

Bee and Wasp Stings

Reactions and Anaphylaxis

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KEYWORDS

- Bee sting • Wasp sting • Hymenoptera • Anaphylaxis • Reaction
- Venom-specific immunotherapy • Epinephrine

KEY POINTS

- Anaphylaxis involves the integumentary, respiratory, cardiovascular, or gastrointestinal organ systems.
- Anaphylaxis involves 1 organ system no more than 4 hours between the sting and onset of symptoms or 2 or more organ systems no more than 4 hours after the sting whether treated or untreated.
- Vespid venom contains similar allergens creating a high degree of cross-reactivity between insects within this group.
- Hymenoptera venom hypersensitivity is the second most prevalent cause of systemic allergic reactions, behind drug-induced systemic allergic reactions.
- Individuals who experience heavy exposure to bees and wasps are at increased likelihood of developing systemic allergic reactions to stings.
- Bees feed on pollen and nectar, whereas wasps have a carnivorous nature.
- Bees have a barbed stinger, which becomes lodged in its victim, typically allowing a single sting.
- Wasps lack barbs on their stinger, allowing them to sting their prey repeatedly.
- Symptoms of an allergic reaction develop within minutes.
- Anaphylactic reactions can be fatal within 30 minutes.
- Reactions may be cutaneous, large local, biphasic, or systemic in nature.
- Integumentary, gastrointestinal, and immunologic symptoms are the most common physiologic responses to an insect sting.
- Atypical responses to stings may occur in the cardiovascular, genitourinary, gynecologic, hematologic, musculoskeletal, neurologic, ocular, pulmonary, and renal systems.
- Prediction of risk of systemic reaction to future stings is primarily based on the severity of past reactions, history and degree of exposure, age of the patient, and the level of sensitivity measured by either a skin test or radioallergosorbent test.

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Disclosures: None.

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- Venom-specific immunotherapy (VIT) is the standard form of immunotherapy used for sting allergy.
- Improvements in quality of life with VIT compared with epinephrine self-injector alone support the use of VIT not only for physiologic indications but for psychological indications as well.
- Education of allergen avoidance is the primary means of treatment.
- Creation of a written emergency action plan helps to streamline self-medication emergency treatment in the event of a reexposure to a sting.

INTRODUCTION

Allergic reactions to bee and wasp stings have been documented since the era of ancient Egypt. One of the legends surrounding the death of the first king of Egypt, Pharaoh Menes in 2640 BC, states that his death was caused by an anaphylactic reaction to a wasp sting.¹ However, it was not until 1902 that Portier and Richet¹ published the seminal work on the phenomenon of anaphylaxis. While at sea, these investigators were attempting to immunize a dog against the venom from tentacles of the sea anemone. After the second injection of the venom, the dog died within minutes. It was from this encounter that the term anaphylaxis was termed.

Numerous definitions and qualifications exist regarding anaphylaxis. The common thread of all definitions states that anaphylaxis typically involves the integumentary, respiratory, cardiovascular, or gastrointestinal (GI) organ systems. In addition, anaphylaxis may or may not include symptom presentation of hypotension or an IgE-mediated hypersensitivity response affecting multiple organ systems.^{1,2} This response, if untreated, can cause severe effects, leading to cardiovascular collapse and death. A more technical definition of anaphylaxis outlines the involvement of 1 organ system no more than 4 hours between the sting and onset of symptoms or 2 or more organ systems no more than 4 hours after the sting whether treated or untreated.³

All stinging insects have the ability to induce an anaphylactic reaction in their hosts.⁴ This article focuses on the Hymenoptera order of insects, specifically bees and wasps. Hymenoptera is the largest order of insects known, and contains suborders of Apidae (bees) and Vespidae (vespids). Apidae includes *Apis mellifera* (honeybees) and *Bombus* species (bumblebees). The suborder of Vespidae (vespids) consists of *Vespula* species (yellow jackets) and *Polistes fuscatus* (hornets and wasps).⁴⁻⁶ Table 1 summarizes these orders and suborders. Hymenoptera, meaning membrane-winged, comprises approximately 100,000 species of bees, wasps, and ants.⁷ Most of these insects have poison-gland and stinging mechanisms, which are used for acquiring food or fending off predators.

The venom of Hymenoptera insects contains protein allergens, most of which have enzymatic activity. In addition, the venom contains nonallergenic components such as toxins, vasoactive amine molecules, acetylcholine, and kinins.^{4,6,8} The venom of the

Table 1 Class/subclasses of Hymenoptera	
Order: Hymenoptera	
Suborder: Apidae (bees)	Suborder: Vespidae (vespids)
<i>Apis mellifera</i> (honeybees)	<i>Vespula</i> species (yellow jackets)
<i>Bombus</i> species (bumblebees)	<i>Polistes fuscatus</i> (hornets and wasps)

honey bee is immunochemically distinct from the other Hymenoptera, making cross-reactivity unlikely. However, vespid venom contains virtually the same allergens between suborder, creating a high degree of cross-reactivity between insects within this group.⁶

The stinging apparatus is located at the tail end of the abdominal segment of the insect and is capable of delivering 50 µg of venom. In the absence of allergic responses, it would take approximately 1500 stings to deliver a quantity of venom deemed to be a lethal dose.⁵ It is this venom that is capable of inducing toxic or vaso-active responses within the body of the host.

INCIDENCE

The incidence of Hymenoptera venom hypersensitivity¹ is from 0.05% to 5% of the population.^{3,7} This prevalence of reactions is second only to drug-induced anaphylaxis.⁹ There are approximately 400,000 visits per year to emergency departments across the United States as result of anaphylaxis of various origins. The location of the individual, and the type of activity in which they were engaged at the time of the sting, are important in determining the most likely cause of the sting.⁵ Of these stings, 40 to 100 Americans die every year as a result of severe systemic reactions to bee, wasp, and ant stings.^{2,7,10}

Systemic allergic reactions can occur at any age, often after numerous uneventful stings.⁶ A medical history of severe sting reactions has been reported by up to 3% of adults and almost 1% of children. In children, a history of systemic allergic reactions can be found documented in medical records of at least 0.8% of children.⁶ There is evidence that most children do outgrow systemic allergic responses to insect stings; however, 1 in 5 individuals stung up to 32 years after the original reaction still show an allergic reaction.¹¹ In addition, there is a small documented cross-reactivity between bee and wasp stings and plant allergens such as ragweed, banana, melon, or cantaloupe or with carbohydrate determinates.^{6,12,13}

Persons at highest risk for allergic reactions are more commonly persons who experience heavy exposure. Beekeepers and their families are at high risk of becoming allergic because of the high rate of contact and risk of being stung during their regular duties. In such a highly exposed population, up to 31% of individuals report large local reactions, whereas 14% to 32% report systemic allergic reactions.¹⁴ Higher incidences of systemic allergic reactions are common in countries and areas where exposure is greater. Switzerland, for example, has a large beekeeping industry. Having an increased chance of exposure to multiple stings simultaneously or repeated stings within a single season in addition increases the chance of systemic reactions.^{6,14}

After the occurrence of a systemic allergic reaction to a sting, the risk of a repeat reaction increases. Sensitization to venom from the sting occurs in more than 30% of adults in the weeks after a sting. However, there is evidence that sensitization may be self-limited in 30% to 50% of cases after 5 to 10 years.⁴

SIMILARITIES BETWEEN BEES AND WASPS

Bees and wasps contain numerous similarities in both appearance and behavior (Table 2). These similarities are in part because of bees' evolution from predatory wasps.¹⁵ Externally, both contain an exoskeleton, which minimizes water loss as well as providing protection from predators. Their bodies are divided into 3 regions: head, thorax, and abdomen. The head is the major sensory region of the insect, housing the eyes, antennae, and sensory hairs. Ingestion and partial digestion of food occurs through the head.⁸

Table 2 Similarities and differences between bees and wasps		
	Bees	Wasps
Anatomy	Exoskeleton Visible hair on body Short compact body 3 body regions: Head Contains eyes, antennae, and responsible for sensory and nutrition Thorax 2 pairs of wings 6 legs Primary locomotion segment Abdomen 7 segments Contains internal organs Barbed stinger	Exoskeleton Minimal to no body hair Narrow streamline body 3 body regions: Head Contains eyes, antennae, and responsible for sensory and nutrition Thorax 2 pairs of wings 6 legs Primary locomotion segment Abdomen 7 segments Contains internal organs Nonbarbed stinger
Behavior	Gather pollen and nectar Lay eggs within hive/colony	Minimal pollen transport Carnivorous nature Lay eggs within colony or on/in prey
Living	Bees Live in hives/colonies Tree hollows, logs, commercial hives Social living Bumble bees Protected structures Deserted small rodent nests, dead grass piles, or garden substrate Social and solitary living species	Yellow jackets Ground-dwelling colonies Social and solitary living species Hornets Large papier-mâché nests Social living Wasps Paperlike honeycomb nests Mud nests Social living

The antennae are the noses of the insect and contain a 10-segment flagellum used to smell. Two different types of eyes exist on the insect’s head: the ocelli and the compound eye. The ocelli consist of 3 eyes located on the top of the head and are arranged in a triangular pattern. The predominate function of the eyes is to detect light intensity. The compound eyes provide a wide range of photoreceptive functions. Each eye is composed of approximately 6900 hexagonal facets, each of which functions as its own independent structure.⁸

The thorax is made up of 3 segments, each of which bears 1 pair of legs, whereas the posterior 2 thoracic segments have 2 pairs of wings. The wings contain powerful muscles for flight, which make the thorax the primary propulsive region of the body.^{8,15}

The abdomen is made up of 7 visible segments. This structure contains most of the internal organ systems, some glands, and the stinger.⁸ However, only female bees and wasps can sting, because the stinger is a modified egg-laying structure not present in males.¹⁵

DIFFERENCE BETWEEN BEES AND WASPS

Evolutionary differences exist between bees and wasps. These differences help distinguish between the 2 within the environment. Bees are visibly hairy, and the fur is distributed across their legs and abdomen for pollen collection. The hairs

distributed on their legs are used to clean dust and pollen from the head and thorax and for pollen sac collection.⁸ Wasps have no fur and therefore are less able to carry pollen. Any pollen collection while visiting flowers is unintentional. Wasps typically have an elongate body, longer legs, and a very narrow waist, whereas bees are usually more compact. These anatomic differences permit a wasp to fly faster than a bee.^{8,15}

Bees are well recognized for their gathering of pollen and nectar from flowers to use as food for their colonies and offspring. Wasps are carnivorous, and although they are attracted by sweet foods, they also hunt other insects as a primary source of food.⁵ These insects include common garden pests such as aphids, tomato hornworms, cabbage worms, and strawberry leaf rollers.¹⁵ Wasps often use their hosts as a nutrition source for their young. Whereas bees lay their eggs within the combs of the colony, wasps may lay their eggs within a nest or either on or in their host. This practice allows the larva to feed on the host as it matures into a grown wasp, eventually killing and devouring the host.¹⁵

However, the greatest difference between bees and wasps is the stinger. Honeybees have a barbed stinger with an attached venom sac. The 2-barbed stinger quickly saws its way into the victim and becomes lodged in the skin of the predator. Because of this mechanism, the stinger typically remains in the victim's flesh after the sting. As the bee pulls away, the venom sac and internal organs are eviscerated from the bee's body, causing death to the bee within hours to days. However, this mechanism allows the stinging apparatus to continue to pump venom into the flesh of the predator for 30 to 60 seconds after evisceration from the bee's body as the muscles surrounding the poison sac contract.^{5,8}

Bumblebees' stingers have fewer barbs than a honeybee's stinger, and can therefore sting repeatedly because evisceration is less likely after a single sting. Similar to the bumblebee, wasps, hornets, and yellow jackets lack barbs on their stinger, making them capable of stinging predators or prey numerous consecutive times.⁷

LIVING ENVIRONMENT

Honey Bees

Honeybees live in hives. Domestic honeybees reside in commercial hives and are easily observed on flowers in nature. However, wild honeybees' nests can be found in tree hollows, logs, and even in the sides of buildings. Their hives may contain thousands of docile bees, which can become aggressive around their hives during cool and damp weather or when provoked.^{5,7}

Africanized honeybees are an especially aggressive hybrid between domestic honeybees and African honeybees. This hybrid is the result from an experiment intended to enhance honey production. This hybrid breed was accidentally introduced into South America and has been migrating northward over the years. They can now be found in several of the southern states of the United States.^{5,6} African honeybees live in colonies and although their venom is no different than that of other honeybees, because of their swarm-and-attack behavior, the number of stings from an encounter is excessive and can therefore be fatal.^{6,7}

Bumblebees

Bumblebees are slow moving and nonaggressive. Stings from a bumblebee are rare, unless the insect is provoked. Bumblebees live in colonies in the ground, in commercial hives, protected structures, or even deserted small rodent nests, dead grass piles, or garden substrate.^{5,7}

Bumblebees have social and solitary species, which are seasonal in nature. The colonies die out in late autumn and the queens hibernate underground to start a new colony the following year.¹⁵

Yellow Jackets

Yellow jackets have ground-dwelling colonies, and because of their urbanized nature, are typically encountered by innocent individuals during yard work, gardening, or farming.^{5,7} When their nests are disturbed, the yellow jackets become aggressive in an effort to defend their colony. It is for this reason that yellow jacket stings are common and are also the most common cause of sting-induced allergic reactions in most areas.⁴ In addition, yellow jackets have been known to follow their predators and sting them repeatedly over distances. Yellow jackets are often found associated with food in the outdoor setting, especially in late summer, when native sources of food begin to get scarce.^{5,7,15} It is because of the wasps' attraction to food that stings in the mouth, oropharynx, and esophagus are common.

Yellow jackets, like bumblebees, have social and solitary species. Yellow jackets also have seasonal colonies that die out in late autumn and the queens hibernate underground to start a new colony the following year.¹⁵

Hornets

Hornets build large papier-mâché nests, which may span several feet in diameter. These nests are usually found in trees or shrubs and use natural protection from the vegetation. Hornets are aggressive when a predator is within the vicinity of the nest, and like yellow jackets, have been known to follow and sting their predator numerous times over distances away from the nest.⁵

Wasps

Wasps build paperlike honeycomb nests or mud nests several inches or more in diameter. These nests are found in shrubs, under eaves of houses or barns, within pipes on playgrounds, or under patio furniture. The variety of locations chosen by the wasps to construct their nests is typically sheltered from direct sun, wind, and rain. These specific locations provide added protection to the nest and young wasps. Wasps are less aggressive than other vespids; however, when the nest is disturbed, they become aggressive and can sting their predators multiple times.^{5,7}

VARIED TYPES OF REACTIONS

After a sting by a wasp or bee, the time of onset to a reaction is often rapid. If the individual experiences an anaphylactic reaction, symptoms typically develop within minutes and can be fatal within 30 minutes of the event. Although there is documentation reporting symptom development several hours after an exposure, early treatment is essential for survival.^{2,9} Several types of reactions exist, all varying in severity of symptom expression (**Table 3**).

These reactions include:

- Localized/cutaneous reaction
- Large local reaction
- Biphasic reaction
- Systemic reactions (anaphylaxis)

Table 3
Types of reactions and common symptom expression

Localized cutaneous	Pain Redness Swelling Pruritus Localized area of induration Symptoms last several days
Large local reaction	Pain Redness Swelling Pruritus Large area of induration often greater than 15 cm Symptoms last 10 d
Biphasic reaction	Pain Redness Swelling Pruritus Reemergence of symptoms after the appearance of a complete resolution of symptoms Symptoms reemerge several hours after initial resolution
Systemic reaction/anaphylaxis	Develops within minutes of sting Generalized cutaneous response Associated hypotensive shock Abdominal or pelvic pain Cardiac rhythm disturbances Coronary vasospasm Angioedema Laryngeal edema Bronchospasm

Localized/Cutaneous Reactions

Localized cutaneous reactions are the most common of reactions, occurring in 80% of individuals. This type of response is often the sole manifestation in most children. However, adults report 15% localized reactions and often with isolated ancillary symptoms such as hypotension or respiratory complaints.^{6,9}

Immediately after a sting, the tissue mounts a localized histamine response to the injected venom. Localized reactions are not IgE mediated, as are systemic reactions, and therefore require only symptomatic treatment rather than systemic treatment.⁵ This histamine response causes localized pain, redness, swelling, and pruritus at and around the site of the sting.^{3,6,16} This prodrome of symptoms is transient and may persist for up to several days.¹ Localized reactions may also include flushing or allergic rhinoconjunctivitis symptoms. Individuals who experience a more significant localized reaction are at an increased risk of developing a systemic reaction to future stings.¹⁴

Large Local Reactions

Large localized reactions are characterized by a late-phase IgE-dependent reaction, which typically develops after 12 to 48 hours after the sting. The diameter of the area of induration often exceeds 15 cm and can persist for 5 to 10 days, with a slow dissipation.^{4-6,9} The characteristics of a large local reaction include extensive erythema and swelling surrounding the site of the sting, pain, and pruritus.⁵

Biphasic Reaction

Most reactions are uniphasic, meaning from the time of the sting, the symptoms of the reaction, whether localized or systemic, intensify and then gradually subside. These uniphasic reactions respond rapidly to therapy. However, some individuals have a protracted reaction, which is shown as either an incomplete response to treatment or a return of symptoms after an apparent complete resolution of the initial prodrome.⁹

Biphasic reactions have been reported in 1% to 5% of cases after either a bee or wasp sting. Because of this potential reemergence of symptoms, individuals should be observed for 3 to 6 hours after a sting, depending on the severity of the symptoms.^{3,6,9}

Systemic Reaction

Systemic reactions, or anaphylaxis, also known as systemic hypersensitivity syndrome,⁹ are the most severe of potential allergic responses. The nature of a systemic reaction is caused by an immunologically induced mast cell or basophil mediator release from an IgE-mediated response.⁵

A systemic reaction typically develops within minutes after a sting.^{5,14} These reactions are characterized by a generalized cutaneous response with associated hypotensive shock, abdominal or pelvic pain, cardiac rhythm disturbances, coronary vasospasm, laryngeal edema, bronchospasm, or angioedema.^{4,5,16} These systemic reactions can become progressively more severe with each sting and show more significant symptoms in a shorter period.⁶ For a victim to experience a toxic effect from the venom alone, they must endure a significant number of stings. However, a systemic reaction requires only 1 sting to develop.⁵

PHYSIOLOGIC RESPONSE

Typical physiologic response to an insect sting is a result of histamine and IgE mediator release. These responses include integumentary symptoms, GI symptoms, and immunologic symptoms.

Integumentary Response

The response of the integumentary system is intended to protect the body from the invasion of toxins. Urticaria, erythematous rash, localized swelling, purpuric maculae, flushing, and pruritus are the most common symptoms shown by the skin.^{3,9,17} In cases of extensive toxin burden, localized necrosis has been seen.¹⁰ This type of response by the skin warrants medical attention for wound care, debridement, and, based on the severity of the necrotic area, possible skin grafting.

GI Response

The GI system is sensitive to stress and physiologic conditions. After an insect sting, and the associated local or systemic response, the gut shows an abrupt response. Individuals report significant abdominal pain, cramps, and other associated GI symptoms including nausea, diarrhea, and indigestion.^{3,6,9,10} These responses by the GI tract are transient, and although discomforting, do not typically cause any long-term effects.

Immunologic Response

The immune response of the body to a sting is complex. In this immunologic mechanism, IgE initially binds to the venom proteins. This binding activates a separate set of receptors known as the high-affinity IgE receptors, located on both mast cells and

basophils. This binding causes a release of histamines and other inflammatory mediators, which cause a full body cascade of physiologic changes recognized as symptoms of anaphylaxis:

- Increased bronchial smooth muscle tone
- Vasodilation
- Increase blood vessel permeability
- Myocardial contractility depression¹⁸

ATYPICAL RESPONSES

Beyond the typical physiologic responses of the body to stings, numerous atypical responses have also been noted. No body system seems to be excluded from the stress response and toxic effects of bee and wasp venom.

Cardiac

Hypotension is a common outcome associated with an anaphylactic reaction as distributive shock sets in. Numerous cases of hypotension, defined as a systolic blood pressure less than 100 mm Hg, have been documented.^{2,3,9,10,17} Increased troponin levels in the absence of chest pain indicate the occurrence of silent myocardial infarctions after several wasp stings to the head and arms of individuals.¹⁷ Holosystolic murmurs, bradycardia, arrhythmias, and angina have also been reported.^{6,10}

The development of coronary vasospasm and an ensuing myocardial infarction secondary to the allergic reaction have been described since 1991 as the Kounis syndrome.¹⁹ Kounis syndrome is the development of an acute coronary syndrome induced by allergic or hypersensitivity reactions, such as that to stings. Kounis syndrome can be classified as a type I occurrence or a type II occurrence. Type I includes patients with normal coronary anatomy, in whom the allergic response causes either coronary vasospasm, leading to unstable angina with normal cardiac enzymes, or coronary artery spasm, progressing to acute myocardial infarction.¹⁹ A type II response includes patients with preexisting atherosclerotic disease. This history of coronary artery disease may be known or unknown by the patient. The catecholamine surge and stress from the acute allergic episode can lead to plaque rupture, leading to an acute myocardial infarction.¹⁹

Genitourinary/Gynecology

Although the documented occurrence of genitourinary/gynecology affects from bee and wasp stings are minimal, there is notation in the literature of fetal demise in pregnant women. In these cases, the woman experienced a spontaneous abortion of what appeared to be a normally developing fetus.⁶

Hematologic

By the nature of allergic reactions, the hematologic system is highly involved in this response. It is not surprising that severe, yet atypical hematologic responses may be experienced by individuals who receive stings by bees or wasps. Beyond the anticipated response of swelling, urticaria, and angioedema, documentation exists surrounding the development of serum sickness, vasculitis, hemolysis, and thrombocytopenia purpura.^{5,17} The incidence of chronic urticaria and cold urticaria has also been noted to develop after a sting.⁶ In more severe reactions and responses, there are noted incidences of coagulation abnormalities, such as disseminated intravascular coagulation and Henoch-Schönlein syndrome.^{5,10,17}

Musculoskeletal

Atypical musculoskeletal effects from allergic responses to stings have been documented to include joint swelling and arthralgias.¹⁰ Large-scale muscle damage, presenting itself clinically as rhabdomyolysis, has been noted after hornet stings.¹⁷

Neurologic

Significant neurologic effects associated with systemic reactions from bee and wasp stings have been documented as well. These effects include acute disseminated encephalomyelitis, Guillain Barré syndrome, myasthenia gravis, other demyelinating diseases, peripheral neuritis, cerebral infarction, encephalitis, and Reye-like syndrome, which have been reported. In most cases, supportive care and steroid therapy over the course of several months have resulted in resolution of the symptoms.^{5,17}

Ocular

Ocular responses can be caused by either direct contact with the sting or the systemic allergic response experienced by the body. Direct trauma from the stinger and venom components have caused ocular lesions, corneal ulcerations and deterioration, and cataracts.¹⁷ In addition, conjunctivitis, corneal infiltrates, lens subluxation, lens abscess, and optic neuropathy have been identified in individuals showing allergic responses to stings.^{5,17}

Pulmonary

Pulmonary responses, like hematologic responses, are not uncommon. Most individuals experiencing a sting report dyspnea, wheezing, and feelings of airway closure. A potential contributor to such symptoms outside the allergic response and physiologic contributors may be psychological in nature. An individual experiences pain and fear as a result of the sting. These experiences exacerbate feelings of anxiety, leading to vocal cord dysfunction and feelings of dyspnea. However, atypically, diffuse alveolar hemorrhage and pulmonary edema have been described. These findings have been documented with multiple stings as well as after a single sting.^{9,17}

Renal

In cases of systemic allergic responses, renal toxic effects have been documented from as few as 1 single sting to as many as 1700 stings. Cases reported include primary renal failure from both domestic as well as Africanized honeybees, interstitial renal edema and tubular destruction, tubulointerstitial nephritis, and acute tubular necrosis.¹⁷ In addition, nephrotic syndrome has been reported after just 2 stings.¹⁷

DIAGNOSTIC TESTS

In making a clinical diagnosis of systemic allergies to bee or wasp stings, significant emphasis should be placed on the individual's history of exposure.⁴ When gathering a detailed history, information should be gathered pertaining to all previous stings, the time course until a reaction and of the reaction itself, as well as all associated symptoms and treatments provided. Symptoms may be overestimated by the individual because of experienced fear and panic. Perceptions of throat or chest tightness, dyspnea, lightheadedness, nausea, or other constitutional symptoms may all be attributed to the anxiety, fear, or panic of the event. In addition, heat, alcohol, physical exertion, or underlying cardiopulmonary disease may exaggerate symptom presentation. Performing either a serum assay or a skin test in an individual with no

history of a systemic allergic reaction to a sting is not useful in determining an individual's potential for systemic allergic reactions.⁶

Criteria essential for diagnosing an individual with insect sting allergy include:

- Clinical history of a systemic reaction
- Positive venom-specific serum IgE antibody
- Positive venom-specific skin IgE antibody¹⁶

Performing diagnostic testing for sting allergy is indicated in individuals who have had a systemic reaction. In the absence of known history of an allergic response to a sting, allergy testing is not required because of the low probability of anaphylaxis.⁶ One percent of individuals with a history of systemic reactions to a sting show a negative skin test or radioallergosorbent test (RAST). Individuals who show a large local reaction to a sting often have significant results to either a venom skin test or RAST sensitivity. However, they show a low risk of anaphylaxis.⁴ In such cases, it may be beneficial to consider the administration of an intentional sting challenge: instigation of an intentional sting by the insect of suspicion.⁴ This test should always be performed in a medical facility where emergency treatment can be administered.

The prediction of risk to an individual of systemic reaction to future stings, therefore, is primarily based on the severity of past reactions, history and degree of exposure, the level of sensitivity measured by either a skin test or RAST, and the age of the patient.⁴ Other means of diagnosing an allergy include the intentional sting challenge mentioned earlier, *in vitro* basophil flow cytometry-based assay, and *in vitro* basophil histamine and sulfidoleukotriene release assay.¹⁶

TREATMENT PLAN

Treatment plans for allergic reactions vary from venom-specific immunotherapy (VIT), home therapies, emergency medical services/hospital systemic treatment, and education/prevention. Hymenoptera venoms were the first standardized allergens on the market. Whole-body extract (WBE) therapy was the standard treatment of prevention of allergic reactions to stings for almost 50 years.⁴ This situation was until WBE was shown to be no better than placebo compared with VIT, which was shown to have a 95% effectiveness.⁶ Half of all cases of allergic reactions are considered unpreventable because of the individuals' having no previous knowledge of past allergic reactions. Therefore, emergency treatments were not rapidly sought and the individual would not have been eligible for VIT without knowledge of an allergic history.⁴ Referral to an allergy specialist is indicated for evaluation of criteria to receive VIT therapy as well as administration of therapy.^{2,16} The process of treatment with immunotherapy decreases the T-cell proliferation after allergen stimulation. In addition, decreased secretion of cytokines and interleukins leads to a suppression of the IgE-mediated immune response.¹⁴

Treatment guidelines support administration of VIT every 4 weeks for the first 18 to 24 months of therapy, followed by administration every 6 weeks from 18 to 24 months. Therapy is then recommended to be continued every 8 weeks either up to a 5-year period or indefinitely.^{4,6} VIT in children reduces the frequency of generalized allergic reactions from 17% to 5% and carries the benefit of offering long-term protection from further generalized reactions in 85% to 95% of cases. However, anaphylaxis may occur with VIT administration, so caution must be exercised with administration.^{11,20,21} Improvements in quality of life have been reported with VIT compared with a deterioration found when individuals are given only an epinephrine

self-injector. These findings support the use of VIT not only for physiologic indications but for psychological indications as well.⁴

VIT is strongly recommended in individuals with positive RAST as well as a history of moderate to severe systemic allergic reactions to bee or wasp stings. In addition, notable respiratory or cardiovascular symptoms after a sting support VIT.¹⁴ Individuals classified as being involved in high-risk activities, such as beekeeping, should successfully tolerate a sting challenge test performed under clinical conditions before returning to their high-risk activities.¹⁴

Home Treatment Regimens

After a sting, home treatment regimens should be instituted. Whether the reaction experienced by the individual is localized/cutaneous reaction, or a large localized reaction, treatment should begin immediately. Treatments to be instituted should include:

- Ice to the site of the sting
- Nonsteroidal anti-inflammatory drugs: ibuprofen (Motrin)
- Prostaglandin synthesis inhibitors: acetaminophen (Tylenol)
- Histamine 1 (H₁) inhibitors: famotidine (Pepcid)
- H₂ inhibitors: diphenhydramine (Benadryl)
- Topical application of antihistamine or corticosteroid medications for symptom relief

The use of an epinephrine injector is not recommended in patients who show a large localized reaction, cutaneous systemic reactions, or who are receiving venom immunotherapy.⁶ Medical attention should always be sought if the effectiveness of home remedies is in question.

Emergency Medical Services/Hospital Systemic Treatment

Individuals with a known history of systemic allergic reactions should not attempt home remedy treatment. Emergency response assistance should be sought immediately and hospital transport made imminent. Individuals with a known history of systemic allergic reactions should maintain an active prescription for subcutaneous epinephrine injector (1:1000). In addition, when an individual anticipates that they may be in a location where a sting is possible, a subcutaneous epinephrine injection cartridge should be carried with them. First responders are trained in the use of subcutaneous epinephrine injector. In addition, oxygen therapy should be instituted.^{2,9,14,16}

After the first administration of epinephrine, if symptoms do not resolve, a second injection of epinephrine should be given. Large-bore intravenous access should be established as soon as possible and the use of antihistamines, hydrocortisone, intravenous fluids, and possible vasopressors should be considered, because clinical manifestations of shock may present. Elevating lower extremities to optimize venous return may be beneficial. If respiratory distress and bronchospasms develop, elevation of the head is more appropriate. Corticosteroid use should be immediately used and measures to secure the airway should be instituted.^{2,9,14,16}

The combined use of H₁ and H₂ antihistamines is a second-line agent and is more effective in treatment of the cutaneous manifestations of a generalized allergic reaction such as urticaria, mild angioedema, and pruritus. H₁ antagonists should not be given alone and also should not be attempted as primary and sole therapy for a systemic allergic reaction.⁹ In addition, individuals on β -blocker medications may be resistant to epinephrine, because of blockade of the receptor sites needed for epinephrine and other catecholamines to have an effect on the body.⁶

Education

Excessive fear of a reexposure greatly impairs an individual's quality of life.⁶ Therefore, education of allergen avoidance is the primary means of treatment. In addition, creation of a written emergency action plan helps to streamline self-medication emergency treatment in the event of a reexposure to a sting.^{14,16} During the education process, an individual should also be made aware of the indications of VIT treatment as well as when to carry and use an epinephrine injector. These injectors are indicated for individuals with history of anaphylaxis after a sting.^{6,9} If the individual is engaged in activities putting them at an increased risk of exposure, such as beekeeping, the individual either needs to stop the activities, or wear protective clothing.¹⁴ Listings of educational resources and guidelines should include:

- Wearing long trousers and shirts when outside
- Avoiding pollinated plants and grassy areas
- Avoiding perfumes, fragrant soaps, and lotions
- Avoiding eating and drinking outdoors and with straws²

SUMMARY

There are many similarities and differences between bees and wasps. In addition, allergic reactions to bee and wasp stings manifest themselves in a variety of ways from simple cutaneous reactions, more complex biphasic reactions, to life-threatening systemic anaphylactic reactions. Treatment may range from home therapies using over-the-counter medications or prescription epinephrine self-injectors to treatment by emergency responders and hospitals, including intravenous medications and intravenous fluids. Education and prevention are the most effective means of treatment. Educating individuals with histories of systemic allergic reactions to avoid situations of likely exposure is essential. Developing an emergency action plan for self-medication administration and seeking of medical attention is a necessary lifesaving step. VIT, when indicated, can provide effective, long-standing treatment against systemic allergic reactions, and improve an individual's quality of life.

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