

Environmental Control of Allergic Diseases

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Allergic disease affects millions of persons in the United States. Environmental control measures are essential for persons who are sensitive to dust mite and cat allergens and may be important in persons who are sensitive to cockroaches and fungus. The bedroom is the most important room in which to implement environmental control measures, such as encasing mattresses and pillows in vinyl or semipermeable covers. Patients with asthma (especially persistent asthma) should be considered for allergy testing and more aggressive environmental control measures. Carpet in the bedroom or over concrete should be removed. For persons who are sensitive to pet allergens, permanent removal of the pet is recommended. Dust mite and fungus growth can be controlled by keeping the household humidity level at less than 50 percent. Removing sources of food and water and using insecticides will help control cockroach populations. Patients who are sensitive to mold and outdoor air pollution should consider limiting outdoor activities when these levels are high. Patients with asthma should avoid exposure to tobacco smoke. (Am Fam Physician 2002;66:421-6,429-30. Copyright© 2002 American Academy of Family Physicians.)

► A patient information handout on environmental control of allergies, written by the authors of this article, is provided on page 429.



Allergic diseases (e.g., asthma, allergic rhinitis, and eczema) affect more than 38 million persons in the United States and result in over 20 million visits to physicians' offices annually.^{1,2} Morbidity and mortality resulting from asthma have increased steadily during the past 20 years in every age group, and there were 5,438 deaths resulting from asthma in 1998.^{3,4} A major component of managing and possibly preventing these diseases is control of environmental allergens. National and international guidelines for the management of asthma and allergic rhinitis include recommendations for environmental control of allergens and irritants (*Table 1*).⁵⁻⁸ Results of studies^{5,9} have shown that sensitization to certain indoor allergens (such as dust mites, animal dander, cockroaches, and the outdoor fungus *Alternaria*) is a risk factor in children for developing asthma.

Exposure to tobacco smoke is also a risk factor for the development of asthma in infancy and childhood and is a major

trigger for an exacerbation of asthma in children and adults.⁵ Additional research^{5,7,10-13} has shown that the level of dust mite exposure correlates with asthma symptoms, a reduced peak expiratory flow rate, and the need for medication in patients who are sensitive to dust mites, and that reducing dust mite exposure reduces asthma symptoms, airway hyper-responsiveness, and evidence of active inflammation. Studies^{10,14-16} of primary prevention of allergic disease have demonstrated that decreased exposure to allergens in infancy decreases the incidence of sensitization and may prevent the development of allergic disease. This article will provide specific clinical recommendations on environmental control of these allergens and irritants.

Dust Mites

The most important factor in an environmental control program is avoidance of dust mite allergen.¹¹ Sensitivity to dust mite antigen is a strong predictor of asthma and asthma severity, and reducing dust mite allergen exposure in the

home can reduce the severity of asthma, eczema, and allergic rhinitis.^{9,10,12,13,17-19} Programs to control dust mites can be easily implemented and are well accepted by patients.¹⁷

Dust mites (*Dermatophagoides pteronyssinus*) are members of the family Acaridae that is closely related to spiders. Dust mites are about 0.3 mm long, feed on human skin scales, and are found in places with dust and high levels of humidity. They thrive at a temperature of 21°C (70° F) and a relative humidity of 70 percent, and can be found in abundance in most modern homes.²⁰ Household areas with the highest levels of dust mite infestation include the following: carpets, pillows, mattresses, drapes, stuffed animals, clothing, and upholstered furniture. The antigen that

appears to be most responsible for sensitization to dust mites is Der p 1, which is primarily found in the mite's fecal pellets.⁸ These fecal pellets are relatively large (at least 10 µm) compared with other airborne particles that carry allergens, and they remain airborne for only a few minutes after a disturbance.^{7,11,20}

The bedroom, especially the bed, is the most important area of the house in which to implement dust mite control measures. Without environmental control measures, persons are exposed to high levels of dust mite allergen during sleep.¹¹ Encasing the mattress and pillows in vinyl or semipermeable covers is very effective in reducing dust mite allergen exposure, resulting in significant reductions in medication requirements and airway hyperresponsiveness.^{10,12} The cost of mattress covers

TABLE 1
Recommended Environmental Control Measures

Dust mites

Encase mattresses and pillows in vinyl or semipermeable covers; wash all bedding every one to two weeks in hot water at least 54.4°C (130°F); other desirable measures include: reducing indoor humidity to less than 50 percent; removing carpet from the bedroom and carpet over concrete; avoid lying or sleeping on upholstered furniture.

Animal dander

Permanently remove pets from the house or, at least, keep pets away from the bedroom, carpeted areas, and upholstered furniture.

Cockroaches

Use chemical control measures and remove sources of food and water.

Pollens and outdoor molds

Avoid outdoor activities when pollen and spore counts are elevated.

Indoor mold

Eliminate water leaks and damp areas associated with mold growth; consider reducing indoor humidity to less than 50 percent.

Tobacco

Avoid exposure to active and passive tobacco smoke.

Air pollution

Consider limiting outdoor activities when air pollution levels are high.

Information from U.S. National Heart, Lung, and Blood Institute. National Asthma Education Program. Expert Panel on the Management of Asthma. Expert panel report 2: guidelines for the diagnosis and management of asthma. Bethesda, Md.: National Institutes of Health, National Heart, Lung, and Blood Institute, 1997; NIH publication no. 97-4051, with additional information from references 6 through 8.

ranges from \$12 to \$100, depending on the size and material. Vinyl covers are the least expensive, but they do not allow air or water vapor to circulate through them. Semipermeable fabrics are more comfortable but are also more expensive. Hypoallergenic mattresses and pillows should also be encased because they can quickly become colonized with mites.⁸

Pillows that are not encased should be washed or replaced frequently. Stuffed toys that cannot be washed should be removed or replaced with washable toys.⁸ Most guidelines recommend washing all bedding (sheets, pillowcases, blankets, and mattress pads) every one to two weeks in water that is at least 54.4°C (130°F) to kill dust mites and remove the mite allergens. Washing bedding in cooler water will remove at least 90 percent of dust mite allergens but will not kill dust mites.²¹ Dry cleaning and tumble drying at 54.4°C for at least 20 minutes will also eliminate dust mites.¹⁰ Encasing mattresses and pillows and washing all bedding reduces mite allergen exposure 100- to 1,000-fold within one month.⁷ These simple measures are acceptable to most patients and can generally be accomplished.¹⁷

Carpets (especially over concrete) are usually heavily infested with dust mites and should be removed, especially in the bedroom. Unfortunately, this is not always feasible or acceptable to patients. Regular vacuuming will remove the surface dust but is not effective at removing dust mites or the majority of dust mite allergen from carpets. Using a vacuum with a high-efficiency particulate air (HEPA) filter will result in reduced emissions compared with use of a vacuum with a regular filter. But vacuuming always causes some degree of transient increase in aeroallergen levels. Patients with severe dust mite sensitivity should wear a mask while vacuuming or leave the house while the vacuuming is done.¹¹

Exposing rugs to direct sunlight for several hours or to freezing temperatures for 24 hours will kill dust mites; however, neither of these methods has been studied in clinical trials.¹⁰

Encasing the mattress and pillows in vinyl or semipermeable covers is very effective in reducing dust mite allergen exposure.

Extensive studies^{12,16,22,23} have shown that treatment with acaricides (chemical agents that kill dust mites) or tannic acid to denature dust mite allergens are only minimally effective and must be repeated frequently. Therefore, chemical treatment of carpets is not recommended for most patients and should only be used as an adjunct measure when carpet removal is not an option.¹⁰

Dust mite allergen accumulates on hard surfaces, which should be cleaned weekly. Wiping with a moist cloth removes over 90 percent of the allergen,¹¹ and keeping the relative humidity in the house below 50 percent greatly suppresses the growth of dust mites. To completely suppress the growth of dust mites, relative humidity must be kept below 35 percent for at least 22 hours a day.²⁴ This can be accomplished by using portable dehumidifiers, but it is difficult when outdoor humidity levels are high. HEPA air filters are not effective at removing dust mite allergen because the particles that carry the allergen only remain airborne for a short time.¹⁰

Pets

All warm-blooded animals produce potential allergens in their dander, urine, feces, and saliva. Persons who are sensitive to animal dander are at a higher risk of developing allergic disease and of having an exacerbation of their allergic disease when exposed to these allergens.^{8,10,20} Exposure to pet allergen, especially cat allergen, can lead to sensitization; however, complete pet avoidance in infancy is not currently recommended, because there is conflicting evidence regarding early childhood pet exposure and the subsequent risk of development of allergic disease.

Some studies^{19,25,26} suggest that exposure to pets early in childhood can even protect

People with asthma should avoid exposure to active and passive tobacco smoke.

against the subsequent development of allergic disease. Current recommendations for patients who are sensitive to pet allergen are to implement environmental control measures; however, few studies have proved these measures to be effective.

Most of the information on pet allergens concerns cat allergy.¹⁰ The most important cat antigen is Fel d 1, which is carried on particles that are less than 4 μm and have a low density that allows them to remain airborne for an extended time and disseminate throughout the household.^{8,10,20} Cat allergen can be found in air samples from all homes with cats, in many homes without cats, and even in some homes that never contained a cat¹⁰; this may result from airborne contamination or the transfer of allergen on clothing.

The best solution for patients with sensitivity to cat allergen is permanent removal of the cat from the house. Long-term or permanent removal of the cat is necessary to yield significant benefits because cat allergen can remain in the house for an average of 20 weeks.⁸ It is impossible to adequately remove cat allergen from upholstered furniture, carpets, and mattresses, so they may need to be replaced; mat-

tresses can be encased with vinyl or semipermeable covers.¹⁰

Permanent removal of the pet is often unacceptable to patients; therefore, the next best solution is isolation of the cat from the main living quarters; however, this is a poor compromise because cat allergens are produced in large quantities and are quickly and easily reintroduced into living areas. Indoor pets should be kept away from carpeted rooms, sleeping areas, and upholstered furniture.²⁰ Bathing the cat weekly may help reduce the amount of dander and dried saliva released into the environment, but the benefit of this intervention is unknown.^{8,10} HEPA filters have been shown to reduce allergen levels, but they have not had a significant impact in reducing associated symptoms.^{11,27}

Cockroach

Sensitization and high exposure to cockroach allergen has been strongly associated with the risk of asthma in some studies.¹¹ Cockroach allergens are found in household dust, with the highest concentrations located in the kitchen. The particles that carry cockroach allergen are relatively large (at least 10 μm in size) and remain airborne for a short period of time after a disturbance. Efforts to reduce levels of cockroach allergen should concentrate on reducing the cockroach population by controlling their sources of food and water and using insecticides; however, the clinical impact of these interventions has not been well established.¹¹

Fungus

Allergy to fungus (especially outdoor *Alternaria*) is a risk factor for asthma.¹⁰ A relationship exists between spore count and daily symptoms, but the effect of avoiding exposure has not been established. Fungi have complex life cycles, with species releasing spores in response to both high and low levels of humidity.⁸ Recommendations concerning restriction of outdoor activity should be dictated by regional spore count patterns. Spore count

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information is available from local news stations and Web sites that deal with the treatment of allergic disorders. Results from studies¹¹ evaluating the relationship between asthma and indoor fungi have been inconclusive because of the difficulty of controlling for confounding mite exposure.¹¹ The measurement of fungi exposure is also difficult because of the lack of readily available immunoassays to measure allergens.¹⁰ Measures for avoiding fungi include restricting outdoor activities when spore counts are high and maintaining a dry environment indoors.¹¹

Irritants

TOBACCO

Exposure to active and passive tobacco smoke should be avoided because it has been associated with decreased pulmonary function, increased medication requirements, and increased absence from work in patients with asthma.⁵ Maternal smoking during pregnancy and infancy increases a child's risk of developing asthma in infancy and childhood more than twofold, and can cause a 3 to 5 percent deficit in lung function.^{19,20,23}

AIR POLLUTION

Increased levels of air pollution precipitate asthma symptoms and increase emergency department visits and hospitalizations for patients with asthma. This is the case, to a lesser extent, with increased levels of sulfur dioxide and nitrous oxide. Patients with asthma should avoid exertion or outdoor exercise when air pollution levels are high.⁵

Selecting Patients for Environmental Intervention

Physicians should encourage all patients with allergic disease to implement the simple and relatively inexpensive dust mite control measures previously discussed; a possible exception may be patients who live in areas of very low humidity.¹⁰ All patients who are receiving daily therapy for persistent asthma should be questioned to determine their sensitivity to seasonal allergens and should undergo skin or in vitro testing to determine their sensitivity to indoor allergens. Allergy testing may be considered in patients with asthma of any severity and severe allergic rhinitis to assist with allergen avoidance, immunotherapy, and determining the patient's risk for developing allergic symptoms. Allergy testing can justify the expense and effort of an environmental control program, and patients are more likely to be compliant with these controls (especially those concerning pets) when presented with proof of sensitivity.⁵

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