Maintenance of Certification clinical management series

Series editor: James T. Li, MD, PhD

# Role of environmental control in the management of asthma and allergy

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**Activity Objectives**

1. To take an environmental history focused on indoor exposures known to exacerbate asthma.
2. To evaluate a patient for sensitization to allergens relevant to the patient's geographic location and community.
3. To incorporate environmental control practice counseling as an integral component of asthma management.
4. To provide evidence-based environmental control practice recommendations to patients.

**Recognition of Commercial Support:** This CME activity has not received external commercial support.

**Disclosure of Significant Relationships with Relevant Commercial Companies/Organizations:** E. C. Matsui received honoraria from Indoor Biotechnologies and research support from the National Institutes of Health. J. T. Li has consulted for Abbott.

## CLINICAL VIGNETTE

An 8-year-old boy and his mother are referred to an allergist by his pediatrician. He has asthma that is reasonably well controlled on daily moderate-dose inhaled corticosteroids in addition to symptoms consistent with persistent allergic rhinitis. His pediatrician and mother are both interested in having him evaluated for allergies that might be contributing to his asthma and allergic rhinitis. He has no nocturnal symptoms, and his last exercise-induced symptoms occurred 2 weeks ago. He typically needs rescue medication once every 1 to 2 weeks. He has never been hospitalized for his asthma, and his last emergency department visit was a year ago. He had 2 exacerbations in the past year requiring oral corticosteroid bursts, and this has been the typical frequency for his exacerbations over the past several years. His exacerbations tend to occur in the winter and fall, and the triggers are generally not clear to his mother. However, she reports that one of his exacerbations occurred after he spent the night with a friend who had 2 cats.

His environmental history is remarkable for the presence of a cat in his home; report of occasional mouse sightings, particularly in the fall and winter; and evidence of cockroaches. The family lives in an apartment with wall-to-wall carpeting, gas heating, and a gas stove. The mother reports no moisture problems or visible mold. An aunt who smokes lives with the patient and his mother. The child's bedroom has wall-to-wall carpet, and there are no allergen-proof mattress or pillow encasements on his bed. The child attends a school in an urban neighborhood and spends the afternoons after school at his grandmother's home. His mother does not know whether there are any classroom pets or pest infestations in the school. However, she has seen evidence of mice at the child's grandmother's home.

The patient's physical examination is remarkable for allergic shiners and large, boggy inferior turbinates. His lungs are clear to auscultation, with no prolonged expiratory phase and good air movement. His $FEV_1$ percent predicted is 90%, and his $FEV_1$/forced vital capacity ratio is 0.82. Skin prick testing is performed to cat hair, dog hair/dander, mouse epithelia, cockroach mix, *Dermatophagoides farinae*, *Dermatophagoides pteryonyssinus*, *Alternaria alternata*, *Aspergillus fumigatus*,

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Received for publication September 7, 2011; revised October 17, 2011; accepted for publication October 18, 2011.

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0091-6749/$36.00

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doi:10.1016/j.jaci.2011.10.022

*Penicillium notatum*, *Cladosporium herbarum*, and a panel of seasonal aeroallergens common to the Northeastern United States, where the patient resides. The patient has an adequate histamine response and negative saline control and positive skin prick test results to cat, mouse, cockroach, and dust mite. His skin test results to the rest of the panel are negative. In addition to reviewing goals for asthma management and providing the mother with a written asthma management plan, the allergist reviews the skin test results with the patient and his mother and makes recommendations regarding environmental control practices as a part of the management of the patient's asthma.

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## REVIEW

## General considerations

When counseling patients about environmental control practices, it is important to recommend an approach that targets not just 1 potential trigger but all potential environmental triggers for that patient.[E1-E4] The menu of potential triggers will vary for each patient, and therefore it is important to identify the relevant allergens and pollutants to which a patient is exposed by taking a detailed environmental history, including potential exposures in the workplace and school.[E5] Evaluation of allergen sensitivity will be critical in determining which potential allergen exposures are likely to be clinically relevant. Table E1 summarizes environmental control practice recommendations for the exposures addressed in this article.

### Furry pets

The most common furry pets are cats and dogs, although patients often have other furry pets, such as gerbils, hamsters, guinea pigs, rabbits, and others. Furry animal allergens are carried on small particles and therefore become airborne with minimal disturbance. The major dog and cat allergens, Can f 1 and Fel d 1, respectively, are ubiquitous in homes and public buildings, likely because these allergens are passively transferred on clothing to other homes and public buildings. However, homes with pets have substantially higher concentrations of the allergens than homes without pets.

A variety of environmental interventions have been evaluated for furry-pet allergens. The first-line recommendation is to find the pet a new home because this approach is the only one that will result in significant reductions in allergen concentrations and has been associated with improved airway hyperresponsiveness and reduced inhaled corticosteroid dose.[E6] Even so, substantial reductions in the allergens will not occur for 4 to 6 months, so that lending a pet to a friend or relative for a few days is not a sufficient empiric trial of pet removal. Because pets are seen as integral to the family unit, patients are reluctant to give them up, and alternative approaches to allergen reduction have been examined. A common second-line approach, which is of limited benefit, is to keep the pet from entering the patient's bedroom and to use air purifiers equipped with high-efficiency particulate air (HEPA) filters.[E2-E4]

### Cockroach

German and American cockroaches are common in urban homes and produce the major allergens Bla g 1 and Bla g 2 and Per a 1, respectively. Environmental control measures that have included integrated pest management (IPM) have been successful at achieving substantial reduction in cockroach allergen concentrations,[E7,E8] and the magnitude of reduction in cockroach allergen levels in one multifaceted environmental intervention study was associated with the degree of reduction in asthma symptoms among cockroach-sensitized children.[E1] IPM includes sealing holes and cracks that serve as entry points for pests, elimination of food and water sources, and application of cockroach bait by a licensed pest-control professional. Cockroach insecticide bait should be targeted to locations with evidence of cockroach activity, as assessed by cockroach trapping. Food and water sources can be eliminated by fixing leaky faucets; storing foods in hard plastic, glass, or metal containers with sealable lids; and meticulous housekeeping practices. Further detail regarding IPM methods can be found in a recent work group report.[E8] Because cockroach allergen is carried on larger particles, it is not readily detectable in the air. As such, there is little rationale for the use of air purifiers in cockroach allergen reduction strategies.

### Mouse

*Mus musculus*, the domestic house mouse, is also a common pest in urban environments. The major mouse allergen Mus m 1 is found in most homes in the United States but is virtually ubiquitous in inner-city homes and present in substantially higher concentrations in inner-city homes than suburban homes.[E2-E4,E8] Similar to cockroach allergen, IPM is the first-line approach to reducing mouse allergen concentrations in the home. For mice, IPM also includes placement of traps, concentrating placement where there is evidence of mouse activity. IPM can result in substantial reductions in mouse allergen concentrations and might be associated with some improvement in asthma health if substantial reductions can be achieved.[E8] Although air purifiers have not been studied for mouse allergen reduction, murine allergen, similar to other furry-animal allergens, is carried on smaller particles and therefore is readily airborne so that air purifiers could be a useful adjunct to IPM.[E9]

### Dust mite

*Dermatophagoides farinae* and *Dermatophagoides pteronyssinus* are the 2 most common dust mite species in the United States. First-line approaches to reduce dust mite allergen concentrations focus on bedding because this is a major reservoir for allergens and is a site at which patients spend a substantial proportion of their time. Allergen-proof mattress and pillow encasements serve to trap dust mite allergen in pillows and mattresses so that it cannot escape to other parts of bedding, and washing all bedding in hot water once every 1 to 2 weeks serves to remove accumulated allergen and kill new dust mites. Dust mites are reliant on humid environments because they obtain water directly from humid air, and therefore reducing humidity to less than 45% will reduce dust mite growth. Second-line interventions include removal of allergen reservoirs, such as carpeting and upholstered furniture. Acaricides and tannic acid have limited benefit and are impractical to use and therefore are not recommended. Although distribution of mattress and pillow encasements to a primary care population of adults with asthma did not improve asthma health, other studies have demonstrated significant improvements in asthma with dust mite interventions. Like cockroach allergens, dust mite allergens are carried on larger particles and quickly fall to dependent surfaces, and therefore air purifiers would be expected to have limited effect on dust mite allergen concentrations.[E2-E4]

### Molds

Although molds have long been recognized as potential allergic triggers of asthma, their complicated biology has made it challenging to study their effects on asthma symptoms. In addition, indoor and outdoor mold concentrations are generally correlated, so that classification of the major asthma-related molds as strictly indoor or outdoor molds might be an oversimplification. To further complicate matters, molds can cause inflammatory responses through a variety of mechanisms because their constituents include allergens, toxins, and innate immune stimuli. Nevertheless, a strong body of evidence supports a role for molds, particularly *Alternaria*, *Aspergillus*, *Cladosporium*,

and *Penicillium* species, triggering asthma exacerbations in sensitized patients.[E4] Fewer studies have accounted for outdoor mold when examining the effects of indoor mold on asthma, but a recent inner-city study found that indoor *Penicillium* species exposure was associated with asthma exacerbations independently of outdoor *Penicillium* species levels.[E10] The repeated and strong association between damp housing and poor asthma health, which is independent of dust mite exposure, suggests that another indoor exposure that thrives in humid conditions, such as mold, might be responsible this association. One randomized controlled trial found that a home dampness intervention, which included household repairs, removal of water-damaged building materials, and heating/ventilation/air conditioning alterations, was associated with decreased asthma symptoms and exacerbations.[E11] In addition to these comprehensive interventions aimed at dampness reduction, patients with asthma who are sensitized to molds might also benefit from controlling indoor humidity with an air purifier equipped with a HEPA filter and cleaning of visible mold.[E4]

## Pollutants

It is also important to consider indoor pollutant exposures when evaluating a patient with asthma. These include particulate matter (PM) and gasses, such as nitrogen dioxide ($NO_2$), which are both linked to asthma symptoms.[E12] Secondhand smoke is a major contributor to PM. An environmental history will reveal some key pollutant sources, such as having a smoker in the home or gas appliances, which are the major sources for indoor $NO_2$. Interventions for indoor PM are first and foremost to quit smoking, but when this is not feasible, use of air purifiers equipped with HEPA filters has been shown to decrease indoor PM concentrations and reduce asthma symptoms in children. $NO_2$ reduction can be achieved by venting gas stoves to the outside or replacing gas appliances with electric appliances, but the efficacy of these interventions for patients with asthma has not been studied.

## THE CASE REVISITED

The allergist has identified several relevant indoor environmental exposures based on history and skin prick test responses. The patient is sensitized and has home exposure to mice, cat, and cockroaches and likely has exposure to dust mites because he lives in a temperate and not arid climate. In terms of pollutants, the patient is exposed to secondhand smoke at home and $NO_2$ because of the presence of gas appliances. The allergist counsels the family to implement IPM, preferably with assistance from a pest management professional; to remove the cat from the home; and to institute other measures aimed at dust mites, as well as the other relevant indoor allergens. These other measures include washing all of the patient's bedding in the hot water cycle every 1 to 2 weeks and placement of allergen-proof mattress and pillow encasements on the patient's bed. Although often not covered by third-party payers, direct measurement of allergen concentrations in dust samples from the home can be helpful in identifying potentially relevant allergens that are not easily identified based on patient report and to assess the efficacy of environmental control practices. In terms of the pollutants, the allergist's first-line recommendation is for the aunt to quit smoking, but if that cannot be achieved, other measures to reduce secondhand smoke exposure should be instituted and include placement of 2 air purifiers with HEPA filters in the home, with one in the patient's bedroom, and banning smoking from the home. $NO_2$ exposure can be reduced by venting the gas stove to the outside of the home or replacing the stove with an electric stove. Because these interventions are not covered by the patient's insurance, the family is referred to the Healthy Housing Program at the City Health Department because this organization can support the family in instituting these environmental control practices. A final consideration, along with implementation of environmental control practices, is allergen immunotherapy, which was reviewed in a recent Maintenance of Certification article.[E13]

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**TABLE E1.** Domestic environmental interventions by allergen or pollutant source

| | HEPA filter | Venting gas stove/replacing gas appliances with electric appliances | Dehumidification and air conditioning | Washing bedding in hot water | Professional extermination | Removal of allergen source or contaminant | Cleaning of walls and floors | Securing food waste | Repair wall and floor cracks |
|---|---|---|---|---|---|---|---|---|---|
| House dust mites | | | XX | XX | | | XX | | |
| Cockroach | | | | XX | XX | | XX | XX | XX |
| Pets | XX | | | XX | | XX | XX | | |
| Mice | XX | | | XX | XX | | XX | XX | XX |
| Molds | XX | | XX | | | | XX | | |
| Tobacco smoke and PM | XX | | | | | XX | | | |
| $NO_2$ | | XX | | | | | | | |

Adapted from Peden and Reed.[E4]