
Measuring allergen exposure in the home: who benefits?

Allergen avoidance is recommended as the first step in asthma management by the expert panel report of the National Health, Lung, and Blood Institute (NHLBI) and several other workshop reports and position statements.¹⁻⁴ In the NHLBI report, evaluation of allergen exposure is based on the patient's history and evidence of allergen sensitization by skin tests or in vitro tests for IgE antibodies.¹ This approach is, at best, a crude measure of assessing exposure. Patients are unlikely, or even unwilling, to provide a reliable history of whether they have dust mites or cockroaches in their homes, and they may be inadvertently exposed to animal allergens in the homes of others or in public places.⁵⁻⁹ Further, housing conditions across the United States vary enormously, which makes it unwise to make routine assumptions about allergen exposure.

Immunoassays for measuring the common indoor allergens have been available for more than 10 years.^{2,10,11} However, their use has largely been confined to epidemiologic studies of asthma, evaluation of allergen control procedures and devices, and allergen standardization. Most allergists do not routinely evaluate household allergen exposures as part of their clinical practice. There are now over a dozen reference laboratories in the United States that provide allergen assay services, but most of the samples are provided by indoor air quality (IAQ) specialists, environmental engineering companies, research studies (either grant-funded or contract research), and litigation proceedings. Visiting patients' homes to collect samples for allergen analysis is time-consuming, costly, and not reimbursed by medical insurance. Most al-

lergists treat patients in their offices or outpatient clinics, whereas IAQ specialists regularly make home visits. Another reason why allergists may have shied away from measuring allergen exposure is that there have been few studies comparing allergen exposures among allergy clinic patients.

In this issue, Barnes et al¹² at the Children's Mercy Hospital in Kansas City, MO solicited dust samples from asthma patients and nonasthmatic controls presenting to their allergy/immunology clinic or to a private allergy office. Diagnosis of asthma was based on National Institute of Health criteria and retrospective chart reviews. Patients were skin-tested for mite, molds, cat, roach, and pollens and asked to provide a dust sample ("1 cup") from their vacuum cleaner bag for allergen analysis. A broad range of allergens was measured by inhibition enzyme immunoassay (EIA) including mite (*Dermatophagoides farinae*), dog, cat, cockroach, pollens, and molds. Specific allergens (Der p 1, Der f 1, Alt a 1 and Alt a 70kD) were measured by monoclonal antibody-based enzyme-linked immunosorbent assay (ELISA).

The results on 47 samples available for analysis showed that all the homes contained detectable cat allergen and that >80% of the samples contained detectable mite and *Alternaria* allergens by monoclonal ELISA. A surprising finding was the high prevalence of samples that contained detectable fungal allergens, including >50% of homes with measurable *Alternaria* and *Cladosporium* antigens by inhibition EIA. Although the authors noted a modest trend toward significant differences in exposure between the asthma and nonasthma groups ($P = 0.03$ to

0.06 for Der p 1, Der f 1, Alt a 1, and Alt a 70kD), these differences were not significant for any of the allergens measured by inhibition EIA. Previous studies have not found significant differences in allergen exposures for asthma and nonasthma patients.² The authors invoke the old canard that epitope structure, density, or distribution may explain some of the differences between polyclonal and monoclonal based assays, but this seems unlikely. Irrespective of the number of epitopes, monoclonal assays measure a single allergen, as with polyclonal antibodies directed against the same protein. The distinctions between the assays reflect the fact that the EIA measures multiple allergens and antigens, making standardization more difficult. The range of measurements reported for mite, cat, and dog allergens are in line with previous studies. The authors conclude that exposure to fungal allergens could contribute to the pathogenesis of asthma. There are some caveats regarding sample collection method and the specificity of the inhibition EIAs, and the results suggest that a large number of patients living in their Kansas City homes were exposed to fungal antigens or allergens. The significance of the fungal inhibition EIAs needs to be further validated by identifying the antigens that they detected and establishing their clinical significance. In other studies using monoclonal ELISA for Asp f 1 and for Alt a1, it has been difficult to detect these allergens in environmental samples.^{13,14} Asp f 1 is not produced in fungal spores, which are the major source of *Aspergillus* in most dust samples, and Alt a 1 measurements need to be validated against dust sam-

ples which have a known content of *Alternaria* spores.

There are a number of reasons why allergists should consider measuring environmental allergen exposures. Epidemiologic studies have consistently shown a strong association between allergic sensitization and asthma, and there is increasing evidence for dust mite of a dose-response relationship between exposure and sensitization.^{2,3,15} Assessing household allergen exposures can play a role in controlling environmental factors that contribute to asthma severity, as emphasized in the NHLBI expert panel report.¹ Data from several studies show that mite allergen exposure in the United States varies according to local conditions, especially relative humidity (RH). A study in Boston, MA, demonstrated that houses with high RH year round contained high levels of Der f 1, whereas centrally heated apartments with <45% RH for 6 to 7 months of the year contained exceptionally low allergen levels (<0.3 $\mu\text{g/g}$, comparable with allergen-free hospital rooms).¹⁶ Conversely, mite exposure in dry arid deserts of the southwest United States can be high because of the use of evaporative cooling systems.¹⁷ "Occult" exposures to animal allergens, especially cat and dog, can occur in schools, workplaces, and other public places and exposure to cockroach allergens has been reported in 20% of urban homes that lacked visible evidence of cockroach infestation.^{5-9,18} These studies underscore the fact that exposure to indoor allergens cannot be assumed.

Monitoring allergen exposure has also been reported to be of value in evaluating the results of mite immunotherapy among asthma patients.¹⁹ Although there are no reported studies for indoor allergens investigating whether household exposure affects the efficacy of immunotherapy, there are precedents from hay fever studies indicating that immunotherapy is more effective when administered out of season, when allergen exposure is lowest. Perhaps the most important ratio-

nale for making allergen measurements is to improve patient education about the relationship between allergens and asthma. The objectives are to show that, in addition to having positive skin tests (or in vitro IgE reactivity) to an allergen, the patient is also exposed to the relevant allergen at home. This information can help patients 1) by better understanding and reinforcing the link between allergen sensitization, exposure and disease activity; 2) enabling informed decisions to be made about treatment options, including immunotherapy and allergen avoidance; and 3) by encouraging implementation and compliance with allergen avoidance procedures. The importance of educating patients so that they can play a leading role in controlling allergen exposures is critical.²⁰ The introduction of allergen control procedures and devices that have been extensively tested for their effects on allergens has provided significant benefits in validating these products for use by allergy patients. Simple screening tests which enable patients to detect mite allergens in the home are now commercially available and will further encourage patients to take steps to control allergen exposure.²¹⁻²³

Allergists should be the prime source of advice and information on measuring and controlling indoor allergen exposures. This could involve the use of allied health personnel to advise patients on sample collection or even to make home visits. Building partnerships with IAQ specialists or environmental engineers may also help provide patients with objective information on allergen exposures. Both patients and allergists will benefit from innovative approaches of this kind, which should improve patient education, promote "low allergen living," and help control asthma symptoms.

Potential Conflict of Interest

The author is founder of the Indoor Biotechnologies companies (Charlottesville, VA and Manchester, UK) which are involved in the production of allergen de-

tection systems and provide reference laboratory services.

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