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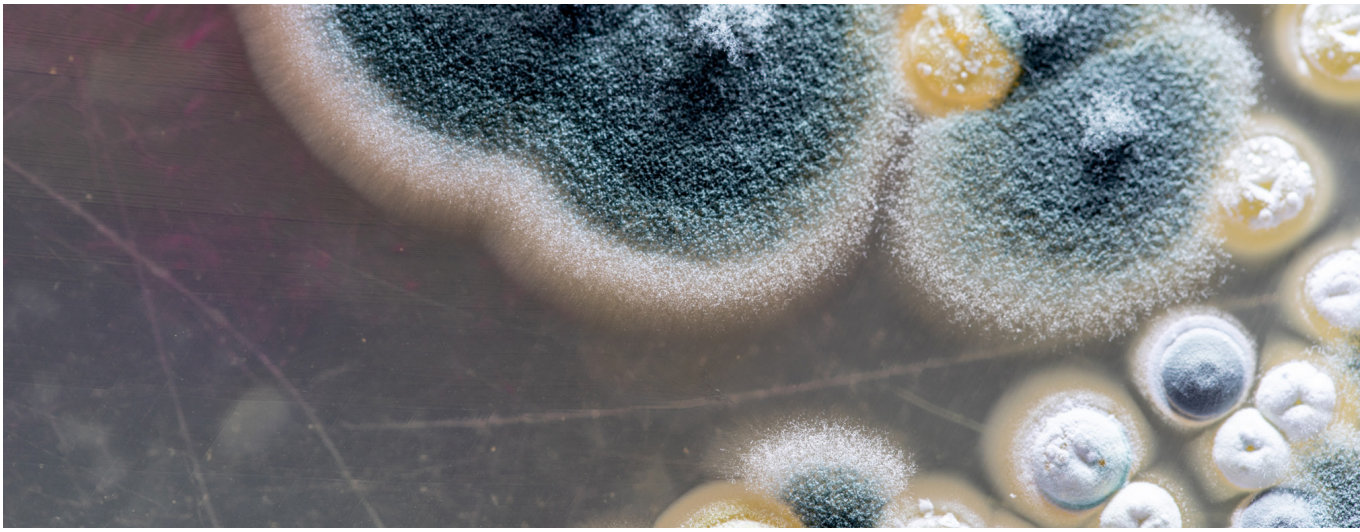
Indoor Air Quality: Health Effects of Airborne Mold & How Mold Is Measured



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INTRODUCTION

Mold spores are present in virtually all environments, indoors and out. People are exposed to molds every day in every setting. The potential for mold to adversely impact indoor air quality is a frequent concern following remediation of water intrusion and/or claims regarding potential health effects due to indoor environments. Adequate assessment requires an overall knowledge of molds, potential health adverse effects, and appropriate investigative and sampling strategies. This white paper is intended for people with some basic knowledge of industrial hygiene. It provides an overview of how airborne molds cause illness in people and how mold is evaluated in indoor environments.

WHAT ARE THE COMMON EFFECTS FROM MOLD IN RESIDENTIAL ENVIRONMENTS?

There are three principal recognized effects of mold in relation to human health: (1) allergy, (2) infection, and (3) toxicity. One or more of these effects can contribute to a sensation of irritation, which some scientists classify as an additional effect.[1]

Allergy

In general, indoor residential exposures are less relevant than outdoor exposure in terms of allergies and effects.1 Allergy is by far the main concern in home and office environments. Molds are common and important airborne allergens along with grass, tree pollen, and pet dander. In order for an allergic reaction to airborne mold spores to occur, an individual must have an allergy to the specific mold being inhaled, and there must be a sufficient amount of spores inhaled to cause a reaction. Response to these allergens is similar and results in hay fever-like symptoms. Allergy symptoms such as "hay fever" do not persist after the exposure to the allergen ceases. Aggravation of asthmatic symptomology can occur in individuals sensitive to mold. People living in damp home environments do not have more allergies than people not living in damp home environments.[2,3]

Infection

Airborne molds are rarely significant causes of infections in humans with intact immune systems. The main concern is hospital environments in which patients are taking immunosuppressive drugs or undergoing surgery. Superficial infections caused by mold are readily treated and generally resolve without complication. Infections of deeper tissues are rare and must be treated by anti-fungal drugs.[4]

Molds causing infections in people with non-impaired immune function may find their way indoors via outdoor air, but normally do not grow or propagate indoors. Since mold spores are present virtually everywhere, it is not possible to prevent immune-compromised individuals from being exposed to molds outside the confines of hospital isolation units.[1]

Toxicity

The chemicals in mold which cause toxicity are called mycotoxins. Molds that propagate indoors may, under some conditions, produce mycotoxins and only during part of their life cycle.[5] The presence of mold is not an indication that mycotoxins are present and not a substitute for mycotoxin measurements.

Adverse human health effects from mycotoxins following ingestion of contaminated foods have been recognized for centuries. Although there is wide-spread belief in the general public that molds growing indoors cause "building-related symptoms," any causal association between mycotoxins in indoor environments and human health effects remains weak and unproven, despite decades of research and published literature on the subject.[1,6,7,8]

Poisoning from mycotoxins in inhaled mold spores and fragments indoors is not expected based on the size of mold spores and fragments and the resulting minute doses. Poisoning from mycotoxins in inhaled mold spores and fragments indoors has not been shown to occur.[1,6,7,9]

Laboratories that conduct mycotoxin testing on biological samples such as urine, based on ELISA technology, are not approved and validated for clinical use. Even if they were validated, the finding of mycotoxins in urine samples is toxicologically meaningless since mycotoxins are found in a number of foods and are present in everyone from dietary sources.[10]

As of February 2015, CDC recommends against biologic testing of persons who work or live in water-damaged buildings and against routine sampling for mold in indoor environments.[11]

HOW IS MOLD MEASURED IN INDOOR ENVIRONMENTS?

A visual inspection, sometimes supplemented by surface and air sampling, is an appropriate method to assess indoor environments for extraordinary amounts of mold.

Surface Sampling

The presence of mold spores or growth on surfaces can be detected with surface sampling techniques such as tape-lift samples. These techniques can differentiate the presence of mold spores and growth from stains, dust, dirt, soot, efflorescence, insect frass, or algae. Mold spores collected from surfaces are most commonly analyzed directly under a microscope (direct exam, non-viable, or non-cultured sample analysis) or can be grown on nutrient agar and the resulting mold colonies are examined (viable or cultured sample analysis). Results from surface samples are analyzed and reported differently by different laboratories. Direct exam results may be reported as spores per sample unit (spores/cm2) or "mold growth" or "normal trapping."

Surface sampling cannot be used to estimate airborne spore levels and therefore cannot be used to estimate potential inhalation exposure. Surface sampling methods are not reliably quantitative because sample collection and analytical techniques have not been validated and are not standardized. Surface sample results cannot be assumed to be representative of all areas of the tested environment without additional information.

The US Environmental Protection Agency (US EPA) has experimented with Mold-Specific Quantitative Polymerase Chain Reaction (MSQPCR) for analysis of vacuumed dust samples from homes and has proposed the Environmental Relative Moldiness Index (ERMI) as a means of assessing damp indoor environments for the potential to cause adverse health effects in humans. MSQPCR analysis is considered a "research tool" by the US EPA and it is not intended for public use and has not been validated for use in indoor environments despite decades of research. The US EPA does not support the use of MSQPCR in a public context.[12]

ERMI involves determining what mold DNA is present in floor dust. The amount of DNA "spore equivalents" (which is determined by MSQPCR) is not related to the number of spores; so results do not inform the industrial hygienist about the number of spores present, not does it tell us if mold growth is present. The results do not convey information about the conditions in the tested area; they do not indicate whether mold growth is present on the surface sampled or the surrounding area, or if there is water damage present, and do not indicate possible airborne mold spore concentrations. ERMI cannot be used to judge whether cleanup is needed or if adverse health outcomes due to mold are likely to occur.

Air Sampling

Mold spores are everywhere in air. Air sampling methods are used to estimate airborne concentrations and potential inhalation exposure to mold spores and mold particles. Air sampling is normally done over a short period of time and one sample does not represent the amount of mold spores present over long periods of time. Therefore, comparisons of indoor to outdoor concentrations of airborne mold spores based on a single sample indoors and outdoors is of almost no value in evaluating exposure.

A common method for measuring the number spores in air regardless of whether they are capable of growing is by drawing a known volume of air across a slide that has a sticky substance on it (spore trap) and then analyzing the slide under a microscope (direct exam, non-viable, or non-cultured sample analysis). Sample results are reported as spores per cubic meter of air (spores/m3).

A common method for measuring the number spores in air that are "viable" or capable of growing is to draw a known volume of air across a plate containing a growth medium (such as agar) and then analyzing the plate under a microscope for colonies of mold (viable or cultured sample analysis). Results are reported as colony-forming units (CFU) per cubic meter of air (CFU/m3).

CONCLUSION

Have Mold Measurements Been Shown to Predict the Presence or Potential for Disease?

Environmental mold measurements of all types have not been shown to predict the presence of or potential for human health effects in indoor environments. Instead, the extent of mold contamination is best accessed by using visual inspection, supplemented by surface sampling as needed.

Legal Requirements for Residential Mold Inspections and Remediation

Mold inspections and sampling are normally done by industrial hygienists, environmental professionals, or individuals trained and certified in a number of voluntary programs around the country. Mold licensure is mandated for inspections and remediation in multiple states. Please contact the authors of this white paper regarding requirements for your specific locations and/or situations.

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