

Update on Airborne Mold and Mold Allergy

Jean A. Chapman, M.D., M.A.C.P.

ABSTRACT

In considering the clinical aspects of fungal sensitivity, assessing exposure potential and clinical testing are essential. Valid prevalence data are difficult to secure. For ambient air, the Burkard Volumetric Spore Traps, or equal, capture spores best. For in-home analysis for fungi, the history and personal inspection of the house remains the most available method of assessment. Allergy skin test material is unavailable for most airborne fungi. Those that are available are not standardized. Yet the practicing allergist/clinical immunologist must select what fungal extract are available based on air sampling data and personal exposure of the patient. A major management approach with patients with proven sensitivity to fungal antigens and a clear correlation with clinical illness is avoidance of fungal sources. Immunotherapy should be considered when avoidance and well tolerated pharmacotherapy are ineffective in controlling the patient's symptoms. (Allergy and Asthma Proc 20:289–292, 1999)

In considering the clinical aspects of fungal sensitivity, assessing the exposure potential and clinical testing are essential.

Air sampling is irreplaceable because fungus sources are generally not apparent as with pollination of plants. Measured levels of biological aerosols are strongly dependent on the method of analysis. The Rotorod is commonly used but is not efficient for small spores. Yet this is the impaction system used in the Aeroallergen Monitoring Network of the Aerobiology Committee of the AAAAI and the source of much of our current data. In general, suction samplers collect small spores efficiently such as filter cassettes,

Andersen Culture Plate Impactors, or slit samplers as the personal or Burkard Volumetric Spore Traps. It is hoped that the majority of collecting stations will convert to the Burkard Volumetric Spore Traps this year.

Valid prevalence data are difficult to secure. Problems due to broad ranges of spore sizes accentuate errors imposed by fallout methods. The viability, "culturability," and growth potential affect recoveries. Viable collections are always lower than spore counts. Culture methods will produce a different list of fungal taxa than particulate counts (even when both are applied to the same sample). Only imperfect fungi grow well (and not all of these).

In assessing the patient for fungal IgE mediated inhalant allergy, it is essential to know the pattern of frequencies of fungal spores in the ambient air in your area. We must recognize local exposures in the out-of-doors and within the home and workplace.

Ambient air spore content is measured with a Burkard Volumetric Spore Trap following the protocol of the Aeroallergen Monitoring Network. Counts from year to year can be compared, date of onset of sporulation, day of termination of spore counts, means, peak of sporulation, and various taxa at that location. An excellent example of how this type data can be collected is published in the 1996 Pollen and Spore Report of the American Academy of Allergy, Asthma, and Immunology:¹ Three year mean and peak recoveries, alternaria, multiple locations, page 255 and Comparison of 1995, 1994, 1993, Spores/m³, Santa Barbara, California, alternaria, page 256. These all reflect the data base that can be accumulated by standardized counting methods and identify the patterns of frequencies of fungal spores in ambient air at specific locations.

Evaluation of the home environment can be improved by the history of the home, personal inspection of the home, and using the Personal Burkard Volumetric Spore Trap in the suspected rooms of the home.

For most of us spore counts will be the major source of daily or seasonal information. Exposure patterns, that is,

From the American College of Allergy, Asthma, and Immunology Presented at the Combined Allergy/Immunology meeting, Southwest Allergy Forum, and the Texas Allergy and Immunology Society, Acapulco, Mexico, January 15–17, 1999

Address correspondence and reprint requests to Dr. Jean A. Chapman, 1703 West Cape Rock Drive, Cape Girardeau, MO 63701

site to site prevalence vary substantially; indoor-outdoor; urban-rural; roof top-surface. Human activities dramatically affect the personal exposure and will be addressed later in this article.

Clinical testing presents a number of special problems. Allergy skin test material is unavailable for most airborne fungi. Those that are available are not standardized and skin test reactivity varies for antigens with identical labels produced by different antigen manufacturers. A number of the imperfects deserve study such as *epicoccum*, *pithomyces*, *torula*. Yet as clinicians, we must use the materials available to us. Selecting the fungal extracts for skin testing and immunotherapy should be based on air sampling data for ambient air and the personal exposure of the patient.^{2,3} When that is not available, Harriet Burge, Ph.D., Harvard School of Public Health, suggests starting with the fungi shown in Table I.

The clinician must recognize local exposures in the out-of-doors. What are the patients' activities? Hiking in old

fields increases mold spore counts 10 to 20 fold. Harvest operations can increase exposures of the farmers 1000-fold.³ Other activities increase exposures: leaf raking, lawn cutting, transfer of stored grain, exposure to effluent of grain dryers, cleaning previously used grain bins, removing stored hay from haylofts, working with compost piles. Since Americans are spending increased hours indoors, the work and home environments are important. High fungal spore exposures would be expected in relatively damp homes, basements, homes with improper vapor-barriers, homes previously flooded or where major water accidents have occurred (overflow bath tubs, washers, showers, and sewers); storage areas, garbage containers, in home greenhouse effect, wicker material, wood or wood dust, poorly maintained cold mist vaporizers, or console humidifiers. All these and many other sources of exposure in the home are important to identify.

A major management approach with patients proven sensitive to fungal antigen and a clear correlation with clinical

TABLE I

Suggested Fungi for Skin Testing When Ambient Outdoor Air Sampling and Indoor Air Sampling is Not Available

Ambient Outdoor Air Exposure	Ambient Indoor Air Exposure
<i>Alternaria alternata</i> *	<i>Rhodotorula rubra</i>
<i>Stemphylium botryosum</i>	<i>Sporobolomyces salmonicolor</i>
<i>Botrytis cinerea</i>	<i>Chaetomium globosum</i>
<i>Cladosporium herbarum</i>	<i>Cladosporium sphaerospermum</i>
<i>Cladosporium cladosporioides</i> *	
Any one or as a mix:	<i>Aspergillum fumigatus</i>
<i>Curvularia inaequalis</i>	<i>Aspergillus niger</i>
<i>Curvularia lunata</i>	<i>Aspergillus repens</i>
<i>Curvularia spicifera</i>	<i>Aspergillus sydowii</i>
<i>Drechslera sorokiniana</i>	One or mixed:
<i>Helminthosporium solani</i>	<i>Mucor mucedo</i>
	<i>Rhizopus nigricans</i>
<i>Epicoccum nigrum</i> *	<i>Stachybotrys atra</i> (= <i>chartarum</i>)
<i>Penicillium chrysogenum</i> *	<i>Paecilomyces varioti</i>

Useful but Unavailable

Basidiospores	<i>Wallemia sebi</i>
<i>Ulocladium atrum</i>	<i>Aspergillum ochraceus</i>
<i>Penicillium oxalicum</i>	<i>Penicillium brevi-compactum</i>
	<i>Penicillium spinulasum</i>
Farmers: Outdoor ambient plus:	Humidifiers, floods: Indoor ambient plus:
<i>Aspergillus flavus</i>	<i>Acremonium strictum</i>
<i>Aspergillus terreus</i>	
<i>Fusarium roseum</i>	Either one or mixed:
	<i>Fusarium roseum</i>
<i>Monilia sitophila</i>	<i>Fusarium moniliforme</i>
	<i>Gliocladium roseum</i>
<i>Sporobolomyces salmonicolor</i>	<i>Verticillium albo-atrum</i>
<i>Saccharomyces cerevisiae</i>	<i>Phoma herbarum</i>

* Also common indoors.

Personal communication, Harriet Burge, PhD.

illness is avoidance of fungal sources. Patients should be advised to avoid known sources when possible such as leaf raking, mowing grass, harvest operations, stored grain transfer, and working in a compost pile. Many times this may not be possible with the agriculture industry, but uncontrollable atopic symptoms may require a change of occupation.

If avoidance of the source is not feasible, proper masking should be attempted such as for leaf raking or lawn mowing, using the 3M 8710 disposable mask. If the occupation, especially farm operations, presents unavoidable exposures, consider the more sophisticated air filtering into such as the Airstream® helmet or equal. If further masking expert advice is needed, consult an industrial hygienist.

What can be done with inside home sources? Eliminate moisture sources; keep the humidity below 70%. Keep bathrooms clean, dry, and ventilated. Reduce the number of plants in the home to avoid the greenhouse effect. Eliminate nutrients through good housekeeping. Keep the basement as free of dust as possible; do not leave sawdust. Avoid carpet glued to concrete. Use short-nap synthetic carpets if carpet is necessary. Substrates that have been attractive to fungi are urea formaldehyde foam insulation, wicker baskets used as plant containers, and carpeting installed in bathrooms.⁴

Removing the source is the most effective means of remedying existing contamination. Furnishings and construction materials that are visibly contaminated by microorganisms should be discarded.⁵ Eliminate visible mold mechanically with fungicides several times a year. Soap, bleach (Clorox or equal), detergents, Zephiran 1:10,000 or 12.5% solution. However, decontamination procedures are not effective in 50% of buildings and the indoor environment remains conducive to fungal growth.⁶ Replace air filters frequently. Consider using HEPA filters. Clean the humidifiers and dehumidifiers frequently. Emphasize preventive maintenance.

Immunotherapy should be considered for patients with allergic rhinitis or asthma after natural exposures to allergens with IgE mediated allergy to the aeroallergen demonstrated by skin testing or in vitro testing when there is inability to control symptoms by avoiding the aeroallergen and/or by well tolerated pharmacotherapy.⁷

Immunotherapy is clinically effective when potent, biologically standardized, and purified extracts are used, especially studied are *cladosporium*^{8,9} and *alternaria*.¹⁰ Immunotherapy may be most effective for suppression of the late phase reactions and conjunctival sensitivities.¹¹ There are commonly large local reactions. The clinician must be cautious because of sudden severe anaphylactic reactions on maintenance therapy.¹²

Because there are no standardized antigens available for any of the fungi,¹³ we must proceed in a prudent manner with the materials that are available.

Since the review by Salvaggio, Burge, and Chapman in 1993,¹⁴ three recent articles addressing different aspects of fungal allergy are of interest.

Two major allergens have been purified from *Alternaria alternata*, GP70 and Alt a1. Dr. Portnoy and colleagues have developed a double Mab-based ELISA that permits measurement of the Alt a1 allergen of *Alternaria*. Now both GP70 and Alt a1 can be measured. These tests will impact the basic understanding of the development of asthma. Homes will be able to be investigated for fungal allergens. These tests can be used for standardization of *Alternaria* extracts for skin tests and immunotherapy. They can be used to test cross reactivity between related species of fungi and to further understand fungal classification. Application of these tests to 3 commercial extracts of *Alternaria* indicated variability of the amount of allergen from 12 to 84 μmL .¹⁵

Helbing et al. again demonstrate that sensitization to *Basidiomycetes* in subjects with respiratory allergy is frequent. *Basidiomycetes* are the most morphological complex of all the fungal classes and include mushrooms, puffballs, rusts, smuts, and bracket fungi. These authors used *Boletus*, *Coprinus*, and *Pleurotus*. The most frequent positive skin test (Bern, Switzerland) was to *Pleurotus* (79%), *Coprinus* (58%) and *Boletus* (40%) in *Basidiomycetes*-positive skin tests. In all atopic patients (457), *Pleurotus* was positive in 8.3%, *Coprinus* 6.2% and *Boletus* 5.4%.¹⁶

Perzanowski et al. found the Pharmacia CAP system is a useful tool for measuring specific IgE to *Alternaria* allergens, although not as important as sensitization to dominant local indoor allergens (dust mites, cat, dog, or cockroach). Sensitization to *Alternaria* allergens appears to be a significant independent risk factor for asthma in children in some locations of the U.S. (Los Alamos and Charlottesville, VA).¹⁷

REFERENCES

1. The 1996 Pollen and Spore Report, American Academy of Allergy, Asthma, and Immunology, Milwaukee, WI, 255-256.
2. Chapman J, Williams S. Aeroallergen of Southeastern Missouri. *Ann Allergy* 52:411-418, 1984.
3. Burge HA, Muillenber ML, Chapman JA. Crop Plants as a Source of Fungus Spores of Medical Importance. In: *Microbial Ecology of Leaves*, Andrews JH, Hiram SS (Eds). New York: Springer-Verlag, 223-236, 1991.
4. Kozak P, Gallup J, Cummings LH, Gillman SA. Currently available methods for home mold surveys II. Examples of problem home surveyed. *Ann Allergy* 45:167-176, 1980.
5. Pope AM, Patterson R, Burge H. (Eds). *Indoor Allergens*. Washington, DC: National Academy Press, 224-227, 1993.
6. Dixit AB, Lewis WH, Wedner HJ. Indoor fungal aerospora and related health effects in reoccupied flooded buildings. *J Allergy Clin Immunol* (abstract) 95:167, 1995.
7. Vanmetre TE Jr, Adkinson NF Jr. Immunotherapy for aeroallergen disease. In: Middleton E, Reed C, Ellis E (Eds). *Allergy Principles and Practice*, St. Louis: CV Mosby Co, 3rd ed., 1334, 1988.
8. Malling HJ, Dreborg S, Weeke B. Diagnosis and immunotherapy of mould allergy. V. Clinical efficacy and side effects of immunotherapy with *cladosporium herbarum*. *Allergy* 41:507-519, 1986.

9. Dreborg S, Agrell B, Foucard T, et al. A double-blind, multicenter immunotherapy trial in children, using a purified and standardized *cladosporium herbarum* preparation. I. Clinical results. *Allergy* 41: 131–140, 1986.
10. Horst M, Hejjaoui A, Horst V, et al. Double-blind, placebo-controlled rush immunotherapy with a standardized *Alternaria* extract. *J Allergy Clin Immunol* 85:460–472, 1990.
11. Metzger WJ, Donnelly BA, Richardson HB. Modification of late asthmatic responses (LAR) during immunotherapy for *Alternaria* induced asthma (Abstract). *J Allergy Clin Immunol* 71:119, 1983.
12. Ostergaard PA, Kaad PH, Kristensen T. A prospective study on the safety of immunotherapy in children with severe asthma. *Allergy* 41:588–593, 1986.
13. Bush RK. Fungal extracts in clinical practice. *Allergy Proc* 14:385–390, 1993.
14. Salvaggio JE, Burge HA, Chapman JA. Rostrum Emerging concepts in mold allergy: What is the role of immunotherapy? *J Allergy Clin Immunol* 92:217–222, 1993.
15. Portnoy J, Brothers D, Pacheco F, et al. Monoclonal antibody-based assay for Alt a1, a major *Alternaria* allergen. *Ann Allergy Asthma Immunol* 81:59–64, 1998.
16. Helbling A, Gayer F, Pichler WJ, Brander KA. Mushroom (*Basidiomycete*) allergy: Diagnosis by skin test and nasal challenge. *J Allergy Clin Immunol* 102:853–858, 1998.
17. Perzanowski M, Sporik R, Squillace S, et al. Association of sensitization to *Alternaria* allergens with asthma among school-age children. *J Allergy Clin Immunol* 101:626–632, 1998. □

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.