2014 ACAAI/AAAAI Certification/Maintenance of Certification
Board Review Course

Indoor Allergens and Avoidance

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Topics:
1. House dust
2. Indoor allergens
3. Exposure-disease relationships
4. Control measures
5. Other indoor biologics

The most significant advance in studying house dust allergies has been the development of monoclonal antibody assays capable of measuring individual allergens in the complex mix present in homes. The second major recent advace in the study of indoor allergens has been the ability to clone allergens thus producing large quantities of identical proteins for study.

It is important to realize that the we are just entering an period in which we are recognizing that the interactions of substances in our environment with our immune systems is much more complex than many have thought in the recent past. The idea that a home environment is simply high allergen leading to IgE production leading to allergic disease is clearly not accurate in most situations. Often high allergen levels are strongly correlated with highly complex microbial communities (bacterial, fungal or viral) and with specific levels of chitin or other biological modifiers which in concert interact with the genetic predispositions of each individual leading to the highly variable immune responses seen clinically. We are only beginning to appreciate and investigate some components of these complex interactions. And as these complex interactions are investigated is it likely that the complexity will increase. It is also important to consider that all of these effects may produce quite different results depending on the age of a person when they are exposed to them.

The major indoor allergens are dust mites, pets, cockroaches, and rodents. The relative importance of these allergens depends on the living conditions and geographic location of the home.

Dust mites

Dermatophagoides farinae and *D. pteronyssinus* are the most common mites in most homes in the continental United States

Dust mite growth depends on the water content of the air. At temperatures normally found in homes >50% relative humidity (6 g/kg absolute humidity) supports abundant dust mite growth.

Der f 1 and Der p 1 are highly cross-reactive as are Der f 2 and Der p 2. Der f/p 10 (tropomyosin) cross reacts with other invertebrate tropomyosins such as shrimp.

Most studies show that dust levels of mite allergen (Der p 1 + Der p 2) above 2-10 µg/g of dust are associated with allergic sensitization in children. Higher levels (>20 µg/g) are required to sensitize nonallergic children (those with a lower genetic predisposition to IgE formation).

Other species of mites may be found in homes. In Florida and other tropical areas the mite *Blomia tropicalis* can be found. Sometimes storage mites including *Lepidoglyphus destructor* and *Tyrophagus putrescentior* are found.

In the US mite extracts are made from isolated mite bodies and contain similar levels of group 1 and group 2 allergens while in Europe extracts are made from both isolated mite bodies and whole mite cultures. Extracts from whole cultures contain approximately 10-fold more group 1 than group 2 allergens.

Cat allergen (*Felis domesticus*, Fel d 1)

Significant fraction on small particles that can remain airborne for long periods of time. Primarily synthesized in skin but found in all glandular secretions. Homologous with uteroglobulin but biologic function is unknown.

Cat allergen extracts assigned potency based on Fel d 1 content.

Airborne cat allergen concentrations of ~500 µg/g are associated with symptoms in sensitized persons within 2 hours.

After removing a cat or cats from homes the levels of Fel d 1 did not fall to those found in homes without cats fro an average of 4 months.

Dog allergen (*Canis familiaris,* Can f 1)

Larger particles than Fel d 1 so not as airborne.

Both cat and dog allergens are found in over 90% of US homes even though only about 45% of homes have a cat or dog as a pet.

Rodents (mice and rats)

Known as occupational allergens for animal husbandry workers. Allergens are being increasingly recognized as important allergens for inner-city residents.

Insects (cockroaches, flies, beetles, may flies, etc.)

Known as occupational allergens for workers exposed to a particular insect on a regular basis (e.g. cricket allergy in those raising crickets for fishing bait and food).

Allergens are different from the allergens associated with adverse reactions to bites and stings.

Cockroaches are the most dominant indoor insect allergens. Major species are the German cockroach (*Blattella germanica*) and the American cockroach (*Periplaneta americana*). The oriental cockroach commonly called a water bug (*Blatta orientalis*) is more closely associated with water such as from leaking pipes that the other common species.

Careful dust mite allergen avoidance, such as by staying in high mountain resorts or living in a hospital room, has been shown to reduce asthma symptoms and reduce bronchial hyperreactivity in dust mite sensitive adults and children.

The value of efforts in homes to reduce dust mite exposure have not uniformly been associated with benefits probably because of the limited extent to which allergen was reduced. Studies which have demonstrated a major (~90%) decreases in mite allergens for 6 months or more have demonstrated symptomatic improvement for allergic individuals.

Measures repeatedly cited for control of dust mite exposure in bedrooms are:

1. Impermeable covers on mattress, pillows and box springs
2. Washing bedding in hot (>130º F) water weekly.
3. Removing carpets, stuffed animals and general clutter
4. Weekly vacuuming with high-efficiency bag or HEPA vacuum.

Molds are important indoor allergens. At the present time the hype of lawsuits over toxic molds has overrun much of our science.

Dampness in homes has been associated with cough, wheeze and asthma in both adults and children in multiple studies.

The relationship of home dampness to mold exposure is not well documented.

Selected review articles:

Lindsay Rosenfeld, Ginger L. Chew, Rima Rudd, Karen Emmons, Luis Acosta, Matt Perzanowski, and Dolores Acevedo-García. Are Building-Level Characteristics

Associated with Indoor Allergens in the Household? Journal of Urban Health: Bulletin of the New York Academy of Medicine, Vol. 88, No. 1

Jay Portnoy, MD, Ginger L. Chew, ScD, Wanda Phipatanakul, MD, MS, P. Brock Williams, PhD, Carl Grimes, HHS, CIEC, Kevin Kennedy, MPH, Elizabeth C. Matsui, MD, MHS, J. David Miller, PhD, David Bernstein, MD, Joann Blessing-Moore, MD, Linda Cox, MD, David Khan, MD, PhD, David Lang, MD, Richard Nicklas, MD, John Oppenheimer, MD, Christopher Randolph, MD, Diane Schuller, MD, Sheldon Spector, MD, Stephen A. Tilles, MD, Dana Wallace, MD, James Seltzer, MD, and James Sublett, MD. Environmental assessment and exposure reduction of cockroaches: A practice parameter. J Allergy Clin Immunol 2013;132:802-8.

Elizabeth C. Matsui, MD, MHS. Role of environmental control in the management of asthma and allergy. J Allergy Clin Immunol 2012;130, 271

William J. Sheehan, MD, Pitud A. Rangsithienchai, MD, MA Robert A. Wood, MD Don Rivard, BA, RIPMP,Sasawan Chinratanapisit, MD Matthew S. Perzanowski, PhD, MPH, Ginger L. Chew, ScD. James M. Seltzer, MD,i Elizabeth C. Matsui, MD, MHS,d and Wanda Phipatanakul, MD, MS Pest and allergen exposure and abatement in inner-city asthma: A Work Group Report of the American Academy of Allergy, Asthma & Immunology Indoor Allergy/Air Pollution Committee. J Allergy Clin Immunol 2010;125:575-81

Here is a table of the most important sources of indoor allergens and the allergens identified from these sources. The relative importance of many of these allergens is hotly debated.

Source	**Allergen(s)** (as of 2007)
Dust mites	
Dermatophagoides farinae	Der f 1,2,3,7,10,11,14,15-17,18w
Dermatophagoides pteronyssinus	Der p 1-11,14,20
Euroglyphus maynei	Eur m 2,14
Storage mites	
Lepidoglyphus destructor	Lep d 2,5,7,10,13
Glycyphagus domesticus	Gly d 2
Tyrophagus putrescentia	Tyr p 2,13
Animals	
Dog (*Canis familiaris*)	Can f 1-4
Cat (*Felis domesticus*)	Fel d 1-4,5w-7w
Horse (*Equus caballus*)	Equ ca 1-5
Guinea pig (*Cavia porcellus*)	Cav p 1,2
Mouse urine (*Mus musculus*)	Mus m 1
Rat urine (*Rattus norvegius*)	Rat n 1
Insects	
Cockroach	
German cockroach (*Blattella germanica*)	Bla g 1-6
American cockroach (*Periplaneta*	Per a 1,3,7

americana)	
Cat flea ? (*Centocephalides felis felis*)	Cen f 1-3
Silverfish ?(*Lepisma saccharina*)	Le p s 1
Fungi	
Aspergillus fumigatus	Asp f 1-18,22w,23,27-29
Aspergillus niger	Asp n 14,18,25
Penicillium chrysogenum	Pen ch 13,18,20
Humans (*Homo sapiens*)	Hom s 1-5