

Environmental Controls of Allergies

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Reduction or avoidance of inhalant allergens is an important cornerstone in the management of allergic rhinitis and the one most directly controlled by the patient. Allergen avoidance is indicated for all patients according to four sets of guidelines from expert panels, two in the United States and two in Europe [1–3].

Allergy testing may be helpful in indicating which allergens the patient should avoid. Although some patients may be aware of their allergic triggers, as is the patient who comes in seeking relief of cat allergies, other patients may not even know they are allergic, but have been suffering year-round with nasal blockage and drainage. Allergens contained in dust mite excreta, in the epidermis and saliva of furred pets, in cockroach bodies, and in fungal spores are present year-round. Allergy testing may be particularly helpful in enlightening the patient and the clinician as to which allergenic triggers to target with environmental controls. Allergy testing for seasonal allergens should be directed to the pollens characteristic of the particular geographical area. The results of allergy testing enable the practitioner to recommend strategies for allergen avoidance. This article reviews environmental controls for various indoor and outdoor allergens.

Early interventions to reduce allergy

Studies on dust mite reduction or dietary manipulation in infancy or childhood are conflicting [4]. In children at high risk for allergy, significant reductions in asthma, atopic dermatitis, and allergic rhinitis at age 8 were seen in children whose mothers breastfed while eating a hypoallergenic diet or who were given hypoallergenic formula, and with dust mite reduction with acaricides and mattress covers [5]. The incidence of asthma and allergy

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is less in children who grow up on a farm, and evidence is mixed with regard to the impact of multiple pets in early childhood and subsequent allergic rhinitis [6].

Evidence that environmental controls make a difference and associated costs

Although there are several recent studies on the value of environmental controls in patients who have asthma, there are very few assessing the impact of environmental controls on allergic rhinitis. In a recent randomized placebo-controlled trial assessing the value of impermeable covers for bedding to prevent dust mite exposure in patients who had allergic rhinitis, a definite reduction in dust mite allergen was shown. There was no significant improvement of clinical symptoms of allergic rhinitis, however [7]. In a controlled study evaluating impact of high-intensity support for the reduction of indoor allergen exposure (dust mite, cockroach, and cigarette smoke) in low income children who had asthma, a significant reduction in asthma urgent health care use and asthma symptom days was shown. The authors projected that this would produce a net cost savings of between \$189 and \$721 over a 4-year period [8].

In an earlier study of inner city children who had atopic asthma, individualized home-based comprehensive environmental intervention decreased exposure to indoor allergens and resulted in reduced asthma-associated morbidity. The reduction in the level of cockroach allergen and house dust mites on the bedroom floor was correlated significantly with reduction in asthma admissions and emergency visits. The estimated cost of the intervention was \$1500 to 2000 per child. The cost savings were not specified [9].

Indoor allergens

Mold

The first randomized controlled trial to demonstrate improvement with eradication of mold from the home of asthmatics was published in 2007. Over 125 households in England that had visible mold present were randomized to receive mold reduction treatment or no treatment for the first year. In the treated houses, all visible mold was removed, and ceiling ventilation was placed. The protocol for mold removal is outlined in **Box 1**.

Asthmatics in the treated households were significantly less likely to have asthma symptoms and required less medication at 6 months compared with the controls in untreated households. At the 12-month evaluation, in addition to continued symptomatic benefit for asthma, patients from the mold-treated households experienced significant reductions in allergic rhinitis and rhinoconjunctivitis symptoms and an even larger decrease in over-the-counter and prescription medication use compared with the asthmatics in

Box 1. Protocol of mold reduction in homes with visible mold*Removal of all visible mold*

Application of RLT Bactdet, an aqueous detergent and surfactant (to clean the surface) combined with a fungicide (sodium dichlorophen)

Surface allowed to dry

Application of RLT Halophen, an aqueous preparation that contains a fungicide (dialkyl dimethylammonium chloride) and chemical agents that aid penetration below the surface to kill mold hyphae in the substrate

Each household encouraged to repaint affected areas with a fungicide mixed into the paint

Installation of a positive input ventilation fan in the loft

Data from Burr ML, Matthews IP, Arthur RA, et al. Effects on patients with asthma of eradicating visible indoor mold: a randomized controlled trial. Thorax 2007;62:766–71.

the untreated households. The primary endpoint, peak expiratory flow rate variability, declined in both groups, and was not significantly different between the two groups. The authors speculate that one reason for lack of difference in two groups could have been that some of the control houses independently embarked on mold reduction interventions. Patients who had improved peak flows tended to be from houses that sustained reduction in mold; however, this was not statistically significant. Interestingly, only 40% of the enrolled subjects demonstrated a hypersensitivity to one of the four molds tested, and improvement did not correlate with presence of mold hypersensitivity demonstrated by prick testing [10].

Mold spores are 5 to 50 μm and are smaller than pollen grains, which are 20 to 80 μm in diameter. Mold spores are ubiquitous and may come from both indoor and outdoor sources. Practical measures to reduce mold growth include prevention of wet areas on walls and carpets. Elimination of household plants, which are a common reservoir for mold growth, is recommended. Patients should be queried with regard to water damage in their dwelling. If water damage is present, then they should be apprised to repair the water damaged areas in the house in such a way as to prevent further damage as well as to remove any mold present. Commercial mold plates can be purchased and placed in the home to determine whether excess mold spores are present. A recent *Consumer Reports* article, however, reported that many commercial mold plates are not reliable [11].

Patients also can be directed to free public Web sites that provide information on environmental controls, such as www.patients.uptodate.com.

Dust mite

Most United States homes have detectable house dust mite antigen, while 46% have at least 2.0 $\mu\text{g/g}$ of dust mite per gram of bed dust, and 24% had 10 μg . Homes without children and with higher humidity were more likely to have dust mite present [12].

Dust mite is the most common sensitizing antigen in the United States [12]. Hundreds of varieties of dust mite exist. In the United States, except for tropical locations such as Florida, most dust mite sensitization is caused by *Dermatophagoides pteronyssinus* and *D farinae*. These microscopic arachnids colonize beds, upholstered furniture, and carpets. Because mites do not drink and rely on absorption of humidity from the atmosphere, reducing humidity below 50% is recommended. Dust mites do not bite, but live off of shed human skin. Dust mites are significantly less of a problem in arid areas and at altitudes greater than 5000 feet, such as Denver. Dust mite presence and sensitization, however, do occur at high altitudes that are moist year round [13].

In low altitude and humid environments, dust mites will be present. Exposure can be lessened by encasing bedding in dust mite covers and pillow case covers and washing bedding in hot water at least once a week. Both dry heat and steam treatments can eradicate dust mites. In bedding that cannot be washed, drying in a clothes drier on a hot setting can be effective. The least expensive of the dust mite barrier bedding covers are plastic; however, these can be uncomfortable for patients. Permeable synthetics that allow vapor and air movement but prevent passage of anything greater than 6 μ are effective in blocking passage of mite allergens. Mite-impermeable covers are considered to be an essential component in reducing exposure to mites.

Air cleaners are usually not effective in reducing dust mite antigen, because the antigen is so large and heavy, it is rarely airborne. Instead measures directed toward the bed, where the mite resides and the patient spends the most time, are recommended. More extreme measures such as removing all carpeting, stuffed animals, and curtains, should be pursued only if simpler measures such as reducing exposure in bedding fail to improve symptoms.

Acaricides and allergen-denaturing agents offer only a modest reduction in dust mite exposure. Benzyl benzoate is marketed as a powder to apply to upholstered furniture and carpets, followed by removal with vacuuming. Although highly toxic to dust mites, benzyl benzoate shows less than a 60% reduction in allergen, and the effect is short lived. Tannic acid denatures mite protein, but has only a minimal effect when applied to carpets [14].

Limited studies, which were reviewed in a meta-analysis of the avoidance of house dust mites with the use of high-efficiency particulate air (HEPA) filters (in one study), acaricides (in two studies), and mattress covers and hot-water laundering of bedding (in one study), demonstrated that active treatment reduced both the levels of house dust mites and rhinitis symptom scores [15]. In children who had allergen-driven asthma, environmental interventions reduced wheezing in proportion to the reduction in the levels

of cockroach and house-dust-mite allergens; however, effects on allergic rhinitis were not evaluated [9].

First line measures, which should be in place for all symptomatic dust mite allergic patients are listed below, followed by second and third line measures, which have limited efficacy or practically.

- Dust mite-impermeable covers to mattress and pillows
- Wash bedding in hot water weekly or dry on high heat.
- Change pillow case covers twice weekly.

Second-line dust mite avoidance measures include:

- Reduce humidity to less than 50%.
- Remove carpeting and upholstered furniture.
- Treat carpeting and upholstered furniture with acaricides or tannic acid.
- Vacuum with double-bagged vacuums or vacuum with a filter.

Third-line dust mite avoidance measures include:

- Move to an arid climate or to an elevation greater than 5000 feet.

Pets

Any furry animal is potentially allergenic. The most allergenic are rodents, cats, horses, and dogs. The most effective control of pet allergens is to eliminate the pet from the allergic person's environment. Because allergic rhinitis is not a life-threatening disease, environmental controls must be considered in the context of the patient and the patient's family's attachment to the pet. This is pointedly made by the saying, "the allergist told the patient to get rid of his cat, so the patient decided to get rid of their allergist." If pets can be kept outdoors, a significant reduction in antigen exposure can be expected. If the pet must come indoors, then the pet should not be allowed in the allergic person's bedroom, and all attempts to isolate the bedroom from pet allergen exposure should be made. Practical steps include keeping the door closed between the bedroom and the rest of the house and using an effective air cleaner in the patient's bedroom. Air filtration has been demonstrated to significantly improve objective measures of asthma in children, even if the animal remains in the house [16].

Bathing cats weekly was once thought to be an effective method of reducing allergenicity. This is extremely difficult to perform in an adult cat, and more recent studies have shown that cat allergen in the air returns to prebath levels as quickly as 24 hours later [17].

A hypoallergenic cat has been developed by breeding cats naturally deficient in the primary antigenic protein, Fel d 1. These neutered cats soon may be commercially available at a cost in excess of \$3500 per cat [14].

Cockroaches

Cockroach sensitization usually occurs along with other sensitizations typical of the inner city, such as mouse, mold, and dust mite, so studies

targeting cockroach reduction alone have failed to show clinical benefit. Studies targeting multiple antigens did show improvement in asthma [9]. Cockroach is ubiquitous and should be part of all allergy-testing panels. If sensitization is present, and cockroaches are present in the living environment, efforts should be made to eradicate them. Current recommendations include placing multiple baited traps or poisons, eliminating food sources, and removing cockroach debris. Air filtration is not effective, because cockroach antigen is heavy, settles quickly, and does not remain airborne.

Outdoor allergens

Controlled trials of the avoidance of outdoor allergens by staying indoors are not feasible. Practical measures to reduce exposure to outdoor allergens are to effectively seal the house during the period in which the outdoor allergens are high, and for the person to stay in the house. Therefore air conditioning in the summer and avoiding open windows and ceiling ventilation fans that pull air in from the outdoors are reasonable recommendations. For the allergic gardener, wearing long sleeve shirts and long pants while gardening and immediately removing these covering clothes after gardening followed by showering may be helpful. Even pets to which a person is not allergic can bring allergenic pollen and mold into the house if the pet roams outdoors. Bathing a pet after a long meadow romp may be helpful.

The grass-allergic person should not mow pollinating grass. If forced to mow, then exposure can be reduced using respirators and goggles; however it is usually easier to find someone else to mow the grass. Mold is frequently present in counts tenfold that of pollens and occurs seasonally. This can be assessed from local pollen/mold counts. Mold is highest in thatch and composting leaves. The mold-allergic patient should avoid leaf raking and composting, unless wearing protection such as a mask or respirator. Patients allergic to outdoor allergens should drive with their windows closed and should use the air conditioner on the recirculation mode during their allergen season to reduce exposure while they are in the car.

Pollen counts are generally lowest after a rain; however around 2 hours after a rain, mold spore counts rise. Warm breezy days are associated with high pollen counts. The allergic patient usually can get a local update on mold or pollen counts in his or her regional paper or on the Internet and can use this information to judge whether outdoor activities are likely to provoke allergy symptoms.

Summary

Avoidance of the allergen remains the safest and theoretically most effective method of managing allergies. Allergy testing allows patients and their doctors to accurately pinpoint targets for environmental controls. Ultimately, environmental controls rest in the hands of the patient, so educational

materials and practical compromises are crucial to effective implementation of allergen-avoidance measures.

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