

Home Assessment and Remediation



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Overall Purpose/Goal: To provide excellent reviews on key aspects of allergic disease to those who research, treat, or manage allergic disease.

Target Audience: Physicians and researchers within the field of allergic disease.

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List of Design Committee Members: Charles S. Barnes, PhD, W. Elliott Horner, PhD, Kevin Kennedy, MPH, Carl Grimes, CIEC, and

J. David Miller, PhD, on behalf of the Environmental Allergens Workgroup

Learning objectives:

1. To understand the issues involved with home environmental exposure.
2. To discuss what a proper home environmental assessment can tell me about a patient's exposure.
3. To become familiar with environmental control measures that can be effective in reducing fungal allergen exposure.

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Awareness of the relationship of fungi to asthma in indoor air is very old and well documented. There is substantial evidence that mold and dampness exacerbate asthma in sensitized individuals. Many governmental and nongovernmental organizations around the world have issued guidelines to the effect that the elimination of moisture intrusion and the removal of moldy

items from living space can improve respiratory health. The process of home assessment for moisture and mold presence is discussed along with factors that can be used to guide fungal exposure reduction efforts. An approach to the assessment process itself is outlined, and common causes of moisture and mold damage are described. Points that should be included in a

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Abbreviations used

AIHA- American Industrial Hygiene Association

ASTM- American Society for Testing and Materials

HVAC- heating, ventilation, and air-conditioning

IEP- indoor environmental professional

QOL- quality of life

USEPA- United States Environmental Protection Agency

report resulting from a home assessment and rudimentary elements of report interpretation are discussed. Emphasis is that interpretation of sampling for moisture and fungal presence should be provided by the person performing the assessment. We conclude that multifaceted remediation contributes to fungal allergen avoidance. The use of an indoor environmental professional to generate evaluation reports and remediation activities can be a valuable contribution to an overall allergen avoidance strategy. © 2016 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2016;4:423-31)

Key words: *Mold growth; Fungal allergens; Non-IgE mediated respiratory inflammation; Moisture damage; Building dampness*

One of the earliest reports of the relationship of fungi to asthma in indoor air comes from Sir John Floyer's book "A Treatise on the Asthma." He described asthma symptoms in people who had visited a wine cellar.¹ Feinberg's 1946 "Allergy in Practice" discussed fungi as a cause of asthma.² The Dutch researcher van der Werff published "Mould fungi and bronchial asthma" in 1958.³ Studies on mold and asthma were reported in the early 1970s in the United States by Kozak⁴ and Solomon.⁵ By the late 1970s, recommendations to reduce mold exposure in residential housing were made by allergy researchers.^{4,6,7} As discussed elsewhere in this series of articles, there is adequate evidence that mold and dampness exacerbate asthma in mold-sensitive individuals among other adverse respiratory consequences.⁸⁻¹⁰ Several organizations and governmental agencies including the United States Environmental Protection Agency,¹¹ the US National Institute for Occupational Safety and Health,¹² Health Canada,¹³ the American Industrial Hygiene Association (AIHA),¹⁴ and the World Health Organization¹⁰ have concluded that elimination of moisture intrusion and leaks and removal of moldy items may result in improved respiratory health.¹⁵ These reports along with mechanistic and epidemiological evidence is considered in other articles in this issue.^{16,17}

The intent of this review is to briefly discuss home evaluation for excessive moisture and mold. We will also describe an approach to home assessments that provides information useful from a public health and clinical perspective. Common causes of moisture and mold damage are outlined as well as typical procedures used for remediation and, where available, the impact on occupant health.

Chew et al¹⁸ describe an evidence-based approach to evaluate the need to inspect a residential structure. A series of questions have been outlined that come from the results of studies of housing and health from across the United States and Canada. Depending on the answers to the questions, a judgment can be made regarding the need for a home assessment for dampness and mold. However, it is common for houses to have several concurrent problems that affect indoor

environmental quality. Investigations of apparent or suspected mold-related health complaints must consider all possibilities.¹⁴ Although mold damage comprises a large percentage of problems in US and Canadian homes, other issues include low air exchange rate and contaminants from outdoor air or from activities in the house such as hobbies involving the use of chemicals.¹⁹ On a population level, there is evidence that the probability of occupant complaints is proportional to the extent of mold and moisture damage.²⁰⁻²²

THE HOME ASSESSMENT PROCESS

It is essential that the assessment process be rigorous, systematic, and well documented. The health care provider should be familiar with basic procedures used to assess a home environment and how these are performed.²³⁻²⁵ Whenever a home assessment is initiated, it is important to determine what the purpose of the investigation will be so that all issues known or suspected in advance can be addressed. If the purpose is related to health, the health care provider and the patient must supply the indoor environmental professional (IEP) with detailed information about any potential concerns. A history of the building should be taken that involves questions targeted at determining whether conditions in the home are likely to adversely affect the structure or occupant health.¹⁸ Documenting the occupant's knowledge of moisture and mold events is very useful. For health-related studies, an assessment protocol and questionnaire²⁶ has been extensively evaluated in studies conducted by Health Canada over 20 years. An example of a detailed inspection/evaluation protocol is provided in [Figure E1](#) in this article's Online Repository at www.jaci-inpractice.org.

A good-quality housing and health assessment is an "informed assessment" by someone with experience in engineering, architectural, and moisture problems in buildings.²⁷ Typically, the capacity of the house to cope with water is the main determinant of moisture and mold damage. Formulation of a carefully crafted hypothesis considering building history, occupant use, and fungal ecology often reduces or eliminates the need for sampling.

Apart from floods, the principal causes of mold damage in housing are similar across the United States and Canada. These include leaks in building fabric, condensation, unattended plumbing leaks, and "household mold."¹⁹ Studies of buildings constructed in the high humidity areas of the United States show that uncontrolled airflow and inadequate barriers to rainwater are the causes of most mold problems. Failed caulking around windows and doors can lead to water leaking into wall cavities.²⁸ Poor installation of windows was the top cause of mold growth in many studies. In climates where warm and humid conditions can prevail for some (southern Ontario) or much of the year (Louisiana), improper sizing and installation of the heating, ventilation, and air-conditioning (HVAC) system for either ventilation or moisture control can lead to the growth of fungi on wallboard or on the inner surface of a wall covering. Common wall components that increase total available moisture include air retarders (eg, unpainted wallboard), vapor barriers (vinyl wall covering and polyethylene sheeting), and insulation.²⁹

Moisture and mold problems are often found in housing. A study in eastern Ontario found wet basements and fungal growth.³⁰ A larger study (184 homes) was conducted in the Atlantic coastal province of Prince Edward Island. In the latter study, visible mold was common on window sills (59%-71% of windows). It was also found in bath enclosures, on the underside

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