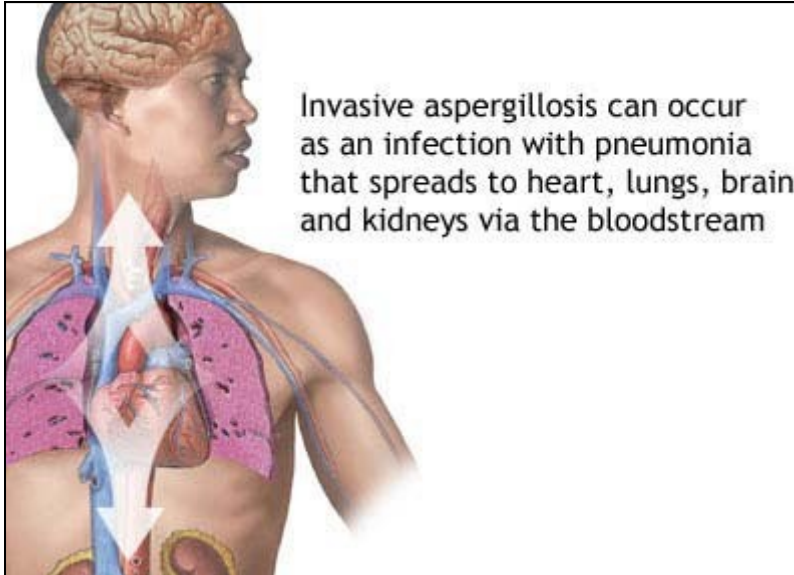


Fungi The Cause Of Many Outbreaks Of Disease, But Mostly Ignored

by ScienceDaily



Invasive aspergillosis can occur as an infection with pneumonia that spreads to heart, lungs, brain and kidneys via the bloodstream

Fungi can cause a number of life-threatening diseases but they also are becoming increasingly useful to science and manufacturing every year. However, many people, scientists among them, are largely unaware of the roles fungi play in the world around us.

Research on fungi and fungal diseases are seriously neglected as

a result -- a situation with grave negative repercussions for human health, agriculture, and the environment-- according to *The Fungal Kingdom: Diverse and Essential Roles in Earth's Ecosystem*, a new report from the American Academy of Microbiology.

The report is the product of a colloquium convened by the Academy in November, 2007, where experts in mycology, medicine, plant pathogens, and ecology discussed the current state of research in mycology and compiled a list of specific recommendations for future work.

"The average person is at risk for several fungal diseases, from toenail infections to athlete's foot to life threatening systemic infections," says Arturo Casadevall of the Albert Einstein College of Medicine and one of the co-chairs of the colloquium. "Fungi may also predispose people to asthma and allergic diseases," says Casadevall. Despite the frequency of fungal infections, according to the report they are relatively understudied, making fungal infections difficult to diagnose and treat. When faced with an undiagnosed fungal infection, doctors are forced to treat their patient without a firm grasp of which drugs will work and which drugs will only cost the patient valuable time.

But fungi are more than just a medical problem: as the cause of more than half of all plant diseases, fungi are also an expensive drain on agriculture. The economic repercussions of managing fungal pathogens on crops -- the money and effort spent, the numerous pesticide applications, the consequences of these applications for surface water and soil quality, and the impacts on crop yields -- are extraordinary.

In the environment, fungi are not seen as a liability but as an integral part of their ecosystems. They break down dead plants and animals (organic matter) into the building blocks plants need for growth and they engage in beneficial symbiotic relationships with plants, all functions necessary for maintaining healthy ecosystems.

When an ecosystem is disturbed, fungi can behave in unexpected and often destructive ways, as in the case of the black mold that is overrunning the areas surrounding the Chernobyl nuclear power plant in Ukraine and outbreaks of coral bleaching that are destroying coral reefs. Scientists still do not understand fungi well enough to predict how these organisms will behave when their environment is disturbed.

Industry and food manufacturing benefit in many ways from the work fungi do. "Fungi are workhorses for research and biotechnology," according to Joseph Heitman of the Duke University Medical Center, the other co-chair of the colloquium. "Both the hepatitis B vaccine and Gardasil (the vaccine for papilloma virus) are produced in yeast," he notes.

The importance of fungi to human health, agriculture, the environment, and industry demands that we

Continued on page 47

Fungi The Cause Of Many Outbreaks... continued from page 46

gain a better understanding of these organisms. Some of the report's key recommendations include:

Evaluate the Impacts of Mold in Homes and Businesses

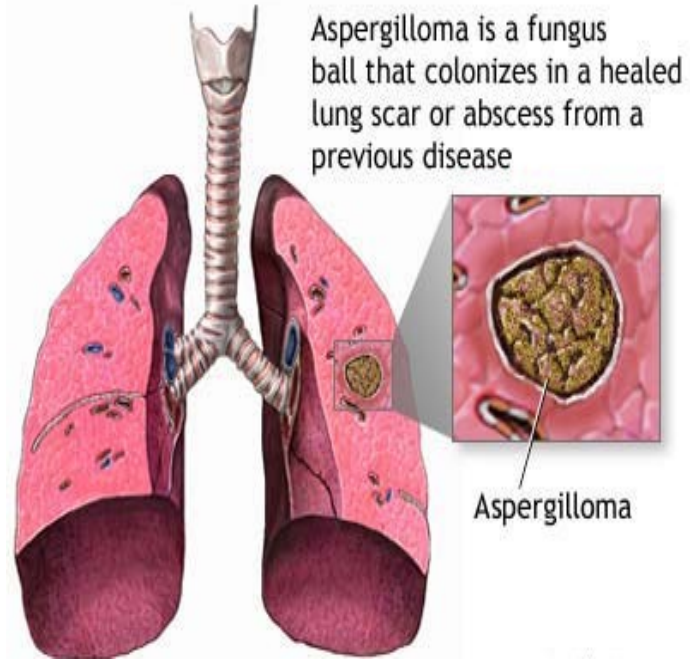
There is a serious lack of scientific data to support any stance with respect to indoor mold toxicity or remediation. More effort should be devoted to testing and long-term monitoring of mold contamination and human health in New Orleans and other areas flooded by Hurricane Katrina. Natural disasters like Hurricane Katrina provide natural laboratories for understanding how fungi respond to disturbance and the subsequent impacts they have on human health.

Create a Fungal Genomes Database

Researchers involved with fungi must focus efforts on developing a comprehensive fungal genomics database in order to make the vast quantities of sequence data more available and to enable the field to fully capitalize on the promise of genomics.

Report and Track Fungal Infections

Public health agencies should implement formal programs to report cases, track disease progress, and design interventions in outbreaks of fungal disease. The lack of reporting and tracking systems has made it difficult



to control the spread of fungal pathogens, because good epidemiological data on the scope of infection is usually not available.

World Health Organization (“WHO”) Develops Guidelines for Dampness and Mold

In October 2007 WHO convened a working group charged with Development of WHO Guidelines for Indoor Air Quality: Dampness and Mould. The report of that working group has now been published. This report is not a copy of the new WHO Guidelines but only the report of the working group. Apparently, the guidelines will be forthcoming at some point in the future. The abstract is copied below and the entire document can be accessed [here](#).

ABSTRACT

Microbial pollution is one of the key constituents of indoor air pollution. It consists of hundreds of species of bacteria and fungi, and in particular filamentous fungi (moulds) growing indoors when sufficient moisture is available. Health problems associated with moisture and biological agents include increased prevalence of respiratory symptoms, allergies, and asthma as well as perturbation of the immunological system. Based on the extensive review of the scientific evidence, this WHO working group identified the main health risks due to excess moisture, associated with microbial growth and contamination of

indoor spaces. It also formulated WHO guidelines for protecting public health, recommending that persistent dampness and microbial growth on interior surfaces and in building structures should be prevented (or minimized) as they may lead to adverse health effects.



No easy fix for expensive problem

By Prentiss Findlay, The Post and Courier



Melinda Ballard sits in her Orange Street home in downtown Charleston on Thursday. Ballard's home in Texas was demol-

ished because of extensive mold problems.

Mold Prevention Tips

- ◆ Keep humidity levels between 40 percent and 60 percent
- ◆ Promptly fix leaky roofs, windows and pipes
- ◆ Thoroughly clean and dry after flooding
- ◆ Ventilate shower, laundry and cooking areas

Source: Centers for Disease Control and Prevention

Melinda Ballard felt so bad that she wondered if she had cancer. Eventually, she learned her illness was related to mold in the leaky Dripping Springs, Texas, home where she lived before moving to Charleston.

"You almost feel like you're dying because it's such chronic fatigue," Ballard said.

Seven years ago, a Texas jury awarded her \$32 million after hearing arguments in her mold-related suit. Her insurance company appealed the verdict to the Texas Supreme Court. Ballard decided to settle the suit for "a goose egg," in essence walking away from the situation because she feared her case would be remanded for a new trial. That would have meant she couldn't bulldoze the house because it would have to be preserved as evidence. She feared the home would become a tremendous liability.

"I just wanted to get out of Texas," she said. She spent \$2 million on the trial and lost \$9 million on the house, she said.

During her Texas legal battle, she had gotten to know Charleston as a frequent visitor to Renaissance Weekend. She purchased a home here and took up the cause of mold-related health and financial issues for homeowners through her locally-based non-profit organization, Policyholders of America.

She said that she fields hundreds of e-mails and phone calls daily from homeowners with questions about mold.

"It's serious business when you talk about people's assets," she said.

Problems with mold in houses here are not unusual, experts say.

"Everybody in the coastal region should run a dehumidifier in their house. Almost every house that we check on, all the levels seem to be elevated. It's rampant," David Swinea, president of Cleanx Corp. of West Ashley, said.

Terrence Tully, owner of Moisture Control Experts of Summerville and Mount Pleasant, tested the homes of three Daniel Island families that left

their residences recently after consulting doctors. Benjamin and Joy Allen said that for months they lived with health problems that affected a young daughter severely. When they noticed a moldy growth on the house exterior, they called in Tully, who opened up a wall and found extensive mold. They recently sued the builder, alleging that construction defects allowed water to seep inside walls, creating conditions for widespread mold.

Tully said musty odors and cupped floors are signs of a possible mold problem. Some homeowners report headaches, a runny nose or flu-like symptoms. Pregnant women, kids and the elderly are most susceptible to problems. "It just depends on the person," he said. Odor is a good way to pick up on a mold problem, he said. However, it might not be apparent to a homeowner who has lived with the smell for a long time. "Get away for a day or two," he said.

Eleven years ago, Tully re-located his business from Long Island, N.Y. He said homeowners initially were skeptical when he recommended mold control measures such as a dehumidifier in a crawl space. "We were told we were crazy Yankees," Tully said.

Government standards or regulations for acceptable levels of residential indoor mold are non-existent, but federal and state agencies recommend actions that homeowners can take to prevent mold growth, which might lead to a health problem.

Maintenance to reduce moisture is the key to preventing a serious mold infestation, experts say. Keeping humidity levels between 40 percent and 60 percent; promptly fixing leaky roofs, windows and pipes; thoroughly cleaning and drying after flooding; and ventilating shower, laundry and cooking areas are recommended ways to control mold growth, according to the federal Centers for Disease Control and Prevention.

"If you can see or smell mold, a health risk may be present," according to the CDC.

There is no practical way to eliminate all mold and mold spores indoors, but the way to control mold growth is to limit moisture, according to the U.S. Environmental Protection Agency. If a mold contamination problem is present, inhaling

mold spores can produce health symptoms including irritation of the eyes, skin, nose, throat and lungs. Molds produce allergens, irritants and in some cases potentially toxic substances, the EPA says.

The state Department of Health and Environmental Control does not perform mold tests or inspections in homes. It recommends consulting the yellow pages under "Environmental Consultants" for professional advice and assistance. The local phone book also has listings under mold and mildew services.

Local mold inspectors said consumers should look for professional certification from the American Indoor Air Quality Council of the Indoor Air Quality Association Inc. Check that the business has environmental pollution insurance and is bonded, Swinea said.

Jim Clark, an environmental consultant with Environmental Solutions and Service of Mount Pleasant, said Indoor Air Quality Association certification includes a four-year science degree, eight years of experience, a week-long class, testing and passing muster with a review board. Clark said some unqualified companies use a "shock treatment" method that bombards homeowners with bad news from mold test results.

The recommended solution is highly-overpriced remediation for a problem that may be minor, he said. Acts of God, improper construction and lack of maintenance can cause a moisture problem that creates a place for mold to grow indoors, Clark said. Homes are built more air-tight these days which is a new factor in the creation of an indoor mold problem, he said.

Ballard cautioned that there is a downside to testing for mold. "If you have to test, know that you may be destroying your own property value," she said. "Stealth testing" which does not directly connect mold test results to a property address is an option, she said. A homeowner can take an indoor sample using a Q-tip or scotch tape and send it to an EPA-accredited lab. The results are e-mailed, she said.

GULF COAST GRASSROOTS HEALTH SURVEY RELEASES INI- TIAL FINDINGS



Baton Rouge, Louisiana, August 26, 2008— Newly released data from a grassroots Katrina and Rita health survey reveals that over 70% of the 277 survey respondents remain ill from hurricane exposures, regardless of race, gender, or source of exposure. Respondents reported having had either no change in their conditions or reported that their symptoms have slightly or dramatically worsened. A higher number—over 75% —of children remain ill.

“Children are a higher risk group than adults because their immune systems, brains, and lungs are still developing,” according to Jack Thrasher, PhD, who is an immunotoxicologist assisting with the health survey. Although the survey responses for children are somewhat low as of yet, the survey team is concerned that the initial findings may reflect a larger scale pattern. Children need to be looked at in greater numbers because if these high percentage rates of children remaining ill are reflected on a larger scale, there is reason to be alarmed. Dr. Thrasher states “I am deeply concerned about the children and we must find ways to reach out into the community to further assess this situation.”

Initial findings indicate that 48.4% of respondents reported becoming sick from the FEMA trailers, mobile homes or park models in which they lived while 68.4% of respondents attributed their ill health to other exposures such as sewage, sediment, flood waters, mold, etc., regardless of whether or not they lived in FEMA-provided housing.

The Katrina and Rita health survey will remain open for an extended period of time to give schools, parent organizations (such as the PTA), community groups, and special -needs groups ample time to input data into the online health survey, which is available in both English and Spanish at www.partnerspublishing.org. The survey is a grassroots effort led by Katrina survivors Kurt and Lee Ann Billings with the assistance of Louisiana Environmental Action Network (LEAN). It is endorsed by the following organizations: Sierra Club Delta Chapter, The Chemical Sensitivity Foundation, and The National Coalition for the Homeless.

American Academy of Environmental Medicine

Molds and Mycotoxins (Toxic Molds) in Human Health Position statement regarding mold

It is commonly recognized that a large body of medical literature and extensive clinical experience indicates that sufficiently high exposures to *indoor airborne* mold can lead to disease in otherwise healthy individuals. Since environmental health has not been a focus of medical education, *many physicians are not fully aware* of the scope of mold related health problems and are inadequately equipped to investigate and manage possible cases of mold exposure in a timely fashion.

Exposure to significant levels of indoor mold can cause acute or chronic *dysfunction or injury to all organ systems* including the respiratory, neurological, cardiovascular, genitourinary, gastrointestinal, musculoskeletal, immune (through both immediate and non-IgE mechanisms) and hematological systems. In addition to the resulting more commonly considered respiratory conditions such as asthma and rhinosinusitis, exposure to mold proteins and mycotoxins has been associated with

fatigue, reduced concentration, imbalance, poor memory and hemorrhagic disorders.

Mold contaminated buildings may well require *prompt, serious remediation* since avoiding further exposure is the first step in treatment as well as a major part of disease prevention.

The American Academy of Environmental Medicine (AAEM) recommends continuing research regarding mold related health problems and suggests that experienced health authorities disseminate knowledge about this public health issue in order to achieve widespread clinical competence among health professionals in the investigation and management of actual or alleged mold exposure.

Supporting medical and scientific literature on this issue, along with opportunities for formal training in environmental health, are available through the AAEM.

Studying the Impact of Indoor Air Quality on COPD Patients

by *medicalnewstoday.com*



Poor indoor air quality can significantly worsen health problems in people with chronic obstructive pulmonary disorder (COPD), according to researchers in Scotland.

High concentrations of fine particulate pollution--the type of pollution associated with secondhand smoke and, in developing countries, indoor cooking and heating fires--were strongly linked to poorer health status.

While the exacerbating effects of outdoor pollutants on COPD patients have been well-documented, few studies have analyzed the impact of indoor air quality on COPD patients. COPD is the fourth leading cause of death in the U.S., and the fifth worldwide, according to lead investigator Liesl M. Osman, Ph.D.

"Although exposure to outdoor pollution is important, most people spend the greater part of their time indoors," wrote Dr. Osman in the article that appears in the first issue

for September of the *American Journal of Respiratory and Critical Care Medicine*, published by the American Thoracic Society.

Dr. Osman and a team of researchers in Aberdeen, Scotland, measured concentrations of indoor air pollutants in the homes of 148 Scottish patients who had mild to severe COPD. Over the course of a week, they took samples of particulate matter up to 2.5µg (PM2.5) every five minutes, sampled indoor endotoxin concentrations and measured indoor NO₂ with passive samplers. Recorded data on concentrations of outdoor PM2.5 were also collected from a nearby monitoring station.

The study participants completed the St. George's Respiratory Questionnaire (SGRQ) to assess their symptoms, activity limitation and the impact of their disease. Each subject was also asked about their current smoking status, which was verified by salivary cotinine levels.

The researchers found that indoor concentrations of particulate pollution in the subjects' homes frequently exceeded standards for outdoor air. In at least one instance, the highest concentration of a home was more than 40 times that of the recommended maximum.

"High levels of PM2.5 were recorded in the homes of patients with COPD," they wrote. "The highest levels of PM2.5 were, on average, four times the maximum recommended by the U.S. Environmental Protection Agency for 24 hour periods," they continued, noting that a significant source of PM2.5 was environmental tobacco smoke. Nearly 40 percent of the subjects were current smokers, and 17 percent of non-smokers lived in "smoking environments" where others smoked in their homes.

Both smokers and non-smokers were negatively affected by increased PM2.5, as measured by clinically significant differences in their SGRQ symptom scores. Interestingly, an analysis of the effect of indoor air quality on smokers versus non-smokers revealed that smokers suffered greater adverse effects than nonsmokers. No significant

effects of NO₂ or endotoxin levels were found.

While these findings may be an artifact of the higher overall levels of PM2.5 in the homes of smokers, the researchers noted that the data also illuminated a gap in the current knowledge on the lives of patients with COPD.

Previous studies of indoor air quality have tended to exclude smokers, which may have resulted in an overall underestimate of the impact of indoor air quality on health status, as well as painted an unrealistic picture of the COPD patient population.

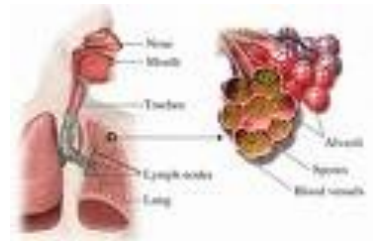
"The finding that indoor PM2.5 concentrations had negative respiratory health effects among both smokers and nonsmokers has important implications for future research," wrote Mark D. Eisner, M.D., M.P.H., of the University of California, San Francisco, in an editorial in the same issue of the journal. "Further research is needed to elucidate the prospective effects of indoor air pollutants on adults with COPD."

Biomechanics of conidial dispersal in the toxic mold *Stachybotrys chartarum*

Kathryn Tucker, Jessica L. Stolze, Aaron H. Kennedy, and Nicholas P. Money¹

Department of Botany, Miami University, Oxford, Ohio 45056, USA

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Abstract

Conidial dispersal in *Stachybotrys chartarum* in response to low-velocity airflow was studied using a microflow apparatus. The maximum rate of spore release occurred during the first 5 min of airflow,

followed by a dramatic reduction in dispersal that left more than 99% of the conidia attached to their conidiophores. Micromanipulation of undisturbed colonies showed that microneutron μN forces

were needed to dislodge spore clusters from their

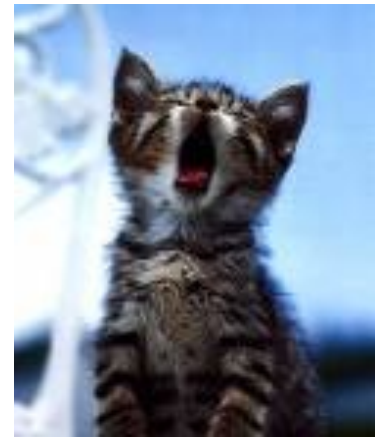
supporting conidiophores. Calculations show that airspeeds that normally prevail in the indoor environment disturb colonies with forces that are 1,000

fold lower, in the nanonewton (nN) range. Low-velocity airflow does not, therefore, cause sufficient

disturbance to disperse a large proportion of the conidia of *S. chartarum*.

ENGLISH TRANSLATION: High levels of fungi (the plural of the word "conidia") won't become

airborne unless contaminated surfaces are disturbed by high airspeeds or vibration. In other words, use of high speed fans, dehumidifiers, and/or tools/appliances that tend to cause vibration of a contaminated surfaces (washer, dryer, hammers, saws, etc...), will cause fungi to become airborne. This would explain why people tend to experience severe symptoms when remediation is conducted in their presence.



Don't get too bored by this scientific article. It's important.



Review of Methods Applicable to the Assessment of Mold Exposure to Children

H. Kenneth Dillon,¹ J. David Miller,² W.G. Sorenson,³ Jeroen Douwes,⁴ and Robert R. Jacobs¹
by ehponline.org

¹Department of Environmental Health Sciences, University of Alabama at Birmingham, Birmingham, Alabama USA; ²Department of Chemistry, Carleton University, Ottawa, Ontario, Canada; ³Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health, Morgantown, West Virginia USA; ⁴Department of Environmental Sciences, Wageningen Agricultural University, Wageningen, The Netherlands

- Planning and Conducting Exposure Assessment
- Description of Methods for Exposure Measurement
- Discussion of Exposure Measurement Methods
- Conclusions and Recommendations

Abstract

This article presents discussion of the assessment of the exposure of children to fungi, substances derived from fungi, and the environmental conditions that may lead to exposure. The principles driving investigations of fungal contamination and subsequent exposure are presented as well as guidelines for conducting these investigations. A comprehensive description of available research sampling and analysis techniques is also presented. **Key words:** (1 3) β -D-glucans, children, ergosterol, exposure assessment, fungi, mold extracellular polysaccharides, mycotoxins, tricothecenes, water damage. – *Environ Health Perspect* 107(suppl 3):473-480 (1999).

This article is based on a presentation at the International Conference on Indoor Mold and Children held 21-24 April 1998 in Alexandria, Virginia.

Address correspondence to H.K. Dillon, University of Alabama at Birmingham, School of Public Health, Dept of Environmental Health Sciences, 309-D Ryals Building, 1665 University Blvd., Birmingham, AL 35294-0022 USA. Telephone: (205) 934-2072. Fax: (205) 975-6341. E-mail: dillonk@uab.edu



Children/Mold

CONTINUED FROM PAGE 51

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Respiratory diseases and their symptoms in children have been associated with dampness and the amplification of fungi in homes (1-5). Several investigators have found evidence supporting the possibility that airborne secondary metabolites produced by fungi, i.e., mycotoxins, and (1,3)- β -D-glucans, present in the cell wall of most filamentous fungi, may contribute to respiratory symptoms (6-9). Opportunistic fungal infections are rare in children but may occur in the immunocompromised (10-13).

The public health professional must be able to recognize and define hazards associated with fungal amplification in buildings, including the residential environment. Confounding these tasks, however, is the fact that the current body of knowledge is inadequate to identify hazards definitively. The lack of good quantitative methods to assess fungal exposure is one of the primary reasons that knowledge about fungal-related respiratory health risks is poor. Consensus has been reached by several professional groups on the following principles: fungal growth in homes or buildings is unacceptable, such growth should be removed and further contamination prevented, and the intrusion or accumulation of moisture in a

home or building is the primary factor inducing fungal amplification (14-16). These principles stress the importance of the prevention or removal of the potential for exposure to fungi or agents derived from fungi.

Planning and Conducting Exposure Assessment

Guidance has been given for exposure assessment involving building-related illnesses and symptoms (i.e., sick building syndrome) (14,16,17). Many of the same concepts apply to the residential environment and to assessment of exposure of children to fungi and substances produced by fungi.

Defining the Objective

Prior to the planning or execution of exposure assessment, the objective should be formulated. The possibilities are numerous; a few examples are offered:

- To determine the precise nature and extent of proliferation and transport of fungal contaminants
- To judge the success of remedial and behavioral changes
- To establish the cause of diagnosed disease
- To link environmental conditions or activities with symptoms

The format of the objective may be a simple specific question, e.g., Are fungi growing in a home? The question may be much more complex, e.g., Does fungal contamination in the residential environment increase the severity and frequency of asthmatic attacks? The former question might be answered by visual evidence of growth. The latter would require an epidemiologic investigation including not only documentation of fungal contamination but also

documentation of the following: the presence of fungal antigen(s) to which children have developed sensitivity, evidence of the presence of inflammatory agents that could aggravate asthma, evidence of a means by which exposure to the antigen(s) and inflammatory agents could occur, and documentation of the severity and frequency of attacks over the course of the study. An epidemiologic study requires a formal statement of a statistical hypothesis, e.g., the severity and frequency of attacks in children with asthma in homes contaminated with fungi are equal to the severity and frequency of attacks in children with asthma in homes that are not contaminated with fungi. It should be recognized, however, that disproving this hypothesis, and thereby demonstrating an association, does not prove causality.

Inspection of the Building or Residence

Inspection of the building or residence is required before a comprehensive exposure assessment strategy can be formulated and may, in fact, preclude the need for a more comprehensive investigation. A thorough inspection of a school, a daycare center, or residential housing for dampness, water leaks, and signs of past flooding is an important component of an estimation of fungal contamination of the building. An estimation of the area of visible mold is an important measure of the degree of exposure to mold. Inspections must be performed by people familiar with building science and residential construction. It should also be emphasized that occupant behavior is important. Storing of firewood

continued on page 53

Children/Mold

Continued from page 52

inside, not venting dryers to the outside, not maintaining plumbing or heating, ventilation, and air/conditioning systems, and attaching greenhouses to the living space are examples of bad practices. Concomitant with the presence of moisture, poor housekeeping favors the cultivation of fungi (as well as dust mites) in carpets, bedding, upholstery, and other porous materials.

The specific features of a building that lead to mold contamination vary according to country and even regions of countries with strong climate differences such as the United States. In the northeast, leaky basements, faulty window framing, and lack of ventilation are the key sources of water problems. More fundamental problems, such as inappropriate location of the vapor barrier in the wall cavity or lack of ventilation in attics or crawl spaces, can also be important reasons for mold problems. Lack of ventilation in closets and behind drawers is a frequent source of mold. In subtropical and desert areas of the United States, condensation in wall cavities or in wallboard is an important cause of mold. In the Pacific northwest and the southeastern U.S., water leaks from rain are important. In areas prone to flooding, failure to clean up properly afterwards can lead to problems.

Examination of total visible mold requires a powerful flashlight, a basic plan of the building to record the observations, a magnifying glass, and a means of testing whether signs of mold are actually mold. This can include materials for taking a sample and an eyedropper with bleach. The sample can be examined microscopically or cultured.

Stains, rather than mold, are sometimes decolorized upon application of bleach. The appearance of mold on an inside surface usually means that there is more mold behind the wall or ceiling. Destructive sampling, that is, the removal of wallboard, is often required to estimate the extent of contamination. Finally, on wallboard, mold growth sufficient to influence the air quality of the adjacent space extends for as much as 0.5-1 m beyond visible heavy mold (18).

The investigator(s) should pay attention to odors. The musty odors of microbial volatile organic compounds (MVOCs) may be an indication of hidden fungi. Chemical odors, e.g., volatiles from cleaning agents or pesticides, indicate the presence of compounds in the air that may contribute, along with fungi or fungal agents, to respiratory symptoms.

Sampling Strategy

Air, surface, and bulk materials sampling during inspection or at a later time may be justified. The visual observation of active or past microbial growth indicates the potential for exposure. The likelihood of exposure may be established by air sampling in the living spaces. Sampling may support a possible association between airborne fungal spores or substances derived from fungi and symptoms consistent with exposure.

Air sampling may also help to locate hidden growth. Surface samples or bulk material samples, including settled dust, increase the likelihood that sources will be found. It is not recommended that aggressive air sampling for viable fungi or fungal agents be conducted. Aggressive sampling involves activities intended to encourage the generation of biologic aerosols during air sampling, e.g., the rapping of ventilation ducts. If it

is possible without compromising the health of the building occupants, air sampling should be conducted during normal indoor activities.

Designing a sampling strategy involves deciding the agent(s) to be sampled, where and when to sample them, the number of samples, and the appropriate sampling and analysis techniques. An analysis laboratory should be selected prior to sampling and can often offer advice in the choice of the appropriate sampling methods. Laboratory selection criteria have been specified (14); the American Industrial Hygiene Association (AIHA) of Fairfax, Virginia, plans to accredit laboratories for the determination of environmental microbiologic samples. Sampling should be conducted in areas suspected of contamination, in areas not suspected of contamination, and outdoors near air intakes. Sampling outside should be conducted as high off the ground as possible to avoid the sampling of soil fungi.

The question of how many samples to take is complex, and recommendations should be interpreted with caution. Eudey et al. present a thorough discussion of hypothesis testing with examples involving biologic aerosols (19). In an epidemiologic investigation, one is often attempting to demonstrate the presence or augmentation of a physiologic effect in the test population of children that is not present or is diminished in the control population. Exposure assessment may be included in an epidemiologic study to search for associations or dose-response relationships that may explain why a particular effect is observed. The investigator can estimate sample size given some preliminary evidence of the



Continued on page 54

Children/Mold

Continued from page 53

expected effect size and the variability in measuring the outcome. Generally, the numbers of children in each of the test and control populations must be high ($n > 30$) if an effect has a reasonable chance of being detected. The numbers of air, surface, or bulk samples used to demonstrate an association between exposure and health effect are generally much higher than subject test and control population size because the environmental variability of exposures must also be considered.

Going beyond the demonstration of an association of an exposure variable with the outcome to establish causality requires a more rigorous approach. Hodgson has reviewed other criteria necessary to support causality (20):

- similar findings across multiple cohorts
- high odds ratio
- cause precedes the effect
- data from different kinds of studies converge
- fewer other causes for the syndrome
- dose-response relationships
- mechanistic considerations make the effect likely

At the present time, no target or threshold levels for fungi or substances derived from fungi have been sanctioned by professional organizations. When reasonable causality has been demonstrated between some fungal agent and disease and an exposure guide can be recommended, then exposure assessment may be conducted for prevention of disease or for

the recognition of the established hazard. Guidance in comparing observed means to occupational health limits has been given (21).

Time-integrated samples that may be used to characterize exposure levels are likely to approximate a lognormal distribution and to have statistical population variances (geometric standard deviations [GSDs]) that are comparable to those experienced in industrial hygiene studies, i.e., 1.5-3.5. For example, in a study of 60 homes in the Netherlands, counts of colony-forming units (CFU) in settled dust demonstrated GSDs ranging from 1.8 to 2.3 (22). Measures that are likely to be related to numbers of culturable propagules integrated over time, such as ergosterol or (1 β -D-glucans as described below, might be expected to exhibit comparable variability. However, the actual environmental variability of most fungal agents has not been characterized definitively.

Practical recommendations for the number of samples required for a qualitative assessment of the biodiversity of fungi have been given (14). Samples should be taken in duplicate at each test and control location and at each sampling time. Comparative indoor and outdoor sampling should be conducted in the morning and in the afternoon. Such sampling should be separated by as much time as possible because outdoor levels are expected to change during the day and indoor levels will vary with work activity and changes in temperature. Some investigators take outdoor samples in the morning, at noon, and in the afternoon that bracket in time the samples taken indoors. For a contaminated indoor environment, a difference in rank order of species inside when compared to those outside is often obvious without

statistical analysis. As stated in more detail in the section on culture methods, the ratio of the sum of the concentrations of soil fungi to the sum of the concentrations of phylloplane fungi should be near 1 if fungi are not being amplified indoors because it is primarily the soil fungi that grow on building materials. If many samples have been taken at many locations in a structure, cluster analysis may demonstrate differences in species distribution (16). The collection of many samples may also allow the determination of the frequency with which an organism is found in samples taken at different times and locations. Frequency of occurrence over various environmental conditions can be useful in identifying those conditions that lead to increased exposure.

Description of Methods for Exposure Measurement

Sampling methods should be consistent with the intended purpose of the investigation. Methods that are likely to be applicable to the determination of fungi and fungal agents in environments where children spend most of their time are summarized below. Primary emphasis is given to the description of air-sampling methods, but most of the analysis techniques presented can be used for determinations in bulk and surface samples. The methods have been selected according to their ability to provide measures or estimates of exposure in residential and school environments but not in agricultural or industrial environments where fungal contamination can be much heavier.

Continued on page 55



Children/Mold

Continued from page 54

Culturable Fungi

Traditional methods for determining microbial contaminants involve culturing on nutrient agar. Air-sampling methods for bioaerosols involve impaction of culturable organisms onto nutrient agar or impingement of organisms into a suitable liquid medium for subsequent culture on agar. Multiholed impactors [such as the Andersen cascade impactor, two-stage impactor, and the N6 single stage impactor (Andersen Instruments, Inc., Smyrna, GA) or the surface-to-air sampler (Pool Bioanalysis Italiana, Milan, Italy)] and the Reuter centrifugal sampler (Biotest Diagnostics Corp., Denville, NJ) have been used extensively for the sampling and determination of airborne fungi. Details of their operation, advantages and disadvantages, and interpretation of results have been presented (14,16). Results are measured as CFUs, and individual colonies can be identified by experienced mycologists. Culturable fungi in surface swab samples and bulk materials can also be plated and identified. The high sensitivity of culture methods allows determinations of typically < 10 CFU/m³ in an air sample, 0.05 CFU/cm² for a 100-cm² surface area, and 5 CFU/g of settled dust or other bulk material.

The primary strength of culture techniques is the ability to identify fungal species. Although it requires extensive pure culture study, determination of fungal species is important in assessing risk because not all fungi pose the same potential hazard. For example, some xerophilic species such as *Eurotium* spp. are of health importance because they have been associated with hypersensitivity pneumonitis (23). Certain fungi, such as *Stachybotrys chartarum*, are of concern because they produce potent toxins. Others, such as *Aspergillus fumigatus*, are opportunistically pathogenic and may also have the potential to produce toxins. Most fungi, including *Alternaria* spp., are potentially allergenic because of their protein content.

Speciation is also important in the evaluation of homes or buildings involving the ecology of molds that grow indoors. In settled dust, normal buildings contain outdoor molds, including the phylloplane molds such as *Cladosporium* and *Alternaria* spp. and the spores of the dominant mushrooms (*basidiomycetes*) for the region. Much is known about the prevalence of the spores of these species outdoors (24). In July, spore burdens in outdoor air approach 20,000/m³. *Aspergillus*/*Penicillium* spp. (Asp/Pen) are present in outdoor air at a relatively constant low rate associated with windblown soil particles. The prevalence of Asp/Pen varies from 10% (of very low numbers) in the winter to < 0.1% in the summer.

A relatively small number of species grow commonly in water-affected building materials. Fungi are restricted by water activity (available water) and to a lesser extent by substrate type (wood, wallboard, carpet, insulation, furnishings). *S. chartarum*, *Chaetomium globosum*, and *Memnoniella echinata* are associated with water-saturated building materials containing cellulose, most often the paper layers of wallboard. These organisms are highly competitive on these surfaces and are common after leaks and floods that take a long time to dry out. In North America, *S. chartarum*, *C. globosum*, *Trichoderma harzianum*, some *Penicillia* such as *Penicillium thomii*, *Penicillium decumbens*, and *Penicillium fellutanum*, as well as

wood rot fungi occur in water-saturated wood including particleboard and plywood. Also in North America, wetted or damp wallboard is contaminated by salt-tolerant xerophilic molds such as *Anpergillus versicolor*, *Penicillium aurantiogriseum*, *Penicillium viridicatum*, *Penicillium brevicompactum*, and *Paecilomyces variotti*, depending on the amount of available water in the material. An additional 20 or so species of molds occur as important contaminants of housing. These may grow in carpets, insulation, materials, clothing, and shoes. Detection of these species in air samples can direct investigators to sources of hidden mold.

Several shortcomings of methods based on culturing, however, place limitations on their utility, especially limitations in the determination of CFU-count concentrations in air that are representative of time-weighted exposures. Such samples represent very short-term collections (< 5 min). For several reasons, including that there can be order of magnitude variation in spore concentrations in minutes, the numerical values are of limited use (8). Different species of fungi have different growth requirements, so the use of any medium produces different recoveries. The spores of different species decline in viability with time; some spores remain viable for years and others for months. In general, the numbers of fungal propagules determined by culture are substantially less (1-50%) than those determined by methods that determine total propagule counts, but this varies between species. Finally, some species are very aggressive in culture and produce antifungal agents that affect the growth of others, e.g., *Trichoderma* species (25). A longer review of these issues can be found elsewhere (8).

To illustrate this point, Table 1 <http://www.ehponline.org/members/1999/suppl-3/473-480dillon/dillontab1.GIF> illustrates the putative response of plating

1,000 spores of *S. chartarum*, 40 spores of *P. aurantiogriseum*, 20 spores of *Wallemia sebi*, and 40 spores of *T. harzianum* on three media: malt extract agar, corn meal agar, and DG18 agar (14). From the 1,000 spores plated, 10 of *S. chartarum* grew on corn meal agar, the best medium of the three for this species, or 1% of the total spores plated. Recoveries on the medium for moderate xerophiles (DG18) were very low. In contrast, a high percentage of the moderate xerophile, *P. aurantiogriseum* spores were culturable on DG18, its optimum medium. For the xerophile *W. sebi*, good recoveries were obtained on DG18. Colonies of the hydrophilic, wood-soft rot species *T. harzianum* are difficult to count under ideal circumstances, and the organism was poorly recovered on DG18.

Table 2 <http://www.ehponline.org/members/1999/suppl-3/473-480dillon/dillontab2.GIF> illustrates the putative response of plating the mixture of species used to form the above example. *S. chartarum* recoveries, even in the optimal corn meal agar medium used, are much reduced because of the presence of the *Trichoderma*. *W. sebi* is not reported at all, and only the *Penicillium* species emerges unscathed.

These examples demonstrate the point that counting CFUs in air or dust samples over-represents the long-lived tolerant *Penicillium* species. It also illustrates why the application of descriptive statistics to concentrations of CFU/m³ does not necessarily give useful information because each sample can be quite different from another

Continued on page 56

Children/Mold

Continued from page 55

and incomparable from a numerical perspective (8). Thus, CFU data either from air samples or from dilution plating of bulk samples may have little inherent quantitative value. Furthermore, a count of CFUs does not provide a measure of exposure to bioactive substances derived from microbes, including mycotoxins, glucans, or allergens. These substances are also present in nonculturable organisms, which generally outnumber culturable organisms by orders of magnitude.

A similar phenomenon occurs when dilution plating bulk samples such as soil or building materials, especially wallboard, except there is an additional difficulty. It has long been understood in soil mycology that dilution plating does not give a reliable indication of the species active in the ecosystem. Kjoller and Struwe (26) have reviewed data from dilution-plating soil samples over about a 1-year period in comparison to measurements of hyphal growth in the soil. Typically, they found no statistically significant correlation between the two such measures, the latter being a direct measure of fungal activity. Fully 85% of the cultures found by dilution plating are of species not active in the ecosystem (27).

On the other hand, the direct measurement and plating of bulk samples (soil crumb method) is the most useful nonbiochemical method of measuring fungal activity in samples. This technique minimizes emphasis on species that are inactive in the system. Using this technique, the analysis of settled dust samples for culturable fungi may provide evidence of exposure integrated over time. In one study, measures of CFU in house dust were associated with greater surface area of visible mold growth and higher moisture source strength (2). Some investigators caution that measures of biocontamination in settled dust may not represent concentrations in air (28). Because

settled dust contains nutrients, settled-out fungal spores may grow at high humidity (29).

Dilution plating has considerable value in determining the total diversity of species present in a sample, and there is some evidence that the data from many replicates produce data that are related to the absolute value (30). When species grown from air samples taken indoors are compared to the species grown from samples taken outdoors, a difference in rank order remains a meaningful indicator of biologic contamination within the building. It is generally true in North America that in any given sample taken indoors, the ratio of the sum of colonies of typical soil fungi, e.g., *Aspergillus*, *Penicillium*, and *Eurotium* spp., compared to the sum of phylloplane fungi, e.g., *Alternaria*, *Cladosporium*, and *Epicoccum* spp., provides evidence of amplification. In a building that is not contaminated, the ratio should be about 1.

A new study of these issues has been made by Miller et al. (18) in which the data from extensive air sampling inside and outside an apartment building were compared to studies of mold damage after massive destructive inspection to examine wall cavities. The CFU/m³ values between the two data sets were not significantly different using descriptive statistics. However, the proportion of samples that failed the AIHA guidelines for comparing rank order of species inside and outside was different ($p < 0.005$). When the data were compared to the area of visible mold revealed by the extensive destructive testing, there was no correlation with CFU/m³ values. The proportion of "AIHA fails" was fairly well correlated with measured mold area with p -values of 0.03-0.10, depending on the stringency of the test.

Total Fungal Propagule Counts

Fungal propagules collected on a filter or on a sticky surface such as that incorporated into the Air-O-Cell cassette (Zefon, Inc., St. Petersburg, FL) can be counted microscopically to yield a measure of total (culturable and nonculturable) fungal mass in an air sample. Propagules in a surface sample taken with sticky tape or in a bulk sample can also be counted microscopically. These techniques have been described in detail in other publications (14,16,31-33). Some fungi have distinctive spores, but many that grow indoors, e.g., *Penicillium* and *Aspergillus* spp., are small spherical spores with few distinctive features that can be viewed with a light microscope. A scanning electron microscope may increase qualitative information for some spore types, but its use is not practical for the routine identification of species. Fluorescent staining with dyes such as acridine orange have been useful, but some fungal spores will not absorb the dyes, and dark spores often mask the fluorescence. Immunofluorescent staining can, however, be used to distinguish propagules of specific species.

Sequential filter sampling (31) and moving-tape or slide samplers such as the Burkard Volumetric Spore Trap (Burkard Manufacturing Ltd., Rickmansworth, UK) or the Allergenco air sampler (McCrone Accessories and Components, Westmont, IL) provide spore count concentrations over time. These samplers can be programmed to run from minutes to hours.



Continued on page 57

Children/Mold

Continued from page 56

The devices may, therefore, be useful for determining time-integrated exposures over long periods of time, e.g., 8-24 hr, or exposures of high intensity over short times (seconds to minutes), e.g., the sporadic and sudden release of spores by the mechanical or convective agitation of actively growing colonies. A primary disadvantage of these counting techniques is that microscopy is labor intensive and requires considerable skill in distinguishing fungal spores and hyphae from other particles. The quantitative data generated are of uncertain quality because viewing is often hindered, as mentioned earlier in this section.

Short-term exposures can best be determined with continuous reading instruments that give responses in real time. Only one appropriate instrument appears to be commercially available, an ultraviolet aerodynamic particle spectrometer reportedly counts and sizes aerosols of biologic origin (TSI, Inc., St. Paul, MN). However, the instrument is expensive, and its reliability and accuracy in determining fungal spores in air samples has not been reported.

Surrogate Measures (Markers) of Fungal Mass and Growth

For the types of fungi amplified in indoor environments, ergosterol, a primary cell membrane sterol of most fungi, appears to provide a suitable measure of fungal mass in air samples (34,35). The quantity of ergosterol in a fungal spore is a function of surface area (34) and growth conditions (35). The ratio of ergosterol to spore mass for 11 species of fungi commonly found in indoor air has, however, been demonstrated to be reasonably constant at $1 \pm 0.25 \mu\text{g/g}$ (34).

In most indoor environments, ergosterol will be a specific measure of fungal mass because it is not present in vascular plants, although it is found in algae and protozoa (35). Ergosterol is determined by gas chromatography with mass spectrometric detection (GC-MS) with a sensitivity that will allow determinations in air samples taken for 24-48 hr (34). There is experience in measuring ergosterol in house dust and air (34-36).

In addition to the suspected health effects of (1-3)- β -D-glucans, these glucose polymers may provide a measure of fungal burden in personal samples. However, (1-3)- β -D-glucan is not a specific marker of fungal mass and originates from a large variety of sources, including most fungi and yeasts, some bacteria, most higher plants, and many lower plants. Sensitive determinations of (1-3)- β -D-glucans with membrane filter sampling can be performed using the *Limulus amoebocyte* lysate (LAL) technique with Factor G as the analysis technique (37). These glucans have variable molecular weight and degree of branching that may appear in various conformations, e.g., triple helix, single helix, and random coil structures of which the triple helix appears to be the preferred form in the environment. Environmental samples are denatured in alkaline solution (0.3 M NaOH) (37) or by hot water extraction (38) prior to determination. However, a standardized protocol for extraction and storage of environmental (1-3)- β -D-glucan samples does not yet exist. The method is highly sensitive; picogram quantities can be detected, allowing concentrations in the nanogram per cubic meter range to be detected. There is also a specific enzyme inhibition assay (EIA) for (1-3)- β -D-glucan measurements, although sensitivity is not as good as with the LAL method

(38). The EIA technique has been used for the determination of (1-3)- β -D-glucans in settled dust in the home and in occupational environments.

Mold extracellular polysaccharides (EPS) also offer potential for the measurement of fungal mass and have been related to culturable fungi in settled house dust (39). Mold EPS are heat-stable and water-soluble nonbranched glycoproteins with variable molecular weight that are an essential part of the mycelial cell wall of practically all molds. During growth of molds these polysaccharides are released in the environment. Antibody responses against EPS from *Aspergillus/Penicillium* are directed to the galactomannans in EPS, of which $\beta(1-5)$ -linked D-galactofuranoside residues present in the galactomannans are immunodominant (40). EPS usually have an antigenic specificity at the genus level, while EPS from *Aspergillus* and *Penicillium* spp. are cross-reactive. The quantity of antigens produced by molds is fairly related to the quantity of mycelium, and antigens are produced under almost all growth conditions (41). This demonstrates the potential usefulness of EPS as quantitative markers for mold biomass, not only in food products but also in the general and occupational environment. A highly specific sandwich EIA has been described by Kamphuis et al. (42) with which EPS of Asp/Pen can be measured. This method recently has been applied successfully in an indoor study (39). Three other sandwich EIAs have recently been developed for the specific detection of mold spp. from three other mold genera:

Alternaria, *Mucor*, and *Cladosporium*. Application of these assays on environmental samples would thus allow

partial classification of the mold genera present. The determination of EPS is an experimental method and has not yet been routinely applied in indoor studies.

Volatile organic compounds produced by fungi may also be suitable markers of visible or hidden fungal growth because the compounds may permeate porous walls in buildings (14). It has been suggested that these compounds, which have been termed fungal MVOCs, may also cause respiratory symptoms, but no supporting evidence has been offered (43). They are collected on a solid sorbent (Anasorb 747; SKC Inc., Eighty Four, PA), extracted with methylene chloride, and determined by GC-MS (14). The method is sensitive, allowing determination of a concentration of about 10 ng/m³ in 25-L air samples. About 15 MVOCs are emitted by fungi, although some are emitted by bacteria as well. 3-Methylfuran has been used as a measure of active fungal growth, 1-octene-3-ol as a measure of inactive growth, and geosmin as an indicator of either active or inactive growth.

Continued on page 58



Children/Mold

Continued from page 57



Mycotoxins

Instrumental methods, particularly high-performance liquid chromatography (HPLC) and GC, and immunoassays exist that may be adapted to determinations of mycotoxins by collection on membrane filters in long-term air sampling, corresponding to air volumes greatly in excess of a cubic meter or to determinations in settled dust. However, many of these methods were developed specifically for the determination of mycotoxins in food stuffs, e.g., aflatoxins, that rarely amplify in indoor environments (44). Recent and ongoing research has provided methods for mycotoxins produced by fungi that grow in water-damaged buildings. For example, methods utilizing HPLC-thermospray mass spectrometric analysis and GC-negative ionization mass spectrometric analysis have been developed for the determination of macrocyclic tricothecenes (45,46). HPLC and thin-layer chromatographic methods have been developed for determinations of several mycotoxins produced by *Aspergillus* and *Penicillium* spp., including sterigmatocystin produced by *A. versicolor* (47).

Cytotoxicity assays based on application of membrane filter extracts to cell cultures have been useful in studies involving potential exposure to mycotoxins (48), and demonstrate adequate sensitivity for fixed-point air sampling or for determinations in settled dust. The method detects the presence of many cytotoxins, including endotoxin. However, the lack of specificity does not preclude the use of the method as a screening tool.

A recently developed method employing filter sampling has demonstrated the ability to quantify the toxicity of tricothecenes in personal samples using a sensitive *in vitro* protein translation assay (49). This technique may be the first to allow personal sampling that is a quantitative measure of the primary biologic effect of a mycotoxin. The method is 400 times more sensitive than a cell culture-based cytotoxicity assay. Also, the protein translation assay is a more specific measure of toxicity because the primary effect of tricothecenes is inhibition of protein synthesis. Initial field testing has indicated a strong correlation between mycotoxin activity and the presence of toxigenic fungi determined by culture methods.

Fungal Allergens

Only a few major fungal allergens can be measured in house dust (50). Few have been characterized, and allergen stability and production may be highly variable (51).

Other Measures of Fungi

The polymerase chain reaction (PCR) is a highly specific molecular biology technique that has been used more and more frequently in the diagnosis of mycotic infections, including aspergillosis, and in the identification of mold contaminants in grains and

other foodstuffs (52-55). Methods useful for the determination of environmental fungi are under development (56). PCR techniques target a particular gene and are dependent on the availability of suitable probes. These techniques can be developed to be as specific as or as nonspecific as desired, i.e., species-, genus-, or even group-specific. Semiquantitation is possible with the use of internal standards.

Lipid signature profiles have been characterized for several fungal species (57-59). The isolation and determination of lipids distinctive of other fungal species is under-way. This technique has the potential to allow the same selectivity in identification of fungi as has been afforded for bacteria by their lipid signatures.

Measures of Other Respiratory Irritants and Disease Agents—Potential Confounding Factors

In addition to the measurement of fungi as potential causes of respiratory disease, allergens from animals, insects, and dust mites should be measured. Also, attention should be paid to compounds that potentiate or otherwise attenuate the effects of allergens and toxins such as endotoxin; formaldehyde; ozone; carbon monoxide; sulfur dioxide; nitric oxide and nitrogen dioxide (NO_x); and tobacco smoke. High-water activities in building materials or standing water favor not only the growth of hydrophilic fungi, but also bacteria, including Gram-negative bacteria with its concomitant endotoxin, and peptidolysin, a cell wall component of all bacteria (36,60). Plywood, particleboard, and fiberboard may be significant sources of formaldehyde, a potential carcinogen, respiratory irritant, and allergen for some individuals. In the summer months especially, ozone formed in the ambient air from

pollutant precursors may infiltrate a home or building. The use of ozone-generating devices, e.g., electrostatic dust collectors, may cause unhealthy concentrations inside the home and is discouraged. Natural gas space heaters, hot water heaters, and cooking stoves contribute carbon monoxide and NO_x to indoor air and should be properly vented. Kerosene heaters emit these pollutants and also sulfur dioxide, all of which may accumulate indoors if not properly vented. Smoke from burning wood and tobacco smoke add significantly to the burden of fine aerosols (PM_{2.5}) in the residential environment.

Discussion of Exposure Measurement Methods

The most pressing need in the investigation of the impact of fungal contaminants on child health appears to be the establishment of causal relationships. To prove causality, reliable measures of exposures to candidate agents by individual children are required. Generating quantitative exposure information can be difficult, especially for children. Personal sampling is the most definitive technique to estimate exposure dose. Getting children to wear personal sampling

Continued on page 59



Children/Mold

Continued from page 58



equipment is problematic, but miniaturization and computerization have produced a new generation of pumps that are less burdensome and more rugged (61). Lack of analytical sensitivity precludes personal sampling for many fungal agents, but a few methods among the methods discussed earlier will allow the determination of average concentrations over periods representative of many exposure situations (1-24 hr). These methods include the LAL method with Factor G for (1,3)- β -D-glucans (37), the determination of MVOCs (14); and the protein translational assay for tricothecenes (49). However, a standardized protocol for the use of the LAL method to determine (1,3)- β -D-glucans has not been established, and the other methods have not yet received wide usage in epidemiologic investigations.

Fixed-point air sampling in areas where children are active can confirm the potential for exposure. With careful preliminary observations, sampling locations can be selected that may represent worst-case exposures; however, fixed-point sampling

does not provide a true measure of exposure. These methods generally involve relatively high sampling rates with membrane filters, e.g., 2-20 L/min for extended times such as > 24 hr. The following examples are given, but the methods presented for personal sampling are also applicable: determination of markers of exposure to fungi, including ergosterol, mold EPS; enumeration of fungal propagules with microscopic techniques; determination of mycotoxins by HPLC; and cytotoxicity screening of collected aerosols. Although not an air-sampling technique, the analysis of settled dust samples for culturable fungi and for bioactive substances such as those named above may provide evidence of exposure integrated over time.

Fixed-point sampling over short periods of time, i.e., 1-5 min, can provide evidence of exposure. However, estimating exposures even for one given location requires a large number of samples. Traditional culturable sampling and analysis methods for fungi fit this method classification; however, the cost of applying these methods to the estimation of exposures over an 8- to 24-hr period would generally be prohibitive. Furthermore, the uncertainties inherent in a determination of CFU/m³ would make the results of questionable value.

On the other hand, the ability of culturable sampling and analysis methods to provide qualitative information offers a distinct advantage, especially when compared to methods in which only markers of fungal exposure are determined. The importance of the speciation of the fungi that contaminate homes or buildings has been discussed at length in the previous section. The use of surrogates to estimate exposure should be accompanied by the use of

techniques that can identify the fungi present. Fixed-point sampling to determine culturable fungi in areas where children spend most of their time is, therefore, justified. Furthermore, fewer samples are needed to conduct a rank order assessment than would be required to estimate exposures with short-term fixed-point sampling, and culturable sampling accurately establishes rank order differences between indoors and outdoors.

Conclusions and Recommendations

Without further research or discussion, the public health practitioner can conclude that the prevention of microbial growth in buildings is an effective means of preventing disease and that moisture intrusion and accumulation in a building are the primary causes of biocontamination. Thus the prevention of microbial growth is an attainable goal that can be realized by the proper maintenance of a building or home.

Continued research is necessary to establish firm causal relationships between disease agents resulting from microbial growth and disease. An increasing number of methods are available that can be used to measure or estimate exposure of children to fungi or fungal agents. However, continued methods development is necessary to provide tools that can be used to provide more definitive support of causal relationships between disease and currently recognized and potential fungal disease agents. Some of the methods described here have not been used extensively, e.g., the *in vitro* protein translation assay for tricothecenes, and need further field evaluation. A better understanding of the advantages, disadvantages, and complementary attributes of the agents that may be used as indices of fungal mass, i.e.,

ergosterol, (1,3)- β -D-glucan, and mold extracellular polysaccharides, needs to be reached. Finally, much work needs to be done on the further development of promising techniques such as qualitative, and eventually quantitative, PCR, or the determination of fungal lipid signature profiles.

In the absence of statistically definitive causal relationships and in the absence of measurement methods capable of establishing the needed associations to establish causality, decisions regarding the respiratory health of children must be made based on the professional judgment of qualified teams. These professional teams should comprise experts in mycology, exposure assessment, epidemiology, medicine, and building engineering.

For the full article with references, [click here](#).





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Kennedys hope TV home gets green light from environmental council

NY Daily News

Bobby Kennedy Jr. has snatched victory - and a TV deal - from the jaws of toxic mold.

For years, the environmental crusader and his wife, Mary, had battled a deadly fungus that had infested their [Westchester](#) County home.

"We finally came to the conclusion that there was no way to save the house," Kennedy tells us. "We had to tear it down. We didn't feel it was conscionable to sell it to someone else."

The Kennedys moved to a rental house, hoping someday to build again on their land.

Now they are planning to erect a state-of-the-art green home whose construction will be supervised by "This Old House" star [Bob Vila](#) for a 13-part TV series.

Having the last laugh on the mold, the Kennedys are recycling every nail and piece of plasterboard from their old place. They're hoping that the solar-powered manse will win a coveted Leadership in Energy and Environmental Design (LEED) certificate from the [U.S. Green Building Council](#).

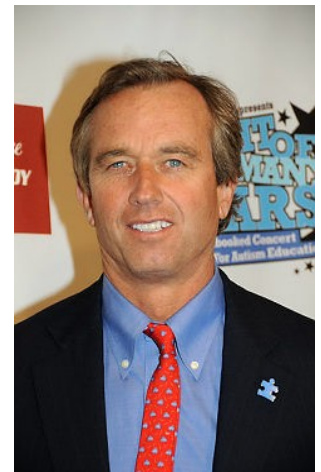
"We're pretty confident we can get a gold LEED," says Kennedy, who is entertaining offers from several TV networks. "Platinum is harder. Some of the ratings depend on how close to rail stations and grocery stores you are."

The show also will look at houses that are "extremely affordable," says Bobby.

The couple is also using recycled materials from a former [Dutchess County](#) men-

tal institution where Bobby once volunteered. "Mary thinks it's good that we're living in an insane asylum," he laughs.

Meanwhile, Kennedy's mother, Ethel, and his sisters Rory, Kerry and Courtney will gather tomorrow at the [East Hampton](#) estate of [Courtney Sale Ross](#) for a 40th anniversary fund-raiser for the Robert F. Kennedy Memorial. Tickets are available at [rfkmemorial.org](#).



Bobby Kennedy Jr.