Allergen avoidance in the treatment of asthma and allergic rhinitis

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INTRODUCTION — Immediate hypersensitivity to inhaled allergens is very common among children and young adults with asthma and rhinitis. Sensitization to one or more of the major indoor allergens (such as dust mite, cat, dog, or cockroach), combined with significant accumulation of relevant allergens in the house, has been consistently found to be the strongest risk factor for asthma in population, case control, and prospective studies [1-5].

This topic reviews measures for reducing exposure to indoor allergens. Approaches for minimizing exposure to nonallergic triggers and reducing a patient's sensitivity to allergens are presented separately. (See "Trigger control to enhance asthma management" and "Subcutaneous immunotherapy for allergic disease: Indications and efficacy".)

GENERAL PRINCIPLES — Evidence for a causal relationship between allergen exposure and asthma comes from bronchoprovocation experiments demonstrating that these allergens can induce bronchospasm, eosinophilic airway inflammation, and prolonged increases in bronchial hyperreactivity [6,7]. Perhaps more significantly, moving some asthmatic children or adults from their homes to a different low-allergen residential setting results in major improvements in clinical symptoms and bronchial hyperreactivity [1,8-10]. This background provides a powerful rationale for recommending that allergic patients should reduce allergen exposure in their houses as part of the management of asthma and allergic rhinitis [11].

There are major differences in the dominant allergens based on climate, housekeeping practices, and pet ownership. In particular, there are now well-defined geographic areas where dust mite, cockroach, or pet dander is the strongest contributor to asthma risk. It is also possible that certain indoor allergens, such as dust mite, are more important in the pathogenesis of allergic airway disease than others, and this is an area of active investigation [12-15]. (See "Risk factors for asthma".)

Specific monoclonal antibody-based assays have been developed to monitor allergen levels during controlled trials and to test the specific measures recommended to control exposure to dust mite, cat, dog, and cockroach antigens [16-18]. These techniques have facilitated detailed studies of specific allergens and have helped to define effective control measures, although the exquisite specificity of these measurements may mean that some forms of the specific allergen (eg, some isoforms of Der p 1) may escape detection [19].

Indications for allergen avoidance — Allergen avoidance is appropriate for symptomatic patients with allergic responses documented either with positive skin tests or serum assays for specific immunoglobulin E (IgE) antibodies. Once specific sensitivities have been defined, it is important to implement a comprehensive environmental control plan for all, or as many as possible, of the allergens that are relevant to that patient. Studies in which environmental control has been most effective are those in which the specific measures taken were tailored to the patient and addressed the major allergens to which each patient was sensitized [20,21].

Urban children with moderate-to-severe asthma represent a population that has been studied with regard to the impact of environmental allergen control on asthma. Comprehensive environmental modification in these children has been shown to be effective in reducing asthma symptoms and appears to be cost-effective if carefully performed [20,22].

Patient/parent education is essential for successful environmental modification. Simply handing a sheet of recommendations to a patient without providing detailed education about the proposed measures or specific follow-up is unlikely to be effective. In addition, the clinician should be mindful that major environmental modifications, such as removing carpeting, modifying heating systems, or replacing old upholstered furniture, are expensive and may not be affordable for some families. Recognition of this and an initial emphasis on low-cost interventions should enhance patient cooperation.

Role of the generalist — Several studies have examined the use of allergy testing and specific advice about avoidance of relevant allergens in the primary care setting [23-26]. Although some interventions can be both effective and practical, such as removal of old carpeting from the home of dust mite-allergic patients, overall results have been mixed. However, there is no reason why advice should not be given in a primary care setting on the basis of skin test or specific IgE blood test results, and the primary care physician can play a major role in educating the patient about the relevance of allergen exposure and in encouraging compliance with measures proposed following evaluation by a specialist. Perhaps the primary difficulty is lack of sufficient time to explain the proposed interventions. In many practices, the primary educational role falls on the technician, nurse, or nurse practitioner, who may have more time to spend with patients, discussing allergen avoidance, asthma therapy, and smoking cessation.

DUST MITES — Dust mites (Dermatophagoides pteronyssinus and D. farinae) are arthropods of the class Arachnida that colonize bedding, sofas, carpets, or any woven material. Dust mites do not bite, and aside from causing allergic disease, are not known to pose other harm to humans. It is sometimes difficult to educate patients regarding dust mites because neither the dust mites, nor their debris, can be seen under normal circumstances.

Dust mites absorb humidity from the atmosphere (ie, they do not drink) and feed on organic matter (including shed human and animal skin particles), usually with the aid of fungal degradation. They require nests to live in, a source of food (rarely a limiting factor when these organisms live indoors), and sufficient humidity. Dust mite infestation is far less common in arid and high-altitude climates, such as the mountain states and southwestern United States. In addition, in areas that have prolonged cold winters, indoor environments are so dry that they are usually free of dust mites.

Dust mite fecal particles contain a complex mixture of allergenic dust mite-derived proteins, endotoxin, enzymes, and dust mite and bacterial DNA, all of which can be immunostimulatory [27,28]. These particles are relatively large and heavy and become transiently airborne after vigorous disturbance, but then settle rapidly, such that no allergen is detectable in the air within 15 minutes [29]. Thus, air filtration plays a very little role in controlling exposure to dust mite. Instead, exposure is believed to occur primarily by close proximity to dust mite debris during time spent in bed, on the floor, or on upholstered furniture.

Specific measures — Effective avoidance measures include physical barriers, controlling humidity, and reducing areas that can harbor dust mite colonies. Other measures to reduce exposure to dust mite allergens include heat treatment, acaricides, and allergen-denaturing agents.

Physical barriers — Physical barriers used to control domestic allergen exposure include covers for pillows, mattresses, box springs, comforters, and furniture cushions (table 1).

The simplest types of covers are plastic, which may be uncomfortable for some patients. Considerable effort has gone into identifying alternative fabrics, including coated plastics, permeable synthetics that allow vapor and air movement, nonwoven synthetics that allow airflow without passage of particles >1 micron in diameter, and finely woven fabrics with pore sizes as small as 2 microns (table 2) [30]. Woven fabrics with a designated pore size up to approximately 6 microns are preferable, because these are very effective at controlling the passage of dust mite as well as cat allergens, while still permitting adequate airflow. These fabrics will also completely block the passage of immature and adult live dust mites. Woven fabrics are identifiable by their smooth texture, higher relative cost, and ability to be laundered repeatedly. In contrast, nonwoven materials, which look and feel similar to heavy weight paper toweling, can retain high levels of allergen on the surface and lose integrity with repeated washing [31].

It is important to counsel patients that the use of bedding covers as an isolated intervention is unlikely to reduce rhinitis or asthma symptoms to a clinically meaningful degree. Instead, bedding covers should be a component of a comprehensive plan to reduce exposure to dust mite, as well as any other allergens that are important to that patient.

- In a large trial of over 1100 adults with asthma and dust mite sensitivity, subjects were randomly assigned to receive allergen-impermeable bed covers or placebo bed covers that allowed passage of dust mite allergen [32]. Although applied without proper advice about washing bedding, the covers produced a significant decrease in dust mite allergen for three months. However, the changes in dust mite allergen were modest and were not associated with decreased asthma symptoms.
- In a systematic review that included just two trials, the reviewers concluded controlled trials of allergen avoidance for perennial allergic rhinitis were not convincing [33]. This was partly for technical reasons in assessing symptoms, and also because only a limited number of subjects in these studies were selectively allergic to dust mite.

Even though the use of dust mite-impermeable bedding covers (as an **isolated** intervention) is probably not sufficient to produce clinical improvement, this intervention is an essential component of any strategy to reduce dust mite exposure [20,34]. The more generalizable point is that effective allergen avoidance must target all of the allergens that are important for that patient [32,35,36]. (See 'Impact on asthma control' below.)

Minimizing upholstery and fabric reservoirs — Efforts should be made to restrict the presence of carpets, upholstered furniture, and drapes in the environment of the dust mite-allergic person, in order to reduce the sites that can be colonized by dust mites. Dusting of surfaces and vacuuming of floors, using a vacuum equipped with a high-efficiency particular air (HEPA) filter, should be performed regularly. The numbers of stuffed toys in children's bedrooms should be minimized. Carpeting can be removed and replaced with finished floors and washable area rugs.

These measures are particularly important in the rooms where the patient spends the greatest amount of time, such as the bedroom, study, and rooms where the television and computer are used.

Regulation of humidity — Decreasing humidity can reduce dust mite growth, and maintaining relative humidity below 50 percent is recommended. This can be accomplished by the regular opening of windows in a dry climate or air conditioning in a humid climate [37]. Humidifier use should be avoided. Dehumidifiers can be used, although these do not filter the air as air conditioners do. Patients who report dry nasal passages should use saline nasal sprays before bed instead of humidifying the entire bedroom.

Upper floors usually have less humidity than lower floors and carpets laid on concrete slabs in a basement or at ground level, which tend to become and remain damp, after which they can become a rich source of bacterial, fungal, and dust mite allergens [38]. In some climates (eg, Boston, Massachusetts), apartments have dramatically less humidity than houses and commonly have up to 10-fold less dust mite allergen. In such situations, moving to an apartment on the second floor or higher may be an effective method of reducing dust mite exposure.

Heat treatment — Both dry heat and steam treatments can eradicate dust mites and reduce exposure to dust mite allergens. One study demonstrated that commercial steam cleaning of carpets kills dust mites and reduces dust mite allergen levels [39]. In another study, asthmatic patients were randomized to receive treatment of mattresses and duvets with hot air (110°C) and steam, as well as steam cleaning of carpets versus sham treatments [40]. A single active environmental treatment resulted in a significant and sustained reduction in Der p 1 and 2 dust mite allergen concentrations, and a reduction in bronchial reactivity as determined by bronchoprovocation testing that was maintained for 9 to 12 months.

Washing sheets, pillow cases, mattress pads, and blankets weekly effectively reduces dust mite counts [41]. We recommend that bedding be washed in hot water with detergent and dried in an electric clothes dryer on a hot setting [41,42].

Insecticides and allergen-denaturing agents — The use of chemicals to kill dust mites or denature allergens has also been investigated, but the data in favor of this approach are modest. Several chemicals have been tested, but only benzyl benzoate and tannic acid have been marketed in the United States.

- Benzyl benzoate is highly toxic to dust mites in the laboratory setting, but when applied to carpets, produces only a modest decrease in allergens (<60 percent) that is short-lived [43].
- Tannic acid potently denatures proteins in vitro, but has a minimal effect when applied to carpets that harbor dust mites and other allergens [44].

Prolonged eradication of dust mites is not possible with commercially-available chemicals. Newer formulations of benzyl benzoate may be more effective, although these would require further evaluation before their routine use could be recommended.

Impact on asthma control — A number of small controlled trials have successfully documented a decrease in dust mite allergen for six months or more following a range of interventions (table 3) [1,32,40,45-48]. Each of these studies reported benefit, and four studies found a highly significant decrease in nonspecific bronchial hyperreactivity. It is important to note that over one-half of the reported trials of dust mite avoidance have failed because the measures proposed did not reduce allergen exposure for a significant period of time [48-50].

There are several conclusions from these studies:

- Successful controlled trials have used combinations of physical measures, including pillow covers, mattress covers, washing bedding in hot water, and carpet removal, rather than chemical treatments.
- At least three to six months of sustained intervention was necessary to demonstrate clinical benefit. Thus, patients should be encouraged to adopt dust mite control measures that they can effectively sustain over time, and they should be advised that symptoms are expected to improve gradually.

PETS — Indoor pets are a common source of allergens, and the vast majority of pet-allergic patients are reactive to cats, dogs, or both. However, a growing number of exotic animals are kept as pets, including reptiles, birds, insects, rodents, ferrets, and monkeys, and allergic responses to these animals are also reported [51].

The most effective measure in controlling allergens derived from animals is to persuade the family or patient not to keep animals in the house. Scales shed from the animal's skin (comparable with human dander) are the major source of animal allergens. Keeping a pet outdoors is effective, but restricting the animal to one part of the house is ineffective because animal allergens, particularly those from cats, are easily carried on clothing. Both cat and dog allergens can remain airborne for extended periods of time due to carriage on particles that, because of their small size, settle very slowly.

Because so many patients refuse to give away their animals, efforts have been made to control cat allergen while the animal remains in the house (table 4) [52]. The clinical effectiveness of these measures is not well-established, and patients must understand that the presence of a cat in the house represents such a large source of allergen that none of the proposed measures can consistently control allergen exposure [53].

Even when cats are removed from the house, allergens persist for many weeks or months [54]. This phenomenon explains the increase in symptoms sometimes observed when a cat-allergic patient moves into a home in which cats were previously living. Aggressive cleaning measures can accelerate the removal of allergens, but the quantity of cat allergen that accumulates in carpets, sofas, and mattresses represents a major reservoir that is difficult to remove without aggressive cleaning, including removal of old carpeting and upholstered furniture.

Cat allergen is transferred on clothing and can easily be detected in schools and in houses without a cat [55-57]. The quantities found in these sites are sometimes surprisingly high, such as 80 mcg per gram of dust of the antigen Fel d 1 (the major cat allergen) or Can f 1 (the major dog allergen). In some cases, this is well within the range of allergen concentration found in homes with an animal. Furthermore, this passively transferred allergen can become airborne and cause symptoms [58-60]. Patients who are highly allergic to cat or dog allergens should be informed about this potential source of ongoing exposure so that they can better understand their symptom patterns.

Specific measures — In homes without a pet, levels of animal allergen may be effectively reduced through aggressive cleaning and the use of room air cleaners (table 4) [1,52]. As mentioned previously, patients should be counseled that these measures are unlikely to be effective if the animal remains in the home.

Air filters — In general, room air cleaners will only be effective if allergen reservoirs (including the pet itself as well as old carpets and upholstered furniture) are removed, because otherwise the air currents they create can increase the quantity of allergen becoming airborne. Air cleaners can reduce the concentration of airborne animal allergens, although studies have reported conflicting results regarding the impact of this reduction on symptoms of allergic rhinitis and asthma [53,61].

An expert panel, organized by the American Academy of Allergy, Asthma, and Immunology, conducted a systematic review concluding that there was evidence of benefit from the use of air filters in patients with allergic airway disease, but neither the magnitude of the effect nor the optimal techniques had been proven [62]. In most positive studies, clinical benefit was demonstrated only after a prolonged period of use (eg, a minimum of one year). Based on the available studies, that panel suggested that allergic patients choose one of the following options [62].

- A room air cleaner with a high-efficiency particular air (HEPA) filter, particularly one that directs filtered air toward the individual's head during sleep.
- A whole house filtration system for homes with forced air heating, with disposable HEPA filters that are regularly changed (a relatively expensive option).

Aggressive cleaning — Regular cleaning and the use of a vacuum cleaner with an effective filtration system are recommended. A controlled trial has reported lower allergen levels and clinical improvement in asthma measures in homes

cleaned with vacuums equipped with HEPA filters, compared with vacuums without specialized filters [63]. The homes in that study did not have pets, but the treatment was effective for cat-allergic subjects.

Bathing pets — The effect of bathing pets regularly has been studied [52,64,65]. Washing cats less often than weekly is unlikely to result in any meaningful improvement in symptoms, as some studies have shown that cat allergen in the air returns to pre-bath levels as quickly as one to three days later [65]. The effect of washing dogs regularly has been less well-studied. Twice weekly washing may be helpful.

"Hypoallergenic" breeds — There is no published scientific literature confirming the existence of "hypoallergenic" breeds of cats or dogs. However, there may be individual animals with lower or higher levels of allergen.

Cats — The majority of people with cat allergy are sensitized to the protein Fel d 1. Several approaches to creating hypoallergenic cats have been suggested. These range from knocking out the gene, to breeding cats that have lower Fel d 1 levels, to simply encouraging breeding among select cats with lower allergen levels. Some Siberian cats have been monitored for Fel d 1 levels to encourage lower allergen levels. On the other hand, other companies that claim to have bred cats with lower levels have not provided objective evidence for their claims. Most importantly, no studies have been published to show that a so-called "hypoallergenic cat" results in lower levels of Fel d 1 in the house. Preliminary studies exposing cat-allergic subjects to the animals showed few symptoms, although no allergen measurements have been published [66]. A study on college students who experienced a prolonged decrease in exposure to cat allergens showed a highly significant decrease in immunoglobulin G (IgG) to Fel d 1 but very little change in immunoglobulin E (IgE) antibody [67]. The result suggests that the impact of avoidance of cat allergens may not be simple to predict. Further information is required to understand the clinical responses of cat-allergic individuals to these animals, both with short-term and prolonged exposure.

Dogs — There is no convincing evidence that certain breeds of dogs are less allergenic than others [68]. The best study to date compared concentrations of the major dog allergen Can f 1 in samples from two groups of dogs and the homes they occupied [69]. The first group of 196 dogs consisted of breeds that are promoted on the internet or by breeders as "hypoallergenic" (eg, Labradoodle, Poodle, Spanish Waterdog, Airedale terrier) and the second, 160 dogs of breeds that carry no such claims (Labrador retriever and 46 other breeds, as well as various mixed breeds). Can f 1 concentrations in the animals' coats, and in the settled and airborne dusts from their homes were compared. No differences were found in allergen levels in the homes of the two groups. Interestingly, concentrations of allergen in hair samples from the hypoallergenic group were significantly higher than those of the control group, although this was not reflected in home dust levels. Within each breed, there was marked variability among individual animals, a phenomenon also noted in earlier studies [70,71]. This study confirmed the findings of an earlier, smaller study [72].

RODENTS — Mice and rats produce urinary proteins that are allergenic in occupational (eg, laboratory workers), school [73,74], and domestic settings [75-78]. Mouse allergens are measurable in nearly all inner-city, multifamily homes, and as many as 50 percent of suburban homes [78,79]. However, the levels in inner-city homes have been as much as 100-fold higher than those in suburban homes [80], and levels in inner-city schools are often higher than in homes [74].

Exposure of infants to mice allergens has been associated with the development of asthma, independent of other factors [81]. Mouse exposure also correlates with poorer asthma control, increased acute care visits, and increased healthcare utilization among inner-city children sensitized to mouse allergens [82,83]. In adults in the community (nonlaboratory workers), sensitization to mouse allergens is significantly associated with asthma and asthma morbidity [84].

Exposure to rodents can be assessed by asking if mice or rats are ever sighted at home or if the family has seen evidence of their presence (droppings, nests) [85]. However, mouse allergen can be high even if the answers to these questions are negative, as rodents may remain entirely hidden from sight.

Specific control measures — Professional extermination and integrated pest management are usually necessary to reduce rodent allergen levels significantly [86]. Mice can become resistant to rodenticides [87]. Evidence for the effectiveness of ultrasonic devices that deter entry of mice into homes is lacking [88]. In addition to extermination, keeping food and trash in covered containers, cleaning food scraps from the floor and countertops, and sealing cracks in the walls, doors, and floors are essential for ongoing control [89].

COCKROACHES — Evidence that allergens derived from the German cockroach, Blattella germanica, are important in the cities of North America has come from case-control studies and provocation studies [56,90,91]. As an example, one study of 476 children found that the combination of specific skin test positivity and exposure to cockroach allergen was

associated with significantly higher rates of hospitalization, compared with when this combination was absent (0.37 versus 0.11 hospitalizations per child per year) [92,93]. Patients should be asked if they have seen cockroaches in the home, although roaches may be present even if they have not been sighted. Sticky traps may be placed near food or water sources to determine if there is an infestation and to evaluate if control measures are helping, as described in a 2013 practice parameter regarding assessment and exposure control measures for cockroaches [94].

Specific control measures — The 2013 practice parameter recommends integrated pest management to eliminate and prevent cockroach infestations. Integrated pest management includes removing reservoirs of accumulated cockroach debris, cleaning the area, reducing or eliminating cockroaches (placing multiple baited traps and poisons), and removing factors that facilitate infestation (eg, standing water, access to refuse or unwashed dishes) [86,94]. Air filtration is not helpful in reducing cockroach allergen exposure, as the allergen settles quickly and does not remain airborne. Professional extermination may be necessary, particularly if there is cockroach infestation in a multifamily building [94].

Despite the ability to measure cockroach allergen and a good understanding of the measures necessary to reduce exposure [95], initial interventional trials were unsuccessful [96,97]. It is likely that cockroach allergen reduction alone is not sufficient to impact symptoms, as was demonstrated in other studies targeting single allergens. This may be particularly true for patients living in poor conditions who may be exposed to high levels of multiple allergens. However, a subsequent trial that included a combined strategy to reduce exposure to cockroach, dust mite, and other indoor asthma triggers was successful in reducing symptoms and improving lung function in urban children with asthma [20].

ASIAN LADYBUGS — Asian ladybugs (ALB) (Harmonia axyridis) were imported to the United States from 1916 until 1990 as a biologic means of controlling aphids. It was anticipated that the insects would not survive the cold of winter. However, they adapted by swarming and invading houses when temperatures drop in the early fall [98-101]. Allergy to ALBs has been increasingly reported as a source of seasonal indoor respiratory symptoms, particularly chronic cough, rhinitis, and asthma [100]. Most cases have been reported in rural areas of the central, midwestern, and southern United States. They can also bite and cause local reactions.

ALBs enter homes through external cracks and crevices, and then infest spaces within walls. They secrete a brown liquid that may stain walls and produce an unpleasant smell when handled. The source of the allergen(s) is not clear [98].

Extracts for allergy skin testing and ALB-specific immunoglobulin E (IgE) immunoassays are not yet commercially available. Some allergy specialists in affected communities have produced extracts for skin testing using the beetles directly [100].

Specific control measures — The primary protection is to have tight windows and walls to decrease access of these insects. The next most promising control measure identified to date is treatment of the outside of a house with pyrethroid chemicals prior to cold weather [100,102]. Other measures, such as treating the already-infested walls with chemicals, sound waves, and traps have not been consistently helpful. In cases of severe allergy, it may be necessary for patients to move to a more tightly-built house or into a more urban area.

STINK BUGS — The brown marmorated stink bug came from Eastern Asia to the United States, presumably in the late 1990s. These insects infest homes during colder weather, and heavy exposure can lead to immunoglobulin E (IgE)-mediated respiratory allergy in some individuals [103]. Allergens are found in the excrement, secretions, and body parts of the insect. Stink bugs have also been implicated in irritant contact dermatitis [104].

Specific control measures — If the home or building is not yet infested with stink bugs, the primary strategy should be prevention. The outside of the building should be inspected to eliminate cracks around windows and doors and tears in screens. Window air conditioning units should be removed during cooler weather, as insects can enter around these. Individual insects can be vacuumed up to avoid crushing or touching them. Once a building is infested, it is generally difficult to control stink bugs, apart from physical removal of the insects. Perimeter pesticide sprays may give temporary relief, but the effective sprays kill all insects nonspecifically, and the benefit is generally short-lived.

INDOOR MOLDS — Indoor molds and fungi are most problematic in homes with high humidity, standing water, or water damage. If the home of a mold-allergic patient contains visible mold or smells of mold, then remediation for this allergen is in order.

A randomized trial of indoor mold remediation in patients with asthma and visible mold growth in the home demonstrated benefit, regardless of whether patients were sensitized to four common allergenic molds by skin prick testing [105]. In this

study, which did not include a placebo/sham intervention, 164 homes housing 232 asthmatic patients were randomly assigned to undergo cleaning with detergent and fungicide and installation of an attic fan, or to have this intervention performed one year later. Some subjects in the control group performed mold remediation on their own. Despite this, there was a dramatic difference between the two groups at six months, with improvement in breathing symptoms in 52 and 0 percent of patients in the intervention and control groups, respectively, although some placebo effect was inevitable. Medication use decreased 41 percent in the intervention group and increased 17 percent among control patients. The benefit in patients not sensitized to the four tested molds was posited to be secondary to reduction in mycotoxins and volatile irritant substances emitted by molds. However, the effect could also reflect a failure to identify allergic patients when using only four molds and prick tests. Another similar randomized trial also found modest benefit [106].

Specific measures — Measures to prevent and remediate indoor mold contamination are reviewed in detail separately. (See "Assessment of mold in the indoor environment", section on 'Prevention and remediation'.)

OUTDOOR ALLERGENS — Outdoor allergens, especially pollens and molds, are difficult to avoid short of limiting contact with the outside world. Patients with documented sensitivity to pollen and mold allergens should be advised to close the windows at home and also in the car, stay indoors when possible, and use air conditioners to filter the air during periods of peak symptoms. Showering before bed to remove allergens from hair and skin can help reduce contamination of the bedding. Over-the-counter saline sprays and rinses can be used to wash allergens from the nasal lining after outdoor exposure.

INFORMATION FOR PATIENTS — UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topic (see "Patient information: Avoiding asthma triggers (The Basics)")
- Beyond the Basics topics (see "Patient information: Trigger avoidance in asthma (Beyond the Basics)" and "Patient information: Trigger avoidance in allergic rhinitis (Beyond the Basics)")

SUMMARY AND RECOMMENDATIONS

- Effective indoor allergen avoidance begins with identification of those allergens that are relevant to a specific patient, either through a careful history, or preferably, with specific allergy testing. Once the patient's sensitivities have been defined, specific measures for each allergen should be implemented.
- The principals of environmental allergen control are:
  - Control potential sources of allergen (eg, pets, rodents, cockroaches)
  - Minimize sites in which mold or dust mites can grow
  - Minimize reservoirs of allergen (eg, upholstered sofas, carpets, and uncovered pillows or bedding)
- Basic measures for the major indoor allergens are summarized in the table (table 5).
- Reducing indoor exposure to dust mites, animal dander, or cockroach debris, is relatively straightforward, although it can be costly. Clinicians should recognize this and emphasize less expensive measures initially.
- Problems arise when severely-allergic patients will not give up pets or are unwilling (or unable) to remove carpets, control supplies of potential food for cockroaches, and adequately reduce humidity. In addition, some patients are primarily exposed outside the home, in environments they cannot directly control (eg, work or school).
- For motivated patients who have adequate resources, we suggest the implementation of avoidance measures for all of the indoor allergens to which the patient is sensitized (**Grade 2C**).

Topic 530 Version 9.0

GRAPHICS

Avoidance measures for dust mites

First: Bedrooms
Cover pillows and mattresses with zippered covers which are impermeable to mites and mite allergens.
Wash sheets, pillowcases, and blankets in hot or warm water with detergent or dry in an electric dryer on the hot setting weekly. When necessary, blankets should be replaced with those that can be washed. Comforters (or duvets) should be removed or covered with fine woven covers.
Use washable, vinyl, or roll-type window covers.
Remove clutter, soft toys, and upholstered furniture.
Where possible, carpets should be removed or replaced with area rugs that can be cleaned/washed.
Second: Rest of house
Reduce upholstered furniture, particularly old sofas.
Replace carpets with polished flooring where possible. Carpets on concrete slabs or over poorly-ventilated crawl spaces are a problem and should be replaced with polished flooring if possible.
Vacuum weekly using a cleaner with a high-efficiency particulate air (HEPA) filtration system.
Window coverings should be washable, vinyl, or roll type.
Control humidity to <50 percent relative humidity at normal temperatures, ie, 68 to 72°F.
Third: Changing houses*
In general, allergy sufferers should not be encouraged to move from their home except in those cases where they are living in basements or overtly damp housing.
Individuals who are allergic to mites (or molds) should be advised about the potential benefit of moving to an apartment (second floor or higher) or a house with second floor bedrooms and wooden floors.

* The average family in the United States moves approximately every four years.

Graphic 60923 Version 5.0

Fabrics for covering pillows and mattresses

	Fabric permeability to allergens		
	Air flow through fabric	**Mite**	**Cat**
Plastic or vinyl covers	Unmeasurable	<1.0 ng	<1.0 ng
Semipermeable fabrics*	<0.1 L/min	<1.0 ng	<1.0 ng
Unwoven synthetics			
Type 1 (Filtrete)	1.3 L/min	<2.0 ng	2.3 ng
Type 2 (Propore)	18 L/min	<2.0 ng	1.5 ng
Finely woven fabrics[1]			
2 micrometers	8 L/min	<1 ng	2 ng
6.6 micrometers	16 L/min	<2 ng	5.7 ng
10 micrometers	19 L/min	<2 ng	78 ng
Traditional cotton or synthetic covers	22 L/min	133 ng	580 ng

* Eg, Gortex and other porous materials.

Reference:

1. From: Vaughan JW, et al. J Allergy Clin Immunol 1999; 103:227.

Graphic 65782 Version 4.0

Controlled trials of allergen avoidance that have achieved prolonged decrease in mite allergen

Authors	Time	Avoidance	Active/controls	Decrease in mite	Primary outcome(s)
Murray AB, Ferguson AC. Pediatrics 1983; 71:418.	One year	Physical barriers	10/10	++	BHR*
Carswell et al. Clin Exp Allergy 1996; 26:386.	Six months	Physical barriers + Acarosan	24/25	+	Peak flow¶ BHR¶
Ehnert B, et al. J Allergy Clin Immunol 1992; 90:135.	One year	Physical barriers + tannic acid	8/16	++	BHR*
Walshaw MJ, Evans CC. Q J Med 1986; 58:199.	One year	Physical barriers	22/20	++	PEFR/BHR*
Halken et al. J Allergy Clin Immunol 1997; 99:S320.	One year	Physical barriers	28/24	++	PEFR* BHRΔ
Htut T, et al. J Allergy Clin Immunol 2001; 107:55.	One year	Dry heat and steam cleaning	20/10	++	BHRΔ

BHR: bronchial hyperreactivity; PEFR: peak expiratory flow rate.

Improvement:

* Highly significant.

¶ Improved, but not significant.

Δ Significant.

Graphic 66390 Version 4.0

Avoidance measures for animal dander

Removing animals from the house
Keep animals outside, eg, in garage or kennel; restricting animals to certain rooms has not been shown to be effective.
Once animal has been removed, the premises should be cleaned thoroughly.
Controlling allergen with an animal in the house
Difficult because the animal contains 10 to 50 mg of major allergen, while the quantities of airborne allergen are only 5 to 20 ng/m^3. Using an air filter can only reduce airborne allergen.
Reduce reservoirs: Remove carpets, reduce upholstered furniture to a minimum, replace drapes with blinds, and/or vacuum weekly using a vacuum with good filtration, ie, double thickness bags and/or HEPA filtration.
Room air filters: HEPA or electrostatic (maintenance data are better defined for HEPA).
Washing cats does not reduce allergen levels significantly. Washing dogs twice a week may help.

HEPA: high-efficiency particulate air.

Graphic 81363 Version 3.0

Basic measures to control exposure to indoor allergens

Indoor allergen	Recommendations for reducing exposure
Animal dander	Remove animal from house, or at minimum, keep animal out of patient's bedroom. Keep pet in a room with a HEPA filter and replace the filter as recommended by the manufacturer.
	Cover air ducts that lead to bedroom with filters. Replace filters as recommended by the manufacturer.
	Use air filters and vacuums with HEPA filters. Replace the filter as recommended by the manufacturer.
Dust mites	Less costly
	Encase mattress, pillows, and boxspring in allergen-impermeable covers. Finely woven covers for pillows and duvets are preferable.
	Wash bedding weekly in warm water with detergent or use electric dryer on hot setting.
	Reduce indoor humidity to <50 percent.
	More costly
	Remove carpets from the bedroom.
	Replace old upholstered furniture with leather, vinyl, or wood.
Cockroaches	Use poison bait or traps to control. Consult professional exterminator for severe infestation.
	Periodically clean home thoroughly.
	Encase all food fully and do not store garbage or papers inside the home.
	Fix water leaks.
Indoor mold	Clean moldy surfaces with dilute bleach solution.
	Fix water leaks.
	Reduce indoor humidity to <50 percent. Avoid use of humidifiers.
	Evaporative (or swamp) coolers should be avoided or cleaned regularly.
Rodents	Consult a professional exterminator.
	Periodically clean home thoroughly.
	All food should be stored in sealed containers. Do not store garbage inside.
	Repair holes in walls, doors, floors, and block other entry points.

The measures that can effectively reduce exposure are different for each indoor allergen. Those listed are suggested, but have not been verified to be effective in isolation. Studies showing greatest benefit from indoor allergen remediation were those that adapted the measures to each patient's individual sensitivities, and addressed all of a patient's allergies in parallel.

HEPA: high-efficiency particulate air.

Adapted from: The Allergy Report. American Academy of Allergy, Asthma, and Immunology (www.aaaai.org).

Graphic 58870 Version 4.0