

Prompt Remediation of Water Intrusion Corrects the Resultant Mold Contamination in a Home

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ABSTRACT

More patients are turning to their allergists with symptoms compatible with allergic rhinitis, allergic sinusitis, and/or bronchial asthma after exposure to mold-contaminated indoor environments. These patients often seek guidance from their allergists in the remediation of the contaminated home or office. The aim of this study was to determine baseline mold spore counts for noncontaminated homes and report a successful mold remediation in one mold-contaminated home. Indoor air quality was tested using volumetric spore counts in 50 homes where homeowners reported no mold-related health problems and in one mold-contaminated home that was remediated. The health of the occupant of the mold-contaminated home also was assessed. Indoor volumetric mold spore counts ranged from 300 to 1200 spores/m³ in the baseline homes. For the successful remediation, the mold counts started at 300 spores/m³, increased to 2800 spores/m³ at the height of the mold contamination, and then fell to 800 spores/m³ after remediation. The occupant's allergic symptoms ceased on complete remediation of the home. Indoor volumetric mold counts taken with the Allergenco MK-3 can reveal a potential indoor mold contamination, with counts above 1000 spores/m³ suggesting indoor mold contamination. Once the presence of indoor mold growth is found, a prompt and thorough remediation can bring mold levels back to near-baseline level and minimize negative health effects for occupants. (Allergy and Asthma Proc 26:316–318, 2005)

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Mold is a constant presence in nature and it often finds its way indoors. Mold contamination occurs because a water intrusion allows unhindered mold growth. Optimum growth conditions for mold are moisture, darkness, and growth mediums that include common building and storage materials such as cellulose, wallboard, wood, and cardboard. As buildings have become better insulated and use filtered air year-round for heating and cooling, outdoor counts do not determine indoor mold counts; therefore, a high indoor mold count generally indicates indoor mold contamination.¹

Spores are released by molds growing on these mediums that allow further contamination and seeding of other rooms in the environment. Some compounds produced by molds are volatile and are released directly into the air. They are known as microbial volatile organic compounds. They have a strong and/or unpleasant odor and can be a source of odors associated with molds. Exposure has been linked to headaches, nasal irritation, and nausea. Furthermore, both the spores and the microbial volatile organic compounds released by molds can cause or contribute to allergic diseases affecting the occupants exposed to this contaminated environment.^{1,2}

Mold contamination of homes, offices, and schools is a growing concern because it can create health problems in sensitive individuals. It also can impact their employment and their ability to sell or purchase a home, and many insurance companies are limiting or eliminating insurance for water damage and the cost for complete remediation of the subsequent damage. It may be impossible to completely remediate a space once fully contaminated by mold and many buildings and homes have been razed for this reason, e.g., McKinley Elementary School in Fairfield, CT.³

Allergists can provide some basic guidance to patients as they work to have their environment quickly and adequately remediated from the lessons learned by a successful reme-



Figure 1. Allergenco MK-3.

diation. This article discusses a successful remediation of a mold-contaminated indoor environment.

METHODS

The mold spore counts in 50 homes were measured using the Allergenco MK-3 (Allergenco, San Antonio, TX) during October 2001 to establish a baseline for homes with no history of water intrusion. Shortly after this was completed, one of these baseline homes suffered water damage. This home's air quality was reevaluated after it became contaminated and again when remediation was completed.

The validated Rhinitis Outcomes Questionnaire⁴ was used to assess the health impact of the indoor mold exposure. The questionnaire quantifies 25 symptoms relating to the occupant's health before becoming ill, at the height of their illness, and after their exposure to the indoor mold has ended. This standardized and validated symptom questionnaire has a maximum score of 130 and a minimum score of 0. The higher the score, the more allergic symptoms a patient has.

Puncture skin testing was performed with the bifurcated small pox needle. Antigens include *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, cat, dog, birch, maple and oak, grass mix, ragweed mix, and saline. Molds were tested intradermally with concentrations being titrated from 1:10,000 up to a maximum concentration of 1:100 w/v. Results were recorded as millimeters of wheal and erythema.

Indoor Air Quality Testing

The total mold spore counts were measured using the Allergenco MK-3 (Fig. 1). In a recent publication by Portnoy, the Allergenco MK-3 was standardized against the Burkard Air Sampler, which is the gold standard for obtaining total pollen and mold spore counts in the outdoor environment. The Allergenco MK-3 was found to be more versatile, portable, and ideal for indoor testing because of its size.⁵

The Allergenco MK-3 collects multiple, discrete samples on silicone-coated laboratory slides according to a preprogrammed 10-minute sample cycle. The same physician read all specimen slides. The Allergenco MK-3 samples the air at 0.015 m³ of air/minute (15 L/minute). Samples are visible on slides as thin traces that are 1.1 × 14.5 mm. These traces are examined under the microscope at 400 power. The slides were read by Dr. Rockwell who completed the American

Academy of Asthma, Allergy, and Immunology's Pollen and Mold identification course. The mold spores were counted using a Whipple Reticule on the microscope ocular. Particulate counts are converted to "particles per cubic meter" (particles/m³) by using the formula:

$$\text{particle density} = \frac{\text{raw count}}{\text{volume sampled}},$$

$$(\text{flow rate} \times \text{minutes sampled})$$

i.e., spore density = raw spore count of trace/volume sampled (e.g., raw spore count = 520/0.015 m³/minutes × 10 minutes = 3466 spores/m³).

The mold spore content of the air in 50 homes was measured during September, October, and November 2001. These homes had not experienced a water intrusion before the initial measurement, and there were no reported mold-related health problems. All counts were done while occupant activity proceeded normally. The air sampler was placed on the floor of either the family room or the living room in these homes.

Remediation of Mold-Contaminated Home

One of the 50 homes, a condominium, suffered a water intrusion 2 months later when on January 23, 2002, the humidifier attached to the furnace in the basement malfunctioned and water spilled onto the concrete floor. The homeowner detected the flooding that day and turned off the humidifier. He then vacuumed the water with a wet vac. Not finding any further water intrusion into the area, he assumed the problem was completely repaired.

Two weeks later (February 6, 2002), the homeowner detected a musty odor coming from the finished bedroom adjacent to the furnace room. He then discovered that the water had gone under the wall separating the rooms and had entered the bedroom closet, which contained cardboard boxes of clothing. The boxes and contents were wet and there was a ½ inch growth of mold on the surface of the boxes. The rebond padding under carpet was soaked. The carpet itself was dry except for the edge under the boxes where the water had flowed slightly over the edge of the rug and was absorbed by the cardboard boxes. The carpet had a waterproof plastic lining that kept it mostly dry and mold free. On February 6, 2002, before remediation was attempted, the spore count for the bedroom was determined using the Allergenco MK3.

To remediate the room, the owner first removed all excess water with a wet vac. The boxes and their contents were removed to the outside of the condominium. None of the furniture had suffered water damage; it was moved to another room. The carpet was rolled back off the padding and the wet padding was removed. The carpet was inverted to allow the plastic liner and any wet edges to dry thoroughly. The wet ends of the carpet were treated with a chlorine cleaning preparation that bleached some of the color out of the edges. High efficiency particle air filter

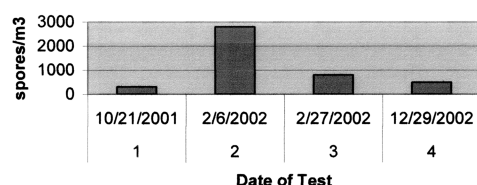


Figure 2. Water-damaged home indoor mold counts.

TABLE I

Values for the ROQ Administered to the Homeowners

	Before Exposure	Height of Exposure	After Exposure
ROQ score	2	18	5

ROQ = Rhinitis Outcomes Score.

cleaners were placed in the room on their highest setting. A dehumidifier was placed in the room to remove excess moisture. The room was allowed to dry for 2 weeks.

When the floor and carpet backing were dry to the touch and there were no visual signs of mold growth, new padding was placed on the floor and the carpet was professionally reinstalled over the padding and all furniture was replaced. The spore count for the bedroom was measured again the next day. Finally, to determine if there had been any return of mold growth in the room, the spore count of the bedroom was again measured 10 months later.

RESULTS

The mold spore count in the 50 homes ranged from 300 to 1200 spores/m³. The mean count was 650 spores/m³. The baseline testing of the rooms in home before the water damage averaged 300 spores/m³. After the water intrusion the count rose to 2800 spores/m³. The predominant mold spore was *Aspergillus/Penicillium*. After remediation, the count in the bedroom was 800 spores/m³. On a recheck the count in the bedroom was 500 spores/m³ (Fig. 2).

Skin testing revealed the homeowner to be sensitive to molds at 1:1000: *Alternaria*, *Aspergillus*, *Penicillium*, *Cladosporium*, *Mucor*, and *Epicoccum*. This patient was negative to saline control. This patient had been diagnosed previously with mild perennial allergic rhinitis. Before discovering the mold contamination, the patient had experienced a worsening of nasal symptoms while at home, especially at night. This is seen in the patients' questionnaire scores (Table I).

DISCUSSION

Prompt attention to an area or room that has suffered water intrusion is the best approach to prevent further mold contamination and permanent damage of the area. Successful remediation of a contaminated area is likely to be possible only if (1) the mold contamination is discovered early and (2) the remediation is both aggressive and thor-

ough. The best remediation is one that can be accomplished in <48 hours to prevent mold growth (United States Environmental Protection Agency Office of Air and Radiation, Indoor Environments Division. Mold remediation in schools and commercial buildings. EPA 402-K-01-001 [6609-J], March 2001. Available at <http://www.epa.gov/iaq/molds/mold-remediation.html>). In cases where the mold growth has been allowed to grow for extended periods and has contaminated the entire building and/or a toxin-producing mold is flourishing in the area, destruction of the building may be the only solution.

In this case, if the homeowner had detected the water in the adjacent room when the flooding had first occurred, mold growth may have been prevented altogether. Furthermore, it is possible that if the homeowner had not found and fixed the problem, the mold contamination may have spread to the rest of the finished basement and ultimately to the entire home. The mold growth was noticed shortly after the water intrusion and the mold had not spread to other rooms, giving the homeowner a chance at complete remediation.

The Allergenco MK-3 volumetric counter is a quick and efficient method for testing indoor mold spore counts. Indoor mold contamination creates an unsafe environment for mold-sensitive patients and setting the standard at 1000 spores/m³, levels that "most likely represent indoor fungal contamination,"¹ is an easily understood standard of measure to evaluate air quality. Our baseline studies, which indicate that a typical home will have mold counts from 300 to 1200 spores/m³ during October, can be useful for those purchasing a home or renting an office building. Furthermore, this standard can be used to check for mold spore counts after a water intrusion and damage. However, this method only provides an indication of the quantity of mold spores in the immediate environment and not a complete identification of the molds contaminating the area. In a building that has been contaminated for an extended period of time, further investigation, including mold identification, is necessary to identify molds capable of producing mycotoxins that may affect the health of the occupants. Finally, mold spore counts should be checked again a few months after the remediation to ensure continued eradication of the mold.

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