges, there are specialized professional companies to perform this job in developed countries. The situation in developing countries is not clear.

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