

CHAPTER 28

House dust, animal proteins, pollutants, and environmental controls

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HOUSE DUST AND MITES

Since the original description of immediate hypersensitivity to household dust (HD) in 1920, we have learned a great deal regarding the specific allergenicity of its components. HD contains many important antigens such as animal danders, fungal spores, pollens, cockroach, housefly, and moth; the HD mite has been studied most intensively. The *Dermatophagoides* species *pteryonssinus* and *farinae* are found in varying concentrations in HD throughout the United States and contain a well-characterized glycoprotein antigen P1 (molecular weight 24,000 daltons), which accounts for 10% to 20% of protein from a crude mite extract. Approximately 95% of P1 appears to be associated with mite fecal particles, making these particles an important source of airborne allergen. *Dermatophagoides* species flourish in conditions of low light, increased temperature, and humidity greater than 8 mg/kg.

The adverse health effects of HD exposure have been well documented. All patients with asthma may experience aggravated symptoms from the irritant effects of HD. Atopic patients with asthma may clearly demonstrate increased bronchial hyperreactivity after HD or mite bronchial provocation. HD mite is a major allergen in childhood patients with asthma. Well-done studies have indicated that avoidance measures may lead to significant decreases in symptoms, improvement in pulmonary function, and decreases in non-specific bronchial reactivity as measured by decreases in PC₂₀ to histamine or methacholine in sensitive individuals.

The scope of HD sensitivity is significant, with 10% of the general population and 90% of allergic patients with asthma demonstrating significant dermal reactivity. Although immunotherapy can be helpful in sensitive individuals with allergic rhinoconjunctivitis and asthma, additional avoidance and control measures should be undertaken. The bedroom is usually the room with the highest mite level and should be the focus of environmental control measures. Although

vacuuming and filtration devices have limited effectiveness, carpet removal, covering mattresses, and washing bedding at temperatures above 70° F can significantly lower mite numbers. Acaricides such as lindane are effective, but potentially toxic. Primi-phosphate methyl is a nontoxic alternative that requires further study.

ANIMAL PROTEINS

Many animal proteins may be the source of significant inhalant sensitivity; the dog and cat allergens have been most thoroughly studied. Although dogs outnumber cats in American homes, sensitive cat owners have more nasal symptoms and worse pulmonary function test results than sensitive dog owners do. In addition, the prevalence of positive skin test results and symptoms with cats appear to increase with age more than do those with dogs.

The cat allergens have been well characterized. The allergenic content of cat pelt and saliva appears to be similar. No allergens are found in urine that are not found in saliva or pelt, whereas at least seven allergens derived from cat are capable of binding IgE in man. Allergen I (CA-1) appears to play the major role in cat allergy. Skin reactivity of cat allergenic extracts correlates with CA-1 concentration. CA-1 has been identified in saliva, pelt extracts, sebaceous glands, ambient air, and voided urine from males, but is absent in cat sera or urine obtained by bladder puncture. These considerations are important in determining appropriate environmental controls and immunotherapy.

Dog allergen is an important perennial indoor allergen. Approximately 5% to 30% of atopic patients have positive skin test results, with well-documented variation in reactivity to different breeds. Allergen is found in epidermal scales, urine, and saliva. Although higher levels of allergen-specific IgE are observed in children with dogs in the home in the first year of life, subsequent dog-specific IgE does not correlate with exposure. The differences observed between responses to dogs and cats may be due to the relative difference in the intimacy of contact. There appears to be a great deal of antigenic diversity in dog allergens, with more than 20 antigens identified in all extracts. Despite this diversity, an international stan-

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dard containing antigens A3 and 13 has been established with 100,000 IU/ampule.

POLLUTANTS

Indoor and outdoor air contain many nonantigenic pollutants that have adverse health effects. Although liquid and solid atmospheric particles vary widely in size, the biologically important particles appear to range from 0.2 to 10 μ . Pulmonary deposition is negligible for particles greater than 10 μ . These pollutants may be more significant in the indoor environment because the average individual spends less than 1 hour per day outdoors.

Indoor concentrations of pollutants are affected by several factors including outdoor levels, indoor sources, and the rate of fresh air exchange inside the building. Cigarette smoke is a complex mixture of pollutants that have a significant adverse effect on childhood health. Children of smoking parents have an increased incidence of upper and lower respiratory complaints and infections as well as diminished FEV₁ and FEF_{25%-75%} when compared with nonexposed controls. The incidence of asthma in children and adults exposed to sidestream cigarette smoke is controversial. Nitrogen dioxide, an indoor pollutant, is a product of high-temperature combustion of fossil fuels. Although its oxidant effect causes lung damage, no consistent effect has been shown on lung function in man. Formaldehyde is a ubiquitous indoor pollutant that is a potent respiratory irritant. Findings from studies investigating its effect on lung function are inconclusive. Although wood smoke is an important source of complex indoor pollutants, its effect on respiratory infection and lung function has not been firmly established in American studies.

Pulmonary reactions to outdoor pollutants have been increasingly recognized as an important health care issue. Sulfur dioxide exposure results in diminished mucociliary clearance in normal subjects and in atopic patients. Additionally, sulfur dioxide at 0.5 ppm may cause increased bronchial hyperreactivity in atopic patients without asthma and in patients with asthma. Ozone is a secondary pollutant that damages type I cells in the lung. Increased sensitivity to ozone in patients with asthma has not been consistently shown. Increased airway resistance can be demonstrated in high-performance athletes after 1 to 2 hours of ozone exposure at 0.37 ppm.

ENVIRONMENTAL CONTROLS

Environmental control measures are of primary importance in the care of allergic patients, but they have received little study. Air conditioning may decrease humidity and can reduce mite counts by tenfold

while substantially diminishing particulates, pollens, and fungi. Maintaining relative humidity at less than 50% may be beneficial in lowering mite counts, but may desiccate tracheobronchial secretions. Because allergens remain airborne for limited amounts of time, theoretically air filtration may have limited effectiveness. Studies to date on electrostatic and high-efficiency particulate air (HEPA) filters have suggested temporary but beneficial effects of removing nonallergic particulates. However, the effects on diminishing allergen content and pollen-related symptoms have not been conclusively demonstrated.

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Which of the following statements is/are true regarding HD mite allergy?

- Forty percent of the general population have positive skin test results
- Less than 50% of atopic patients with asthma have positive skin test results
- Mites flourish in high temperature and low humidity
- Vacuuming is the most effective environmental control measure
- Antigen P1 accounts for 10% to 20% of the protein from a crude mite extract

Explanation: *Dermatophagoides pteronyssinus* and *farinae* species are common inhalant allergens that yield positive skin tests in 10% of normal subjects and 90% of atopic patients with asthma. Vacuuming is an ineffective environmental control measure, whereas carpet removal, air conditioning, and mattress covering can be effective. P1 antigen is associated with mite feces and has been identified as a major mite allergen.

Answer: e.

References: Pollart SM, Chapman MD, Platts-Mills TAE. House dust sensitivity and environmental control. *Primary Care* 1987;14:591-601; Chapman MD, Platts-Mills TAE. Purification and characterization of the major allergen from *Dermatophagoides pteronyssinus*—antigen P₁¹. *J Immunol* 1980;115:587-92.

Which of the following statements is/are true regarding cat allergens?

- a. CA-1 play a major role in inhalant cat sensitivity
- b. Skin reactivity correlates with CA-1 concentration of extract
- c. The allergenic content of cat pelt and saliva are similar
- d. CA-1 is absent in urine obtained by bladder puncture
- e. CA-1 is the only identified IgE binding antigen from cat pelt

Explanation: CA-1 is a clinically important antigen found in cat saliva, pelt extract, ambient air, and voided urine, but absent in sera and bladder puncture urine. Skin reactivity to cat extracts correlates with the amount of CA-1, but can be due to other identified IgE binding antigens.

Answer: a, b, c, and d.

References: Anderson MC, Baer H, Ohman JL Jr. A comparative study of the allergens of cat urine, serum, saliva, and pelt. *J ALLERGY CLIN IMMUNOL* 1985;76:563-9; Murray AB, Ferguson AC, Morrison BJ. The frequency and severity of cat allergy vs. dog allergy in atopic children. *J ALLERGY CLIN IMMUNOL* 1983;72:145-9.

Which of the following statements is/are true regarding dog allergy?

- a. Higher levels of IgE are observed in infants in homes with dogs
- b. Dog-specific IgE levels do not correlate with dog exposure in adults
- c. Fifty percent of atopic patients have positive skin test results
- d. Inhalant sensitivity varies with breed differences
- e. Sensitive dog owners report more nasal and respiratory symptoms than do sensitive cat owners

Explanation: Dog antigens are important respiratory allergens and produce positive skin tests in 10% to 30% of atopic patients. Higher levels of dog-specific IgE are observed in infants in homes with dogs, but do not correlate with exposure in adults. Antigens are found in epidermal scales, urine, and saliva and vary among breeds. Sensitive dog owners report less symptoms than do sensitive cat owners.

Answer: a, b, and d.

References: Murray AB, Ferguson AC, Morrison BJ. The frequency and severity of cat allergy vs. dog allergy in atopic children. *J ALLERGY CLIN IMMUNOL*

1983;72:145-9; Larsen JN, Ford A, Gjesing B, et al. The collaborative study of the international standard of dog, *Canis domesticus*, hair/dander extract. *J ALLERGY CLIN IMMUNOL* 1988;82:318-30.

Which of the following statements is/are true regarding indoor air pollution?

- a. Exposure to sidestream cigarette smoke in children results in increased incidence of upper and lower respiratory tract infections
- b. Long-term sidestream cigarette smoke exposure in adults has been conclusively shown to result in diminished FEV₁
- c. Nitrogen dioxide exposure results in accelerated decline in FEV₁
- d. Formaldehyde may be a prominent respiratory irritant
- e. Ozone exposure consistently results in increased bronchial hyperreactivity in adult patients with asthma

Explanation: Sidestream cigarette smoke exposure is associated with increased respiratory symptoms and respiratory infections, but no consistent trend can be documented in adults. Nitrogen dioxide, ozone, and formaldehyde can all be respiratory irritants, but indoor exposures have not been consistently associated with declines in pulmonary function.

Answer: a and d.

References: Linn WS, Buckley RD, Spier CE, et al. Health effects of ozone exposure in asthmatics. *Amer Rev Respir Dis* 1978;117:835-9; McManus MS, Koenig JQ, Altman LC, Pierson WE. Pulmonary effects of sulfur dioxide exposure and ipratropium bromide pretreatment in adults with nonallergic asthma. *J ALLERGY CLIN IMMUNOL* 1989;83:619-26.

Which of the following statements is/are true regarding environmental control measures?

- a. Air conditioning may lower humidity and significantly lower mite counts in some environments
- b. Currently available acaricides are effective but potentially toxic
- c. Free-standing electrostatic and HEPA air filtration devices significantly lower allergen counts in indoor environments
- d. HEPA filters may be effective by removing non-allergenic irritating particles
- e. Room air conditioning units are ineffective in lowering allergen counts in bedrooms

Explanation: In some environments, central and bedroom air conditioning units can not only diminish allergen content by removing allergenic particles, but may also lower humidity and reduce mite loads by as much as tenfold. High-efficiency particulate absorptive air filtration devices add little to air conditioning units but may effectively diminish nonallergenic irritating particulates. Although currently available acaricides such as lindane are effective, their potential toxicity in man has limited their widespread use.

Answer: a, b, and d.

References: Solomon WR, Burge HA, Boise JR. Exclusion of particulate allergens by window air conditioners. *J ALLERGY CLIN IMMUNOL* 1980;65:305-8; Murray AB, Ferguson AC. Dust-free bedrooms in the treatment of asthmatic children with house dust or house dust mite allergy: a controlled trial. *Pediatrics* 1983;71:418-22; Arlian LG, Bernstein IL, Gallagher JS. The prevalence of house dust mites, *Dermatophagoides* spp, and associated environmental conditions in homes in Ohio. *J ALLERGY CLIN IMMUNOL* 1982;69:527-32.