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## Environmental allergen avoidance: An overview

Peyton A. Eggleston, MD,<sup>a</sup> and Robert K. Bush, MD,<sup>b</sup> *Baltimore, Md, and Madison, Wis*

In 1999, the American Academy of Asthma, Allergy and Immunology published a position statement that recommended that physicians include indoor allergen avoidance approaches as adjunctive therapy for patients with chronic allergic asthma. This statement supported the development of a public education process to increase general awareness of the role of environmental allergens in the pathogenesis of allergic asthma. Additionally, it recommended that patients with allergic asthma be given practical advice on allergen avoidance. As a first step in accomplishing public education and providing physicians with a fully referenced and detailed summary of the present knowledge about indoor allergens, a group of experts has been assembled. Their task has been to create a document that presents scientific thought concerning allergen avoidance. This consensus document, containing the articles included in this special supplement, draws on the published information by investigators currently active in this area.

### ASSESSMENT OF ALLERGIC STATUS

Before recommending environmental allergen avoidance to a patient with asthma, it is essential to determine the patient's allergic status (ie, not only whether the patient is allergic but also whether the patient is allergic to one of the specific allergens described in this document). Indicators in the medical history that suggest that a patient has allergic asthma include a history of eczema,

allergic rhinitis, or food allergy or a family history of these illnesses. In addition, a history of increased symptoms during the spring or fall pollen seasons or during exposure to animals, house cleaning, or damp musty environments also suggest that the patient has allergic asthma. The diagnosis can be confirmed with skin testing or by means of in vitro testing for specific IgE antibodies to indoor allergens. These tests not only confirm that the patient has allergic asthma, but they also identify the specific allergen that affects the particular patient so that appropriate specific advice can be provided. However, these tests require confirming history and should not be used by themselves to determine the patient's allergic status. In addition, skin testing requires technical skills that may not be available to a primary care physician. Nonetheless, a number of studies have linked sensitization to common indoor allergens to the development and severity of asthma. The most common indoor allergens that should be avoided include house dust mites, animals, cockroaches, and fungi.

### DUST MITE ALLERGENS

In most areas of the world, house dust mites are a major source of allergens in the indoor environment. There is convincing evidence that exposure to house dust mite allergens in susceptible populations can induce perennial allergic rhinitis and allergic asthma. Mite bodies and mite feces are the principal source of many of these allergens. Many of the purified and characterized house dust mite allergens associated with mite fecal matter are enzymes that originate from the mite's digestive system. For many of the major house dust mite allergens, immunoassays have been developed that allow for the quantitation of these allergens in dust samples, and higher levels have been associated with the development of sensitization (IgE antibodies) and the development of asthma in susceptible children. Mite allergen levels above 2 µg/g settled dust are a risk factor for sensitization.

From <sup>a</sup>the Department of Pediatrics, Johns Hopkins Hospital, Baltimore; and  
<sup>b</sup>the Department of Medicine, William S. Middleton VA Hospital, University of Wisconsin-Madison.

Reprint requests: Robert K. Bush, MD, William S. Middleton VA Hospital, 2500 Overlook Terrace, Madison, WI 53705.

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House dust mites infest fabrics in the home, such as mattresses, bedding, rugs, clothing, upholstered furniture, and stuffed animals. The allergens are carried on large particles, which become airborne to a limited extent. The heaviest exposure occurs from bedding when the patient lies down to sleep.

House dust mite allergens are among the best understood of indoor allergens, and many of the recommendations for their avoidance have been shown to improve asthma morbidity in formal clinical trials. It is clear that the use of mattress and pillow encasings both reduces allergen exposure and improves asthma symptoms and physiology. Bedding treatment and other recommendations reduce allergen exposure, but health effects have not been demonstrated. Research is still needed for many of the avoidance measures listed below.

There are many changes that are simple to implement and have been proven to be effective. Those for the bedroom are as follows:

- encase pillows (less than 10  $\mu$ m pore, fine weave, or vapor-permeable cover);
- encase mattresses in vapor-permeable or plastic cover;
- encase box springs in vinyl or plastic;
- wash bedding weekly in hot (130°F) water; and
- remove stuffed animals, toys, or both from the bed.

Simple and effective changes for the house are as follows:

- vacuum clean weekly (wear mask; leave room for 20 minutes after cleaning); and
- ensure that vacuum cleaner has good quality bags (usually double-thickness or high-efficiency particulate air filter on air outlet).

Changes that are more difficult to implement or are unproven are as follows:

- reduce indoor relative humidity;
- replace carpets with polished wood flooring;
- replace upholstered furniture with leather, vinyl, or wood;
- replace draperies with washable shades or blinds; and
- avoid living in basements.

## ANIMAL ALLERGENS

Animal allergens, principally those from cats, dogs, rats, mice, horses, and cows, are also a common cause of acute and chronic allergic asthma. Allergic sensitization can occur in the home environment, as well as in the workplace. Occupational allergy to rats and mice (laboratory animal handlers), cattle (farmers), and horses occur generally through occupational activities. Many of the mammalian allergens that have been identified and purified belong to a family of proteins called lipocalins. These allergens originate in secretions, either saliva, perianal gland secretions, sebum, or urine, and contaminate the fur, dander (shed skin particles), and bedding. They become airborne on small aerodynamic particles, which may stay airborne for several hours and are widely distributed through the home or work environment. They are

also carried on clothing to schools, offices, or automobiles, places where the animals themselves may never go.

Avoidance measures for animal allergens are listed below. These have been tested, and although removal of a pet will clearly reduce household allergen exposure, health effects have not yet been tested. Other measures, such as restricting the pet or using air filters, will reduce allergen exposure, but these measures have not been shown to affect asthma symptoms. Washing the pet reduces allergen exposure for a few days only. A great deal more research is needed in this area.

Changes that are simple to implement and have been proven to be effective are as follows:

- do not bring a furred pet into the home; and
- find an existing pet a new home.

Changes that are difficult to implement or have not yet been proven are as follows:

- restrict the pet to one area;
- keep the pet out of the patient's bedroom;
- use high-efficiency air cleaners, either central or portable;
- remove carpet or other reservoirs for allergens in the bedroom; and
- wash the pet weekly.

## COCKROACH ALLERGENS

Cockroach infestation in the indoor environment has been implicated as a major contributor to asthma throughout the world. Several studies have demonstrated that patients sensitized to cockroaches who are exposed to high levels of the cockroach allergen Bla g 1 (8 U/g settled dust) in their home are at risk for emergency department visits for asthma and hospital admissions. Major allergens have been identified in the digestive secretions and on body parts of cockroaches. Because cockroaches depend on water and food sources to survive, the highest allergen levels are found in the kitchen or bathroom. However, significant allergen levels can be detected in bedrooms, as well as in schools and public buildings. Extermination can be accomplished in over 90% of homes by using safe odorless insecticides and gel formulations that can be placed precisely in kitchens and other rooms. Cockroaches hide in cracks and crevices, and therefore the allergen collects in reservoirs that require extensive cleaning after extermination to successfully remove allergen from indoor environments. Successful treatment also requires behavioral changes to reduce the chance of reinfestation of the dwelling.

Avoidance measures are listed below. Research in this area is extremely limited; extermination and cleaning have been shown to reduce exposure but with unknown health effects.

- Exterminate with pesticides (professional assistance usually needed);
- vacuum and wet-wash home thoroughly;
- place trash outside the home nightly or daily;
- wash dishes daily;
- store food in sealed plastic containers;
- seal cracks and other portals of entry; and

- remove sources of standing water (refrigerator drip pans and leaking plumbing).

## FUNGAL ALLERGENS

Studies conducted throughout the world indicate that fungal sensitivity is common among asthmatic subjects. An accumulating body of evidence suggests that fungal sensitization, particularly to *Alternaria* species, is a risk factor for the development of asthma, increased severity of asthma, and asthma-induced fatalities. Fungal allergen exposures are generally considered to take place in outdoor environments; however, many species can invade homes through open cracks or windows. Certain species, such as *Penicillium* and *Aspergillus*, are often recovered in greater amounts from within buildings than from the outdoor air. Although fungal allergen exposures are an important clinical problem, much less is known about the sources of allergen exposure compared with those of house dust mites, cockroaches, and animals. Fungi grow in mycelium and reproduce through spores, which become airborne. Although fungal allergen exposure is believed to be primarily associated with airborne spores, other airborne particles may carry fungal allergens as well. Although a number of important fungal allergens have been identified, immunoassays to quantitate fungal allergen exposure are limited. The assessment of fungal allergen exposure is usually performed by conducting spore counts or quantitation of colony-forming units obtained by means of culture methods. Indoor levels of fungal spores exceeding 1000/m<sup>3</sup> of air or colony-forming units in the range of 1000 to 10,000/m<sup>3</sup> of air generally are suggestive of indoor fungal contamination. Fungi are dependent on water and a carbon source for survival. Therefore they can grow in a variety of materials, although some are more facile and require specific substrates for propagation.

Indoor fungal exposure occurs in 2 ways: through infiltration of spores from the outside environment and through the growth of fungi indoors. Successful abatement strategies need to consider both sources of contamination. Avoidance depends on changing the conditions that encourage fungal growth (moisture) or that are capable of killing fungi. Avoidance measures are listed below. None of these have been scientifically tested as to effects on exposure and health. Such studies will be essential in the future for treating patients allergic to fungi.

- Prevent spore infiltration by closing doors, windows, and using air conditioning;
- control moisture by means of dehumidification, seal water leaks (ventilate bathrooms and kitchens and use air conditioning during the summer months and times of high humidity), and use dehumidifiers;
- clean and remove contaminated materials by applying fungicides (chlorine bleach with detergent or quaternary amine preparations);
- use high-efficiency air filters;
- maintain heating ventilation and air-conditioning systems; and
- use personal protective equipment (particle mask when involved in cleaning contaminated materials).

## MULTIPLE ALLERGEN EXPOSURE

Most patients with allergic asthma tend to be sensitive to more than one allergen. To recommend changing many features in their home environment may become confusing and burdensome to patients and the parents of children with asthma. Experience of other areas of asthma treatment suggest that patient adherence to treatment advice will be increased by simplifying the regimen and establishing a cooperative partnership between the physician and patient.