Allergic Rhinitis and Asthma: How to Help Patients Control Environmental Triggers

**ABSTRACT:** Avoidance of allergens and irritants known to cause or aggravate allergic rhinitis and asthma is a key component in the management of these disorders. For patients who are allergic to house dust mites, the use of bedding encasements reduces dust mite allergen levels and bronchial hyperresponsiveness. Other measures, such as dehumidification, air filtration, and frequent vacuuming, reduce indoor allergen exposure and may prevent symptoms. Effective control of cockroaches requires intervention, such as extermination, every 1 to 2 months. A comprehensive approach to management of asthma and allergic rhinitis incorporates allergen testing to identify causes and triggers as well as indoor allergen detection for correlation of allergen sensitization with environmental exposure. Ongoing patient education and behavioral modification are essential for optimal outcomes.

**Key words:** allergic rhinitis, asthma, allergens, irritants

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 Exposure to environmental allergens is associated with the development of allergic rhinitis and asthma; appropriate interventions can reduce indoor allergen exposure and improve clinical outcomes. On page 490, I reviewed the environmental determinants of allergic rhinitis and asthma. In this article, I address the importance of allergen avoidance measures in patients with these conditions and describe the interventions that effectively reduce exposure to dust mite, pet, and cockroach allergens.

**ENVIRONMENTAL INTERVENTIONS**

Many studies have investigated the effects of environmental interventions on reducing allergen levels and improving asthma and allergy symptoms. These studies are labor-intensive and require continual assessment for at least 6 months to a year before changes in clinical outcomes can be identified. Studies in which little or no improvement in allergen exposure levels or clinical outcomes were observed need to be carefully interpreted to ensure that the duration of the study and control of potential confounding variables were adequate.1

Table 1 lists specific environmental interventions that reduce allergen exposure and symptoms.

**Dust mite allergen.** The following measures have been shown to reduce the levels of dust mite allergen:

**Change of environment.** A study that demonstrated the effectiveness of allergen intervention in improving asthma symptoms was conducted in Davos, Switzerland.2 Children from an urban environment who had asthma and dust mite sensitization were sent to a sanatorium on a mountain, where dust mite allergen levels are very low. After 1 year, baseline bronchial hyperresponsiveness had either significantly decreased or completely disappeared. Many children were able to reduce or discontinue their medications. However, after the children returned to their homes in the city, their asthma symptoms and bronchial hyperresponsiveness returned. Other high-altitude studies have reported similar findings.3

**Bedding encasements.** Subsequent studies have examined more practical environmental control interventions, such as bedding encasements. Ehnert and colleagues4 found that bedding encasements reduced dust mite allergen levels by 98% and reduced bronchial hyperresponsiveness in dust mite–sensitized children with asthma. Maintaining dust mite levels between 2 and 10 µg/g of dust—levels that have been relatively innocuous for causing dust mite sensitization and asthma symptoms—was possible with encasements alone. However, subsequent studies have found that although encasements used alone as an environmental control interven-
tion effectively reduced dust mite allergen levels, they did not reduce symptoms related to allergic rhinitis and asthma.5,6

Murray and Ferguson7 randomized dust mite–sensitized children with asthma to 2 groups. One group received dust mite protective bedding and aggressive house cleaning; the other group received no intervention. After 1 month, the children in the intervention group demonstrated significant improvement in asthma, measured by reduction in symptoms and medication requirements. They also experienced measurable improvement in peak expiratory flow rate (PEFR) measurements and histamine-induced bronchial hyperresponsiveness.

Dehumidification has also been studied as an intervention for dust mite control. Arlian and colleagues8 found that maintaining mean daily indoor relative humidity below 50%, even when the relative indoor humidity is above 50% for 2 to 8 hours a day, effectively reduces dust mite growth and production of allergen. They concluded that maintaining the relative humidity below 35% for at least 22 hours a day is necessary to completely eliminate dust mites.

Cabrera and associates9 reported that dust mite allergen levels were reduced by more than 50% with dehumidifier use. They concluded that dehumidification was a simple and effective way to control dust mites, especially in humid climates.

**Vacuum cleaning.** Removing carpets and replacing them with tile, linoleum, or hardwood flooring reduces the amount of indoor dust mite allergen. However, this measure is not always affordable or practical. Special high-efficiency particulate air (HEPA) vacuum cleaners and, to a lesser extent, standard vacuum cleaners with double-layered bags, pick up dust mite allergen from carpets more efficiently; they also produce less airborne dust. Vaughan and coworkers10 recently reported that vacuum cleaners designed with HEPA filters and microfiltration bags leaked significantly lower amounts of allergens than standard vacuum cleaners and vacuum bags.

Hegarty and associates11 compared 4 microfiltration vacuum cleaners with a conventional upright vacuum cleaner using standard bags or special bags with a pore size of 0.1 µm. They found that the microfiltration vacuum cleaners produced lower levels of airborne dust mite allergen than conventional vacuum cleaners with or without the special bags. However, microfiltration vacuum cleaners varied in how much dust they retrieved.

**Carpet treatments.** Many studies have investigated the effectiveness of carpet treatments that either kill dust mites or denature dust mite allergen. Woodfolk and colleagues12 found that benzyl benzoate and tannic acid reduced airborne dust mite allergen by more than 64%. The percent change in dust mite levels after treatment was significantly greater than for untreated carpets. However, the same reductions were not found for cat allergen. Repeated applications with tannic acid were necessary to maintain reduced allergen concentrations. Chang and associates13 found that the addition of benzyl benzoate to conventional house dust mite avoidance measures resulted in a significant reduction in carpet dust mite levels that persisted up to 3 months.

Recent studies support the need for multiple interventions in the home to effectively reduce dust mite allergen levels. van der Heide and associates14 compared the effect of mattress encasements with or without application of benzyl benzoate on the mattress and bedroom and living room

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**Table 1 – Effective environmental control interventions directed at indoor allergens**

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Reduction in allergen levels</th>
<th>Reduction in allergen levels and symptoms</th>
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<tbody>
<tr>
<td>Bedding encasements</td>
<td>Dust mite, cat, mold</td>
<td>Dust mite, cat</td>
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<tr>
<td>HEPA filtration</td>
<td>Cat, dog</td>
<td>Cat, dog</td>
</tr>
<tr>
<td>HEPA vacuum cleaner</td>
<td>Dust mite, cat, dog, cockroach</td>
<td>Not studied</td>
</tr>
<tr>
<td>Dehumidification</td>
<td>Dust mite, mold, cockroach</td>
<td>Not studied</td>
</tr>
<tr>
<td>Thorough cleaning</td>
<td>Cockroach</td>
<td>Not studied</td>
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HEPA, high-efficiency particulate air.
*Based on high-quality evidence.
carpets on lung function and airway hyperresponsiveness in dust mite–sensitized asthmatic persons. Airway hyperresponsiveness significantly improved in groups that used mattress encasements. A small but statistically significant change in airway hyperresponsiveness was detected in the group that also used benzyl benzoate.

**Cat and dog allergens.** Frequent vacuuming with a HEPA vacuum or standard vacuum with double-layered bags helps reduce cat allergen in carpets. Woodfolk and colleagues\(^1\) studied the effectiveness of 4 groups of vacuum cleaners in controlling airborne cat allergen during vacuuming. Vacuum cleaners with double-thickness vacuum bags and HEPA filtration effectively retained cat allergen compared with the other models studied, which leaked allergen. When modified with an electrostatic filter, some models more effectively captured and retained allergen.

Studies suggest that even some HEPA filters may leak, which results in inadequate cleaning, and that vacuuming can increase one’s personal exposure to cat allergen.\(^1\) The consensus recommendation is to vacuum intensively and slowly, using either a HEPA vacuum or a standard vacuum cleaner with double-lined bags. This method reduces carpet allergens for longer periods.\(^4,17\)

One study compared a regular vacuum cleaner with a central vacuum cleaning system and found that the level of airborne dust mite or cat allergen was the same before and after use. This study indicates that proper vacuuming technique is more important than the type of vacuum cleaner used.\(^18\)

The most cost-effective intervention for reducing cat or dog allergen exposure is to remove these animals from the home. However, many patients are unwilling to comply with this recommendation. If removal is not possible, suggest to patients that they keep the pets out of the bedroom(s) and main activity rooms.

Studies have shown that freestanding HEPA filters can reduce airborne cat allergen levels in the bedroom and living room.\(^19,20\) Some studies have also demonstrated that the reduced levels of cat allergen were associated with improved lung function and reduced asthma symptoms in patients with cat-induced asthma symptoms.\(^20\)

Other reports have shown a similar association between decreased airborne dog allergen levels and improved clinical outcomes.\(^21\)

Washing pets frequently may reduce allergen levels temporarily (less than 24 to 48 hours), but this is not an effective long-term solution for animal allergen exposure.\(^1,22\)

**Cockroach allergen.** Cockroach management and control require persistence. Cockroach allergen levels can last for several months after the insects have been exterminated. Furthermore, there are no effective methods to kill cockroach eggs. To effectively control cockroach populations and allergen levels, interventions must be conducted every 1 to 2 months. Sarpong and associates\(^23\) investigated the effects of extermination every 6 months in an urban dormitory infested with cockroaches. Rooms were vacuumed once a week and carpets were shampooed once a year. Dust sampling for cockroach allergen revealed that extermination significantly reduced cockroach allergen levels.

Eggleston and colleagues\(^24\) intervened in 13 inner-city homes infested with cockroaches. Each home was professionally cleaned by vacuuming and thorough cleaning of the kitchen. Pesticides were placed in the kitchen and other parts of the home every month up to 8 months, at which time dust samples were also collected. The results showed that extermination effectively killed cockroaches, but that standard housecleaning procedures were only partially effective in removing the residual cockroach allergen. A subsequent multiple-intervention study designed to reduce airborne particulate matter and indoor allergen (including cockroach allergen) levels in inner-city homes demonstrated only a modest effect on asthma morbidity.\(^25\)

Williams and associates\(^26\) found that the number of living cockroaches is greatly reduced by extermination procedures. However, the amount of cockroach allergen does not appreciably decline over 6 months. The authors speculated that longer periods are required to reduce cockroach allergen levels. The difficulty in reducing cockroach allergen in inner-city homes is largely attributable to socioeconomic factors that preclude strict adherence to avoidance protocols.

**Mold allergens.** No studies have examined mold interventions and their effects on health outcomes. However, there is a clear relationship between home dampness and increased respiratory illness.\(^27,29\) Interventions such as dehumidification and UV irradiation may effectively prevent mold spores from propagating, but the long-term benefits of these interventions require further investigation.\(^29,32\)

A double-blind, placebo-controlled trial to determine the effect of
Educating patients about the relationship between allergens and asthma is the first step in improving compliance. To accomplish this formidable task, it is necessary to raise the awareness of patients, employers, and health care practitioners about indoor air quality and allergen exposure.

High-efficiency HEPA filtration in conjunction with dehumidification on reduction of airborne mold and bacteria levels in 2 day-care centers revealed that this intervention effectively controlled indoor dew points in both facilities and reduced airborne culturable fungal spore levels in 1 of the facilities. More recently, in-duct central UV irradiation units installed in the homes of allergic asthmatic children have been demonstrated to reduce the children’s PEFR variability and many of their symptoms. Although not statistically significant, there was an overall positive trend in reducing levels of culturable fungal spores in these children’s homes.

NHLBI GUIDELINES

The results of the aforementioned studies strongly support the relationship between allergen exposure, sensitization, and the development of allergic rhinitis and asthma. Furthermore, many studies have shown that appropriate interventions can reduce indoor allergen exposure and improve clinical outcomes. There is now agreement that avoidance of allergens and irritants known to cause or aggravate allergic rhinitis and asthma should be a central component in the management of these disorders.

The most recent version of the National Heart, Lung, and Blood Institute (NHLBI) National Asthma Education and Prevention Program asthma guidelines released in 2007 emphasizes the importance of asthma control. These guidelines continue to emphasize the importance of assessment and monitoring, avoidance of triggers known to cause asthma, pharmacologic therapy, and asthma education. The wide dissemination of these guidelines has resulted in an asthma mortality plateau but the morbidity and cost to treat asthma in the United States has continued to rise.

Therefore, it is essential that physicians who treat patients with asthma read the asthma guidelines and attempt to incorporate them into their routine management of their asthma patients. These guidelines emphasize the importance of subjective and objective criteria for making a definitive diagnosis of asthma.

Asthma control. Patient centric questionnaires called the Asthma Control Test (ACT) and the Asthma Control Questionnaire (ACQ) have been developed to quantify asthma control. These instruments are very easy for the patient to complete at each office visit and have been shown to correlate with lung function (FEV1). For the ACT, the higher the score the better the patient’s asthma is controlled, whereas for the ACQ, a higher score indicates poorer control.

Assessment and monitoring. Most patients with asthma require controller medications to prevent smooth muscle dysfunction and airway inflammation, the 2 cardinal pathogenic features of this disease. Therefore, pulmonary function testing should be performed before and after bronchodilator medications are administered.

Table 2 – Integrative approach to the assessment and management of asthma and allergic rhinitis

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<thead>
<tr>
<th><strong>History:</strong></th>
<th>Includes a thorough environmental survey of home and workplace.</th>
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<tr>
<td><strong>Assessment and monitoring:</strong></td>
<td>Includes allergen skin testing or specific IgE in vitro tests, nasal eosinophil smear, peak expiratory flow rate measurement, and/or spirometry. Dust sampling is important for assessing levels of indoor allergen exposure and for monitoring effectiveness of environmental remediation.</td>
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<td><strong>Avoidance of asthma and allergy triggers:</strong></td>
<td>Specific recommendations are based on environmental history, skin test sensitization, and objective measures of environmental exposure.</td>
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<td><strong>Pharmacologic treatment:</strong></td>
<td>Therapy is directed at controlling symptoms and reducing airway inflammation. Immunotherapy should be incorporated when appropriate, based on the patient’s history, skin test sensitization, and environmental exposure.</td>
</tr>
<tr>
<td><strong>Education:</strong></td>
<td>Behavior modification is essential for improved compliance with physician recommendations, environmental control interventions, and pharmacologic treatment.</td>
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administered to determine whether there is at least a 12% improvement in forced expiratory volume in 1 second. If spirometry results are normal but the history suggests asthma, PEFR monitoring for 2 to 3 weeks to assess for diurnal variability greater than 20% may help establish the diagnosis. If the diagnosis is still equivocal, methacholine challenge is a useful adjunct for establishing airway hyperresponsiveness consistent with asthma. Recently, exhaled nitric oxide (eNO) has been found to be a useful adjunctive non-invasive tool for assessing airway inflammation in patients with suspect or existing asthma.\(^{35}\)

The effort and cost involved in confirming a diagnosis of asthma are minuscule compared with those associated with an erroneous diagnosis. Although not emphasized in the most recent version of the NHLBI guidelines, monitoring with a peak flow meter or newer computerized flow meter helps alert the clinician to inadequate therapeutic response and early deterioration of lung function, which may herald an asthma exacerbation.

**Avoidance of triggers.** This component necessitates a thorough environmental history of home and workplace. However, history alone is insufficiently sensitive to identify environmental exposures.\(^{36}\) A walk through the home or workplace is recommended for identifying the sources and magnitude of allergen and irritant exposures. Unfortunately, this can prove costly and time-consuming for the physician, patient, and employer.

Currently, recommendations for avoidance measures are based on history and allergy skin testing, the preferred method for identifying whether a patient is sensitized to 1 or more allergens. However, skin sensitization alone does not indicate that the patient has clinical allergies or that he or she is currently exposed to the offending allergen. The physician must correlate skin test results with the patient’s history and environmental exposure to confirm allergies.

To further complicate matters, patient compliance with avoidance measures is generally poor. Studies indicate that only 10% to 30% of allergic patients implement environmental interventions.\(^{37}\) Given the importance of reducing exposure to asthma triggers, a greater effort by physicians and allied health personnel is necessary to improve patient compliance.

**Education.** Educating patients about the relationship between allergens and asthma is the first step in improving compliance.\(^{38}\) To accomplish this formidable task, it is necessary to raise the awareness of patients, employers, and health care practitioners about indoor air quality and allergen exposure.

The traditional approach for assessing indoor air quality requires the services of a professional experienced in dust and air sampling methods. These analyses can be costly and may not always be warranted. A more practical approach would enable the patient to collect dust samples from different rooms in the home or workplace and send these samples to a central laboratory for analysis. This information would enhance management of asthma and allergies by enabling the physician to more precisely tailor recommendations for environmental control.

Dust sampling would also allow the patient and physician to monitor the effectiveness of environmental control measures in reducing indoor allergen levels. In addition, effective reduction of indoor allergen exposure should improve the therapeutic response to medications and immunotherapy. Thus, an affordable and reliable indoor allergen detection method that identifies allergen exposure is the missing piece of the puzzle that connects allergen sensitization to clinical symptomatology. Allergen detection should increase compliance with environmental control measures just as peak flow meters and spirometry help improve both the diagnosis of asthma and compliance with controller medications.

**An integrative approach.** A comprehensive approach for incorporating environmental assessment into the sequential evaluation of patients with allergies and asthma is outlined in Table 2. Such an approach is required for optimal management.

Evaluation should incorporate allergen testing to identify causes and
Recent studies support the need for multiple interventions in the home to effectively reduce dust mite allergen levels.

triggers and indoor allergen detection for correlation of allergen sensitization with environmental exposure. This will enable the clinician to make specific recommendations regarding environmental control measures.

As with any chronic illness, repetitive education and behavioral modification are essential for optimal outcomes. Occupational studies have demonstrated that removing the worker from an exciting asthmagen or removing the exciting asthmagen from the workplace significantly reduces the incidence of occupational asthma. This observation has been well established for numerous high and low molecular weight agents, such as detergent enzymes and isocyanates.1, 42 The practice of indoor allergen and irritant avoidance in the home is also effective but requires that the patient take responsibility to modify his living environment and cleaning behaviors.

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