ACPM

Leadership in the Science,
Policy and Practice of Preventive Medicine

INDOOR MOLD

A Time Tool Resource from the American College of Preventive Medicine

The following resource document provides the evidence to support the health professional version of the Mold Time Tool. Links within the health professional document connect to this Resource. The following bookmarks are available to move around the Resource document.

1. INTRODUCTION

Mold is a nonscientific term used to describe any fungal growth. Mold, along with mushrooms and yeast, belong to the kingdom, fungi.

- Fungi do not have internal digestive systems, so they do not consume food; rather they secrete digestive enzymes to break down living or dead matter in the environment.
- The products of this breaking down are absorbed and used for energy and cell growth.
- Fungi play a vital role in breaking down dead plant and animal matter. They are ubiquitous in our environment, in any shady, damp location where leaves or other vegetation are decomposing. [1,2]

Fungi reproduce by releasing microscopic spores into the air. They also release spores when they are disturbed. They move with the air, so are found both indoors and outdoors. [3]

- They are carried indoors through open doorways, windows, vents, and heating and air conditioning systems.
- They can also attach to clothing, shoes, bags, and pets to be carried indoors.
- Spores that end up in a moist environment at the right temperature range indoors will germinate and grow.
- They can grow on virtually any surface, as long as moisture, oxygen, and organic material are present. Wood, drywall, paper products, cardboard, ceiling tiles, leather, carpet padding, dust, wall paper paste, insulation, and anything that contains cellulose are suitable.
- As they grow they continue to release spores into the air.
- The key is that for mold to be present indoors, there has to be a moisture problem.

Mold growth often looks like spots, can be many different colors, and can smell musty. If you can see or smell mold, a health risk may be present. [3]

Exposure to airborne spores can produce, in some people, symptoms such as nasal stuffiness, throat irritation, coughing or wheezing, eye irritation, or, occasionally, skin irritation. In others it has no effect. [3,4]

- People with mold allergies may have more severe reactions.
- In those who are immune-compromised or have chronic lung illnesses, such as COPD, the risk for serious lung infections is increased when exposed to mold.
- It is advisable for these people to avoid areas likely to have mold, i.e., water-damaged indoor spaces and chronically damp sites such as compost piles, cut grass, and wooded areas.

2. PREVALENCE

Mold spores are present in all indoor environments and can never be completely eliminated. [5]

- Exposure is unavoidable; it occurs through inhalation, ingestion, and touching moldy surfaces. [6]

Prevalence data for mold and mold-related disease are difficult to secure due to the difficulties in making a valid assessment of the environment as well as a diagnosis. [7] [see section of diagnosis and assessment]

Prevalence of mold/dampness

Several authors have tried to estimate the prevalence of homes with high humidity levels and mold growth. Estimates vary from 14% to 66%. [8,9] The WHO estimates the prevalence of homes with indoor dampness as 10% to 50%. [10]

- A prospective study of respiratory disorders in infants included on-site home visits to evaluate observable mold or water damage, as well as other environmental risks; they found that *more than half* of the homes had mold or water damage, and 5% had major mold or water damage with visible mold at 0.2 m2 or more. [11]
- Data from an investigation of a low-income, urban neighborhood in Brooklyn, New York showed that 2 in 5 residences had elevated levels of airborne mold. Most had other environmental hazards as well. [12]

- A study of nearly 15,000 adults across six regions of Canada found that 38% lived in homes with dampness and/or molds (that is, damp spots, visible mold or mildew, water damage, and flooding). [13]
- A study examining the relationship between home dampness and respiratory symptoms in a cohort of nearly 5000 children living in six U.S. cities found that five of the six cities had at least one indicator of dampness in more than 50% of homes. [14]
- Data from a low income urban population in Seattle/King County, Washington, showed that mold was visible in 27% of homes, water damage was present in 19% of homes, and damp conditions occurred in 65% of households. [15]

Schools

Dampness and mold problems are frequently encountered in schools. The CDC reports that approximately one third of US public schools require extensive repairs or need at least 1 building replaced due to mold or moisture problems. [16]

- Environmental data from 60 elementary schools in southeast Texas showed that almost two-thirds of classrooms had mold spore counts > 10,000 colonies/g (median, 14,400 colonies/g; range, 2,000-52,000 colonies/g). [17]

Prevalence of mold sensitivity

Molds are common and important allergens, with about 1 in 20 people reacting to them with some allergic airway symptoms. [5]

- A California study of 141 allergic patients found that 11% to 22% had a positive response to mold using a standardized prick puncture technique. [18]
- Another mold allergy survey, of 100 patients referred to a Midwestern allergy clinic for the evaluation of rhinitis found that 44% of atopic patients had mold sensitivity. [19]
- Sensitization to molds has been reported in up to 80% of asthmatic patients. [20]

3. CHALLENGE FOR CLINICIANS

Patients may present with a wide variety of symptoms that may be attributable to mold exposure. This poses a challenge for the clinician:

- The clinician must take a thorough history and review of symptoms and do a complete physical examination.
- In the differential diagnosis, she must consider all the possibilities, and use available diagnostic tests to arrive at a diagnosis

Patients who are concerned that their health problems are due to mold should be given time to tell their story and should be worked up appropriately.

- A patient who reports respiratory symptoms while working in a damp environment and resolution of symptoms during the weekend provides a compelling case for mold induced illness.

Non-specific symptoms

- A patient complaining of fatigue, nausea, and body aches may also have a mold-induced illness, especially if the symptoms resolve upon leaving that environment and return when re-entering. Many other etiologies must be considered in the differential diagnosis.
- In the indoor environment, various microbiological agents with diverse, fluctuating inflammatory and toxic potential are present simultaneously with other airborne compounds, inevitably resulting in interactions. Such interactions may lead to unexpected responses, even at low concentrations. [10]

4. ETIOLOGY

The environment for mold

High air humidity, condensation and water damage promote the survival and growth of fungi, resulting in increased exposure to fungal allergens and fungal toxins and irritants. [10]

- Excess moisture on almost all indoor materials leads to growth of microbes, such as mold, fungi and bacteria, which subsequently emit spores, cells, fragments and volatile organic compounds into indoor air.
- When sufficient moisture is available, hundreds of species of bacteria and fungi – particularly mold – pollute indoor air.
- Microorganisms are ubiquitous. Microbes propagate rapidly wherever water is available.
- The dust and dirt normally present in most indoor spaces provide sufficient nutrients to support microbial growth.

The amount of water available on or in materials is the most important trigger of the growth of fungi. [10]

- Microbial growth may result in greater numbers of spores, cell fragments, allergens, mycotoxins, endotoxins, β-glucans and volatile organic compounds in indoor air.
- It is very difficult to identify the independent effects of individual microbes.
- Microbial indoor air pollutants are widely heterogeneous; people are often exposed to multiple agents simultaneously; we don't have valid ways of estimating exposure.

Buildings in which there is chronic water damage or where humidity levels are high are most at risk of fungal contamination. [5,22]

- In older houses with recent water damage, the degree of mold exposure was directly related to the incidence of asthma symptoms and bronchial responsiveness. [23]
- In newer, tighter and better insulated buildings, there is an increase in the heat and moisture content that often results in pockets of dampness where mold can thrive. [1]
- Energy efficient construction techniques have led to reductions in air exchange, leading to an increase in problems associated with indoor air pollution and dampness. [24]
- As the number of signs of dampness (e.g., condensation on window panes and/or walls) increased, the ORs for respiratory symptoms increased (OR for nasal symptoms = 4.4 -- lowest to highest groups). [24]

Pathways of disease

Both atopic and nonatopic people are susceptible to adverse health effects from exposure to dampness and mold, although some outcomes are more common in atopic people. [10]

- Therefore, both allergic and non-allergic mechanisms appear to be involved.

The mechanisms are largely unknown, but it is clear that no single mechanism can explain the wide variety of effects associated with dampness and mold. [10]

- In vitro and in vivo studies show diverse inflammatory, cytotoxic and immunosuppressive responses after exposure to the spores, metabolites and components of microbial species found in damp buildings.

Role of inflammation

Many dampness-associated conditions appear to involve inflammation -- inflammatory responses to many microbiological agents have been found. [10]

- Dampness-associated asthma, allergic sensitization and associated respiratory symptoms may result from repeated activation of the immune defenses, exaggerated immune responses, prolonged production of inflammatory mediators and tissue damage, leading to chronic inflammation and inflammation-related diseases.
- Although fungal spores associated with damp buildings produce metabolites with demonstrate acute cytotoxicity, the spores also have toxic effects other than those caused by the inflammatory reaction.

Interactions between microbial agents

Various microbial agents with diverse, fluctuating inflammatory and toxic potential are present simultaneously with other airborne compounds, inevitably resulting in interactions in indoor air. [10]

- Such interactions may lead to unexpected responses, even at low concentrations.
- Makes it difficult to implicate specific exposures in the causation of damp building-associated adverse health effects.

- Thus, microbial interactions must be carefully considered when evaluating the health effects of exposure in damp buildings.

The allergic response
The early phase involves the upper respiratory system – results in clear rhinorrhea, nasal congestion, sneezing, post-nasal drip with sore throat, coughing, and hoarseness.
- The late phase leads to increased nasal obstruction and hyperresponsiveness in the lower respiratory system.
- There is concern that chronic rhinitis may be a response to colonization with fungi. Early in the development of hypersensitivity, the inflammatory responses and symptoms subside between episodes of exposure.
- The responses follow a recurrent temporal pattern after re-exposure.
- Over time, the symptoms and inflammatory responses become more chronic and less specific, making recognition of the immunologic instigator more difficult.

It is now evident that asthma and allergic rhinitis have similar pathophysiological mechanisms and that upper respiratory allergic symptoms can presage the development of asthma in a significant percentage of patients. [27,28]
- Progression of disease may occur either through increased oral breathing and consequent lower respiratory allergen exposure in patients with chronic rhinitis, or through induction of nasal-bronchial reflexes leading to obstructive changes in the airways. [29]

Other allergic effects
In contrast to pollens, fungal spores and/or mycelial cells are associated with a range of allergy-related illnesses, including allergic bronchopulmonary mycoses, allergic sinusitis, hypersensitivity pneumonitis and atopic dermatitis. [20]
- And, again in contrast to pollen-derived allergies, fungal allergies are frequently linked with allergic asthma.

Infectious effects
Except for persons with severely impaired immune systems, indoor mold is not a source of fungal infections. [5]
- Fungal infections of deeper tissues, such as the lungs, are rare but serious.
- In general, they are limited to persons with severely impaired immune systems.

Toxic reactions
Some molds produce toxins under certain conditions, especially excessive humidity or with water damage.
- Most notable of these is *S chartarum*, which has been referred to as "toxic mold". [30,31]

5. HEALTH EFFECTS OF MOLD

The most important health effects of exposure to mold and related pollutants are respiratory symptoms, allergies and asthma, as well as disturbances of the immune and nervous system. [10,25]
- Occupants of homes and children who attend child care settings or schools with excess dampness and mold growth often present with complaints of respiratory symptoms. [32,33]
- Epidemiological data clearly supports the link between dampness and mold and respiratory symptoms. The volatile organic compounds (VOCs) released by mold also contribute. They are responsible for the unpleasant odor of mold. [25,26]

The type and severity of illness that an individual experiences depend on 3 independent variables:
1) the specific exposure
2) the concentration of products in the air and duration of exposure
3) the biological response of the individual's cells to the products. [1]

The point at which mold contamination becomes a threat to health varies. [34]

- Different people in the same house respond differently; some people show greater sensitivity to mold than others (especially infants, children, elderly, people with certain diseases or immunosuppressed, atopic patients, etc). [31,35]

THE MOST CURRENT EVIDENCE REVIEW OF THE HEALTH EFFECTS OF MOLD

The latest evidence review by the World Health Organization (WHO, 2009) [10] updates the previous review by the Institute of Medicine (IOM, 2004) [30] and a meta-analysis by Fisk et al (2007) [36].

- The IOM review found sufficient evidence of an association of mold or dampness with asthma exacerbations, upper respiratory tract symptoms, and hypersensitivity pneumonitis in susceptible persons. [25]
- Other outcomes had only limited, but insufficient, evidence of an association.

Findings of the updated WHO review:

The WHO review strengthened the findings of the IOM, with new studies, and added some additional outcomes substantiated by more recent research. [10]

Overall findings

Current evidence shows that residential dampness is consistently and strongly associated with a wide range of respiratory health effects, most notably asthma, wheeze, cough, respiratory infections and upper respiratory tract symptoms. [10]

- These associations have been observed in many studies in many geographical regions.
- Positive associations have been found in infants, children and adults and some evidence was found for dose–response relations.
- The evidence for associations with measured exposures to fungi is less consistent, due to uncertainties in exposure assessment.

Causal relationships still hard to come by

In agreement with the Institute of Medicine (2004), the WHO concluded that there is still insufficient evidence of a causal relationship with any of the health outcomes reviewed. [10]

- This is due to the nature of the research (epidemiological) and the lack of quantitative measures more than the lack of a true causal relationship.
- There is no evidence that there is *not* a causal relationship.

Exacerbation of asthma – the strongest association

Exposure to mold or dampness is clearly associated with an increase in frequency of exacerbations of asthma; the evidence was considered to be nearly sufficient to establish causality of dampness-related factors. [10]

- A number of new studies added to the evidence of an association between dampness and asthma exacerbation since the IOM review. In all of these studies, dampness-related factors were consistently associated with asthma exacerbation, for both adults and children.

Asthma patients sensitized to mold have an increased risk of bronchospasm, chest tightness, and shortness of breath. [29,37,38].

- Sensitization to molds has been reported in up to 80% of asthmatic patients. [20]
- The degree of mold exposure was directly related to symptom severity and bronchial responsiveness. [39]
- A report from the European Community respiratory health survey found that the severity of asthma symptoms is increased significantly in those with sensitization to mold and dust mites, but not to pollen or cats. [40]
- Indoor exposure to mold and dampness has been associated with significantly greater airway hyperresponsiveness (AHR) in a general practice-based cohort of 526 asthmatic children. After adjustments, the OR for severe AHR in children exposed to mold was 3.95 [95% CI: 1.82-8.57]. [41]

Estimates of the increase in respiratory conditions

Available estimates suggest that residential dampness (visible dampness, mold or mold odor) are associated with a large proportion of human respiratory disease. [36]

- 50% increase in current asthma, cough and upper respiratory symptoms,

    - 44% increase in wheezing,
    - 30% increase in development of asthma
- An EPA analysis estimated that 1 in 5 cases of current asthma in the US may be attributable to residential dampness and mold. [42]

Outcome	Participants	No. of studies	OR (95% CI)	Estimated % increase with residential dampness
Upper respiratory tract symptoms	All	13	1.70 (1.44–2.00)	**52**
Cough	All	18	1.67 (1.49–1.86)	**50**
	Adults	6	1.52 (1.18–1.96)	**-**
	Children	12	1.75 (1.56–1.96)	**-**
Wheeze	All	22	1.50 (1.38–1.64)	**44**
	Adults	5	1.39 (1.04–1.85)	**-**
	Children	17	1.53 (1.39–1.68)	**-**
Current asthma	All	10	1.56 (1.30–1.86)	**50**
Ever-diagnosed asthma	All	8	1.37 (1.23–1.53)	**33**
Asthma development	All	4	1.34 (0.86–2.10)	**30**

Fisk et al, 2007 [44]

- The WHO review confirmed these estimates.
- They must be interpreted with caution, but suggest that some dampness-related risk factors contribute substantially to the burden of human respiratory disease.

Respiratory symptoms

Odds ratios in the range of 1.3 to 2.3 have been consistently reported in case control studies that evaluated the impact of dampness or mold in the homes of children and adults on the incidence of respiratory/asthma symptoms. [2]

- Exposure to mold is associated with increased risk and severity of childhood wheezing illness. [43]
- Exposure has also been shown to produce significant mucosal irritation and inflammation. [44]

Dyspnea

The IOM concluded that there was limited or suggestive evidence of an association between dyspnea and dampness. [25]

- The WHO review included 4 more studies, still cross-sectional, but the measures of association between dampness-related factors and dyspnea were predominantly (81%) greater than 1.0, ranging from 0.41 to 9.38. [10]

Persistent cold-like symptoms

Children with mold allergies may develop persistent cold-like symptoms in the winter that defy conventional therapy. It is often the result of the increased exposure to mold in the home. [45]

Mold Mycotoxins

Some molds produce mycotoxins -- natural organic compounds that can initiate a toxic response in humans (mucosal and skin irritation, immunosuppression, and systemic effects), often at very low concentrations. [2,32]

- The primary means of exposure is by inhalation.
- Many studies in vitro and in experimental animals have demonstrated the toxic potential of a variety of mycotoxins, including trichothecenes and sterigmatocystin. [25,46]

One mold, *Stachybotrys chartarum*, has been linked to a diverse array of illnesses, sometimes referred to as "Toxic mold syndrome."

- The typical presentation includes a variety of symptoms, both non-respiratory and respiratory, including rhinitis (62%), cough (52%), headache (34%), respiratory symptoms (34%), central nervous system symptoms (25%), and fatigue (23%). [47]

Outcomes not evaluated by the IOM
There was sufficient evidence for associations between indoor dampness and four health outcomes that were not so classified or were not evaluated by the Institute of Medicine (2004): asthma development, dyspnea, current asthma and respiratory infections. [10]

- This shows the growing recognition of dampness and mold as respiratory health risks.

Asthma Development
Four new studies -- all with effect measures exceeding 1.0 for most evaluations of dampness-related factors – added to the strength of this association. [48-51]

- These studies were also not included in the Fisk meta-analysis, which found a summary OR of 1.3 (95% CI, 0.9–2.1) for asthma development and dampness factors. [36]

One strong study [51] showed that dampness or mold in the main living area of a house was related in a dose–response fashion to asthma development in infants and children.

- The adjusted ORs for asthma incidence associated with three levels of severity of moisture damage (assessed by civil engineers) were 1.0, 2.8 and 4.0.
- This study is the strongest available piece of evidence within a body of generally consistent findings that dampness-related exposure is not only associated with, but may cause, asthma in infants and children.

The EPA estimates that the proportion of current asthma cases in the U.S. that are attributable to dampness and mold exposure is about 20%, or approximately 4.6 (2.7-6.3) million cases. [42]

Current asthma
Current asthma was not evaluated in the IOM review; in the WHO review, it was consistently associated with qualitative markers of indoor dampness. [10]

- The one prospective study found predominantly (75%) elevated ORs for current asthma (range, 0.92–1.54), and three cross-sectional studies of adults or children also found mainly (81%) elevated ORs (range, 0.46–8.50).
- In the Fisk meta-analysis, an OR of 1.6 (95% CI, 1.3–1.9) for current asthma and dampness factors was reported. [36]

Respiratory infections
Respiratory infections were also not evaluated in the IOM review, but the WHO review found new evidence. [10]

- Two prospective studies of children found consistently elevated ORs, and five cross-sectional studies in children found mostly (73%) elevated ORs.
- In studies with quantitative measurements of mold levels, two prospective studies of children had mixed findings, with 67% of ORs above 1.0 but ranging from 0.46 to 6.88.
- The few findings on otitis media showed weaker relationships.

Rarer conditions
There is also clinical evidence that exposure to mold and other dampness-related microbial agents increases the risks of rare conditions, such as hypersensitivity pneumonitis, chronic rhinosinusitis, allergic fungal sinusitis, allergic alveolitis and pulmonary hemorrhage in infants. [10]

Hypersensitivity pneumonitis is a rare chronic lung disease usually the result of occupational exposures, notably farmers working with moldy hay. [31,35,52]

- It requires heavy and repeated exposure to small fungal particles.
- In homes the main cause is neglected humidifiers contaminated with mold. [1]

Chronic rhinosinusitis (CRS) is an inflammatory disorder affecting the nose and paranasal sinuses. Fungi may be responsible for some forms of it. [53,54]

- The prevalence of the disease and the dominant fungal pathogen appear to vary in different geographic regions and probably are related to individual host conditions.

- Allergic reactions to mold appear to be associated with disease in some patients, but not in all.

Pulmonary hemorrhage in infants
- A mid-1990s outbreak of pulmonary hemorrhage and hemosiderosis in infants was associated with exposure to chronic water damage and molds (particularly *S chartarum*). [55,56]
- The association warrants additional study [57]. Many cases of infant pulmonary hemorrhage have been reported [58-60] and guidelines affirm that infants diagnosed with these conditions should not be returned to damp or moldy dwellings. [31]

Other conditions that have not been studied enough
There are several other respiratory conditions and outcomes that simply have not been adequately studied; this does not mean that relationships with mold exposure are weaker, just that evidence is lacking.
- Indoor dampness also appears to be associated with bronchitis and allergic rhinitis, but the evidence is either mixed (allergic rhinitis) or based on relatively few studies (bronchitis).
- Similarly, the effect on altered lung function is suggested but too few studies.

Allergic rhinitis
Most reactions to mold and moisture are allergic, manifesting as asthma or allergic rhinitis. [2]
- Molds are major triggers of symptoms of perennial allergic rhinitis in atopic individuals. [37,61-63]
- Such reactions have been shown to occur in office workers of fungus-contaminated buildings. [64]
- Mold can also induce occupational rhinitis; nearly a quarter of rhinitis patients in a 10-year study in Finland had allergies to mold. [65]

Sick building syndrome
Building dampness has also been associated with an irritant symptom complex that includes headache, drowsiness, cough, dermatitis, and burning and irritation of the eyes, nose, and throat. [2]
- “Sick building syndrome” is the term used to describe this syndrome IF the symptoms resolve after the person leaves the environment.
- Between one-third and two-thirds of people who work in indoor office environments report one or more weekly building-related symptoms such as eye, nose and throat irritation, headache, and fatigue. [66]

Sick building syndrome is poorly understood, with no consensus regarding its pathophysiology or etiology. [67]
- But interest is shifting to the impact of bioaerosols, especially indoor mold.
- Molds can produce a number of volatile organic compounds (VOCs), such as alcohols and ketones, during their growth cycle; both biological (e.g., fungi or endotoxin) and chemical (VOCs) exposures may contribute to the symptoms. [32,68]
- Many patients and some physicians attribute cognitive and other neurological symptoms to mold exposures.
- Many pure microbial toxins have been shown to be neurotoxic in vitro and in vivo. [10,69-73]
- A cross-sectional study of 522 teachers from 15 public schools, eight 'water-damaged' and seven with no visible water damage showed that mold growth was associated with headaches and difficulties concentrating. [74]

6. ROLE OF THE HEALTH CARE PROVIDER

Disorders related to indoor air quality have become a major concern for primary care physicians, who are often asked to evaluate patients whose symptoms may be caused or aggravated by indoor exposure to mold. [75]

- Microbial contamination of indoor air seems to be becoming a bigger issue; up to half of indoor air-quality cases investigated by the National Institute for Occupational Safety and Health (NIOSH) have been related to microbial contamination. [76]

The primary care physician plays a critical role in making a correct diagnosis and in the treatment of mold-related illness, as well as answering patients' questions about their health, and educating them about what is known and not known about the health effects from exposure to mold. Tightly integrated in the diagnosis of mold induced respiratory symptoms is the problem of identifying the patient's source of exposure and how to minimize or avoid exposure. [2]

Specific strategies to evaluate possible environmental disease in patients include the pursuit of a specific diagnosis, an evaluation of the temporal pattern of symptoms and pathophysiologic changes, and an office-based evaluation of the patient's environment. [2]

- When this process leads to a strong likelihood that the environment is playing a role in a patient's illness, the physician can assist the patient in accessing resources for environmental assessment and remediation.
- Intervention in the environment represents an opportunity to decrease the morbidity of asthma and other respiratory illness, and possibly combat the increasing prevalence of asthma in our communities.

Primary care practitioners play a key role in educating families about mold, its adverse health effects, exposure prevention, and remediation procedures. [77]

- At the first sight of fungi growing in the home; the individual should take steps to find out where the water is coming from. [33]

Patients often seek guidance in the remediation of a contaminated home or office. [78]

- They should be informed that regular inspection and cleaning can remove most mold and prevent recurrent problems. [33]
- They also need to be referred to professionals if the contamination is really widespread.

Persisting health problems

The indoor environment may help explain health problems that do not respond to traditional treatment.

- Physicians should investigate such problems by means of a comprehensive questionnaire and physical examination to evaluate patients' medical histories, previous exposures, and possible sources of exposure to mold and dampness. [2,31,79]

Key role in asthma management

Environmental control is a key part of asthma management.

- Mold spores are an important indoor trigger, although they are not as well understood as other allergens. [80]

In regards to mold, clinicians are in a key position to make proper environmental control recommendations to patients – how to change the indoor environment to reduce mold and dampness and the associated symptoms. [80]

- The primary care clinician's key functions are to educate patients about mold and to provide steps to control moisture in the home [see management]. [81]

Overcoming the uncertainty that has been created around mold

In 2003, the American College of Occupational and Environmental Medicine (ACOEM) published a position paper, "Adverse Human Health Effects Associated with Molds in the Indoor Environment," in its journal, the Journal of Occupational and Environmental Medicine. [82]

- This position paper has been criticized for a series of "biased and ethically dubious decisions and ad hoc methods" that resembles a litigation "defense report" which omitted or inadequately acknowledged research that validated the association between mold and building-related symptoms. The paper was published without conflict disclosure, and has been relied upon by attorneys and expert witnesses representing defendants in mold litigation to disclaim and invalidate claims of building-related health effects from indoor mold exposure.

Primary care clinicians must educate their patients regarding this. Mold can be detrimental to health, and both patients and physicians need to know more about it.

- It must be addressed in a systematic and comprehensive way.
- And, most important, it cannot be ignored.

7. ASSESSMENT AND DIAGNOSIS

People are constantly exposed to fungi (mold) in indoor and outdoor environments. Therefore, it is extremely difficult to pinpoint a single source of exposure. By becoming familiar with the common symptoms caused by mold exposure and the usual sources of exposure, a physician can begin to make a diagnosis and determine the appropriate course of action.

There are two avenues for investigating health problems potentially related to mold. [31,79]

- First, is to evaluate the home or other indoor environment.
- Second, is to test the patient for allergen sensitivities by serum assays of immunoglobulin E antibodies or skin tests with aeroallergens. Neither is considered a gold standard, both may be used by allergists for persistent cases.
- Unfortunately, at this time there is no definitive method for testing either the environment or the patient.

Consider the host

Any time a physician prepares a differential diagnosis, she must consider if the patient is generally immunocompetent or immunocompromised (HIV, cancer, autoimmune disease, long term steroid use, transplant, etc.). [31,79]

- This greatly increases the risk for a fungal infection.

The key to making a diagnosis

Disappearance or diminishing of symptoms when removed from the exposure remains the gold standard for determining the origin of reported health problems. [31,79]

EVALUATING THE INDOOR ENVIRONMENT

Begin with simple observation and inspection for dampness and visible mold

Indicators of dampness and microbial growth include the presence of condensation on surfaces or in structures, visible mold, perceived mold odor and a history of water damage, leakage or penetration. [10]

Quantitative assessment of exposure is hampered by several variables. [10]

- A lack of valid assessment methods.
- Lack of values or thresholds for acceptable levels of contamination by microorganisms.

A personal thorough inspection of the house remains the most available method of assessment. [10]

- Semi-quantitative dampness/mold exposure indices, based solely on visual and olfactory observation and weighted by time spent in specific rooms, can predict existence of excessive building-related respiratory symptoms and diseases. [83]
- Relative extent of water stains, visible mold, mold odor, or moisture can be used to prioritize remediation to reduce potential risk of building-related respiratory diseases.

Limitations of testing indoor environments for mold

Inspections and testing of indoor environments for mold growth increased dramatically in the past decade. [84]

- Allergists can now be asked to interpret reports and laboratory data, although they are seldom trained to review environmental data.
- There is no single sampling method that is both specific for mold growth and robust enough to reliably detect mold growth.
- There is no standard method for these inspections or testing and no widely recognized credential for investigators, and therefore reports also vary in quality, objectivity, and thoroughness.

- Despite these issues, inspections coupled with qualified analyses of samples that are collected with a useful and systematic strategy can usually indicate whether mold growth is present in a building, but the nature of the inspection should be assessed before any interpretation of the results and data is attempted.

Determining the type of mold is not necessary.
It is not necessary to know the type of mold growing in the home -- CDC does not recommend routine sampling for molds. [85]
- Sampling for mold can be expensive, and standards for judging what is a worrisome quantity of mold have not been set. The best practice is to remove it and work to prevent future growth.

Mold air sampling remains problematic
Current air sampling methods have limitations in assessing mold and other biological agents. This limits the ability to demonstrate relationships between bioaerosol exposures and health. [83]

Interpreting the results of mold air sampling is difficult. Sampling data often has great variability. [86]
- Without established exposure limits, indoor air quality investigators often must rely on their professional judgment, but the lack of a consensus "decision strategy" incorporating explicit decision criteria requires professionals to establish their own personal set of criteria when interpreting air sampling data.
- In a study that examined the level of agreement among 18 indoor air quality practitioners in their assessment of airborne mold sampling data there was only weak overall agreement in their evaluation of the data; there were substantial differences that were likely due to differences in personal decision criteria employed by the individual evaluators.
- The study concluded that there is a need to examine decision criteria, weightings used by individual practitioners, and the rationale under which criteria are adopted as first steps toward the larger goal of developing a consensus mold decision strategy.

TESTING THE PATIENT
Identifying the specific fungi
All allergen-specific treatment is dependent on defining sensitization. This can be achieved through serum assays of immunoglobulin E antibodies or skin tests with aeroallergens. [88]
- Information on sensitization can then be used to educate patients about the role of allergens in their symptoms, to provide avoidance advice, or to design immunotherapy.

Many fungi are capable of causing IgE-mediated hypersensitivity in humans. [89]
- Pure and relevant allergens are essential for diagnosis as well as for understanding the immunopathogenesis of the disease.
- Until relatively recently, pure and standardizable antigens from fungi were not available.
- In recent years, many recombinant allergens have been produced by molecular cloning. Using these allergens, novel methods are being developed to improve diagnosis of mold-induced allergy.
- By understanding the immunopathogenesis of allergens, new avenues might open up leading to improved patient care, including immunotherapy and vaccination.

Intradermal skin testing (IDST) for inhalant allergy is still in development
The use of IDST for inhalant allergy varies widely among allergists. [90]
- When performed, it is necessary to use a 100- to 1,000-fold dilution from the stock allergen extract. Only a few inhalant allergens have been evaluated with challenge models for IDST.
- Most of the literature suggests that with a negative skin prick test result, a positive IDST result adds little to the diagnostic evaluation of inhalant allergy. However, additional studies are necessary using challenge models for less potent and nonstandardized inhalant allergens (molds, trees, dog, weeds).

Although some allergists are using skin and inhalation testing for fungi, the tests have not been validated and this is still an experimental procedure. The diagnosis is made on clinical grounds if it exists at all. [91]

8. MOISTURE CONTROL – REMEDIATION

The health risks of mold are best addressed by considering dampness as the risk indicator. [10]

- Eliminating or minimizing persistent dampness on interior surfaces and building structures is the most important means of containing mold and avoiding harmful effects on health.

Apart from occasional leaks, heavy rain and flooding, most moisture enters buildings in one of two ways: 1) in incoming air, including infiltrating though the building envelope, or 2) from occupants' activities within the home. [10]

Managing moisture thus requires:

- Keeping rainwater and ground water away from the interior, [81]
- Properly maintained heating and air conditioning systems, [81]
- Maintenance of interior water sources to prevent leaks. [81]
- Proper control of temperature and ventilation to avoid excess humidity, condensation on surfaces and excess moisture in materials. [10]
- Ventilation distributed throughout spaces, and stagnant air zones avoided. [10]

Building owners are responsible for ensuring proper building construction and maintenance to provide an environment that is free of excess moisture and mold. [10]

- Occupants are responsible for managing the use of water, heating, ventilation and appliances in a manner that does not lead to dampness and mold growth.

Building factors required for proper control of moisture: [10]
Exterior:

- Rainwater (downspouts, and runoff) and surface water drained away from the building.
- Watertight roof – adequate slope, sealed pipes penetrating the roof, proper drainage.
- Eaves to protect walls from rain.
- Vapor barrier covering exterior walls.
- Adequate insulation.
- Weatherproof windows with adequate caulking.
- Nonmetal window frames.

Interior:

- Watertight, sloping floor with floor drain in wet-process rooms.
- Good ventilation, especially in bathrooms, laundry rooms and kitchens.
- Attics and crawl spaces ventilated when applicable.
- Prevention of condensation on walls and windows -- surfaces that become cooler than the surrounding air.

Sources of Moisture:
Leaks
Water can leak from a broken pipe or plumbing fixture, through holes in a roof or cracks in a basement foundation, or around inadequate window or door flashing. [1]

- The rate of leakage and how long it lasts determine the extent of the mold problem.
- The growth of mold can provide clues about the leak and the direction of water movement.

Airborne Moisture
Moisture can also come from condensation – see it on window panes [1]

- A shower adds about a half pint of moisture to the air for each 5 minutes of use.
- A clothes dryer not vented to the outside adds about 5 pints per load.
- Cooking adds moisture to the air; the breathing of 4 people adds nearly half a pint per hour.
- Furnace humidifiers can add a gallon per hour.

Building Materials

- Concrete loses moisture for several months as it cures – can add over a gallon of moisture to the indoor air.
- A dirt crawl space can add up to 100 pints of moisture per day by evaporation.
- Many new synthetic building materials also keep moisture inside.

Relative Humidity (RH)
RH is the amount of moisture in the air at a specific temperature vs. the total amount of vapor that could be in the air. As temperature drops, the capacity to hold water decreases.

- The dew point is the temperature at which moisture condenses from the air.
- Condensation does not, however, require 100% RH; just coming in contact with a cooler surface can cool indoor air to the dew point.
- Aspergillus can grow in 75% relative humidity (i.e., dry appearing surfaces), while Stachybotrys requires nearly saturated conditions (wet). [1]

Air Exchange Rate
Homes built before World War II have an exchange rate of about 1.00, meaning that indoor air is completely exchanged with outdoor air every hour. [1]

- But as homes have become tighter and better insulated, the air exchange rate has dropped – may now be about 0.25, meaning it takes 4 hours to fully exchange indoor air.
- This means that simple activities, such as a shower or cooking, result in higher relative humidity, and an increase in condensation; this is often seen in older homes when windows are replaced and insulation added.

The importance of ventilation
Proper ventilation reduces indoor moisture levels. High indoor humidity is associated with increased growth of mold and bacteria. [25]

- Ventilation dilutes or disperses concentrations of airborne viruses or bacteria that can cause infectious diseases. Higher ventilation rates reduce the prevalence of airborne infectious diseases. [92,93]
- Ventilation rates greater than 10 l/s per person, up to approximately 20–25 l/s per person, are associated with a significant decrease in the prevalence of symptoms of sick-building syndrome and improved air quality in office environments. [94,95]
- In comparison with natural ventilation, air-conditioning (with or without humidification) is often associated with a statistically significant increase in the prevalence of one or more sick-building syndrome symptoms in office buildings. [96]

Remediation Trials
Few intervention studies have been done, but their results show that remediation of dampness problems can reduce adverse health outcomes.

- Kercsmar et al (2006) [97] conducted a well designed study on asthma exacerbation in the houses of highly symptomatic children living in a home with indoor mold and found that comprehensive removal of sources of dampness and cleaning of visible mould dramatically reduced asthma exacerbations.

In another remediation study of a home, mold counts fell from 2800 spores/m3 at the height of the mold contamination to 800 spores/m3 after remediation. [78]

- Baseline mold spore counts for non-contaminated homes ranged from 300 to 1200 spores/m3.
- Occupant's allergic symptoms ceased on complete remediation of the home.
- Upper respiratory symptoms resolved in patients after reservoirs of fungal organisms in contaminated ductwork of the air delivery systems were eliminated with rigorous maintenance in the building's heating, ventilation and air-conditioning (HVAC) system.

In a commercial building with severe moisture problems (*Trichoderma* and *Phoma* as dominant micro fungi) initial renovation eradicated most visible signs of molds and resulted in a decreased number of symptoms. [98]

- A follow-up remediation effort sufficiently cleaned the building, and the rate of symptoms and peak-flow variability fell to normal levels. A focused and thorough cleaning after renovation may be necessary for optimal eradication of symptoms.

Remediation of mold in a school environment has been shown to have beneficial effects on teachers' health. After the remediation, bronchitis, conjunctivitis, symptoms of allergic rhinitis and the sum of respiratory infection episodes decreased significantly, along with the mean duration of sick leaves. [99]

- A longitudinal intervention study showed the positive effects of the moisture and mold remediation of a school building on children's health as well -- significant decrease in the prevalence of 10 of 12 symptoms studied. [100]

9. THE MANAGEMENT PLAN

Involves three steps:
1) Determine if mold is a problem – the need for intervention
2) Conduct an assessment to determine the location of mold and source of moisture
3) Make recommendations for remediation [2]

STEP 1. DETERMINE IF MOLD IS INVOLVED

A. Evaluate current symptoms
- Use Table D: Current Symptoms, Section 11, Appendix.

Clinical Practice Guidelines, Table D, Page D-6, http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf

B. Evaluate specific conditions and symptoms that are suggestive of mold:
- Use Table A: Sentinel Conditions, Section 11, Appendix.

Clinical Practice Guidelines, Table A, page D-2 http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf

C. Evaluate common symptoms that become worse in a particular environment:
- Use Table B: Questions for Patients with Common Symptoms, Section 11, Appendix.

Clinical Practice Guidelines, Table B, page D-3 http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf

D. Medical Evaluation: Tailored to the patient, not the environment.
Pulmonary function testing and immunologic allergy testing can play a role in making a correct diagnosis, but are often unnecessary.
- Allergen testing sometimes yields an equivocal result; if symptoms are compelling for mold allergy, it may be appropriate to proceed with modification of (not testing of) the environment to reduce exposure.

When considering testing, a physician must consider a number of issues: [2]
- How will the test change what I plan to do next?
- If the symptoms are clinically related to mold, will testing add any additional information?

E. Decide on Making a Referral:
Any time a primary care practitioner feels that a consultant would add to the patient's care, especially with symptoms of unclear etiology, referral to a pediatrician, pulmonologist, allergist, neurologist, toxicologist, or preventive medicine specialist is recommended. [2]

STEP 2. ASSESS THE ENVIRONMENT

Controlling mold is about limiting the conditions that enable it to grow. [5]
- Requires locating the mold and determining the sources of moisture problem.

Once mold is confirmed, or at least strongly suspected, as contributing to the patient's symptoms, the next step is to perform a qualitative assessment to identify factors that support mold growth. [2]
- It is important to use a "whole house" approach to evaluating for moisture problems because a problem in one part of the house can easily affect other areas. [1]
- The purpose is to locate the mold and determine the source of moisture. [1]
- A moldy odor or visible evidence of mold or mildew on materials indicates the presence of mold. However, mold may be present even if not smelled or seen.

- The assessor can be the patient, a family member, or a professional.

A good initial assessment:
- Includes the outside of the building, the ventilation systems and the interior of the building.
- Pays special attention to areas where symptoms are experienced – may lead you to hidden mold (especially if patient feels better in the area when wearing a mask suitable for mold).
- Focuses on areas where there is water damage (from leaks, high humidity) and any musty or moldy odors.

Air sampling is not recommended initially as results are often not representative of the biological exposures a patient actually faces, and can be misleading. [2]

A. Who will do the assessment? Patient, family member or professional

The patient or a family member may assess the environment for mold.
- Provide the patient with a home checklist if doing it themselves (Table C).
- Advise appropriate caution when exploring the environment, especially not disturbing any mold.
- Also, if symptoms develop while investigating, advise having someone else continue the assessment.

If the patient or family do not want to do the assessment, then a professional can be hired.
- Includes industrial hygienists, indoor environmental quality consultants, and environmental health professionals. [2]
- Experience conducting environmental assessments with a focus on bioaerosols is a key qualification.
- The local public health department can usually provide information about experienced professionals in the area.

B. The Walk-through Assessment

If the patient/family is doing the walk through make sure they understand the directions below:
- Begin with where in the home environment and under what conditions (such as heat on or off) the patient experiences symptoms.
- Examine the outside of the home or building.
- Note water or moisture incursion from past and present leaks, spills, and condensation.
- Review ventilation and note apparent mold, mildew, and areas with moldy, musty odors.
- Examine places where moisture may accumulate, such as crawlspaces.

Outside Inspection

Visually assess the immediate outside environment and building exterior for:
- Sources of outside molds (for example, leaf piles).
- Damage to the building (roof, wall, windows and foundation), especially damage that
- would allow water intrusion.
- Accumulations of organic material in or near air intakes (e.g., bird or bat droppings because they support fungal growth).
- Grading (poor drainage and below-grade air intakes or basement windows).
- Evidence of standing water where it may be affecting the indoor environment.

Ventilation Review

A systematic review of the mechanical ventilation system should be part of the initial assessment. Outdoor air enters and leaves a house by infiltration, natural ventilation, and mechanical ventilation.
- The amount and quality of the air flowing through the system can be of critical importance to the indoor air quality.
- The assessment focuses on good maintenance practices to ensure dirt and moisture do not accumulate and to provide adequate ventilation; includes checking:
    - Filters (dampness and microbial growth, dirt).
    - Heat exchangers (e.g., cooling coil section including drain pan), ductwork, and air diffusers (for dampness, microbial growth, dirt, and rust).

    - Air conditioners (standing water, microbial growth, dirt).
- A home's ventilation rate can be increased by opening windows and doors, operating window or attic fans when weather permits, and running a window air-conditioner with the vent control open.

Interior Inspection
- Careful inspection for water damage (leaks, high humidity, musty or moldy odors) and signs of chronic condensation (typically cool surfaces such as outside walls and windows).
- Inspection of covered or closed in areas (closets, behind bookcases, underneath furniture).
- Carpets (for evidence of water damage) and other fabric materials such as upholstery, furniture, and drapes (for dampness, microbial growth, and dirt).
- Portable humidifiers (for standing water, microbial growth, and dirt).
- House plants (for mold growth on dirt or plants, for water damage underneath pots).

C. Summarize the Findings – Enough to Plan the Remediation?
If the information gathered from the inspection and ventilation review is adequate, the assessor should be able to identify the exposures that need to be addressed.
- If the patient/family assessment is not satisfactory, then hiring a professional mold investigator should be considered. [1]
- A professional may need to implement a well-planned program of sampling and microscopic analysis in order to guide the remediation.

Professional Sampling and Assessment
Generally, professionals use two types of sampling: *source sampling* of materials where mold may be growing (such as wood, carpets, wallboard, and adhesives on wallpaper) using swabs, wipes, or adhesive tapes and *air sampling*, in which a standard volume of air is passed through a filter or impacted on growth media plates or greased microscopic slides to collect mold and spores.
- Microscopic examination of the residue picked up by clear tape may indicate the type of mold present. For comparison, the assessor will sample areas not indicating moisture or mold.
- Samples from suspected mold-contaminated materials or dust collected from suspected areas can be analyzed for mold, as well as other allergens.
- A partially quantitative approach is to collect spores on membrane filters or slides. Spores are counted and provide some information about the type of fungal spores present.

Testing the Air
Patients may sometimes ask to "have their air tested", especially parents of school age children who attribute their child's symptoms to mold exposure in school.
- Testing the air in homes, schools, or workplaces for mold is currently not a recommended practice for many reasons. [101]
- First, you can find mold in nearly any environment you test.
- Second, there are no specific standards for air monitoring.
- Third, there is great variation in the virulence of molds sampled and wide variability in individuals' susceptibility to mold.

Instead of investing money in testing the air, current guidelines suggest that it may be better spent finding out the source of water and removing it. [2]

STEP 3. PERFORM THE REMEDIATION

If a location is identified where a patient's symptoms are most noticeable, there are a number of suggestions a physician can make to empower the patient.
- As a practical point, it is important for people who are highly sensitive to mold not to perform clean up themselves.

Remediation involves fixing the causes of unplanned moisture, controlling the humidity, cleaning mold from nonporous materials, and discarding water damaged or contaminated porous materials.

Emphasize the need to act promptly.

- If fungal contamination is not addressed early, substantial damage can occur, requiring professional remediation. [33]
- Regular inspection and cleaning can prevent many fungus-related problems.

A. Provide information on clean-up:

- Basics Of Controlling Mold:
  http://www.cdc.gov/mold/dampness_facts.htm

- Guidelines for clean up:
  http://www.cdc.gov/mold/cleanup.htm
  http://www.epa.gov/mold/moldresources.html

- A Brief Guide to Mold, Moisture and Your Home:
  http://www.epa.gov/iaq/molds/moldguide.html
  http://www.cdc.gov/mold/dampness_facts.htm

- For floods -- The Federal Emergency Management Association and American Red Cross booklet "Repairing Your Flooded Home" is very helpful -- available at:
  www.redcross.org/services/disaster/0,1082,0_570_,00.html and
  www.fema.gov/hazards/floods/

B. Suggest Resources for Assistance

- Renters -- contact landlords to discuss mold removal.
- Parents of children affected in schools -- contact the school administration.
- For assistance with assessing mold -- the local health department
- Questions related to mold related illness -- the state or local health department

C. Provide instructions for remediation:

1. Mitigate Moisture Incursion Identified in Assessment

- Repair leaks and moisture migration into the building envelope (roof, walls, floors and basement) and leaks from the building's plumbing system.
- Ensure that heating, ventilation, and air-conditioning (HVAC) system drip pans are clean and unobstructed.

2. Maintain Low Indoor Humidity

- The relative humidity (RH) of the indoor air and the ventilation system should be below 60%, ideally between 30 and 50% because at an RH of 50% or more hydroscopic dust will absorb water that may allow the growth of fungi. [102]
- Use an air conditioner or a dehumidifier with HEPA filtration during humid months and in damp spaces, like basements; controls indoor dew point and reduces airborne mold spores. [103]
- Dust mite and fungus growth can be controlled by keeping the household humidity level at less than 50%.
- Vent exhaust fans and dryer vents outside the home.

3. Clean or Remove Mold-damaged Building Materials, Furnishings, and Other Items

Mold can be removed from hard surfaces with commercial products, soap and water, or a bleach solution of no more than 1 cup of bleach in 1 gallon of water.

- Never mix bleach with ammonia or other household cleaners. Mixing bleach with ammonia or other cleaning products will produce dangerous, toxic fumes.
- Open windows and doors to provide fresh air.
- Wear non-porous gloves and protective eye wear.
- If the area to be cleaned is more than 10 square feet, consult the EPA guide http://www.epa.gov/mold/mold_remediation.html.

Remove chronically damp or contaminated materials, including: [104]

- Building materials, furnishings, and other items that have been repeatedly wetted or subjected to long periods of dampness.
- Carpets and upholstery that have been soaked and cannot be dried promptly.
- Do not use carpet in rooms or areas like bathrooms or basements that may have a lot of moisture, or over concrete in bedrooms.
- Restoration and water damage professionals may be able to clean valuable porous items such as treasured books or upholstered furnishings.
- Care must be taken to not contaminate clean environments during the removal of contaminated materials. [33,85]

Emphasize caution during clean-up [1,2]
Because mold remediation involves exposure to mold spores, it is prudent to suggest that individuals other than the patient do the cleanup.

- Do not touch mold, or work with bleach solutions or hazardous cleaning liquids, with bare hands; wear long-sleeved protective gloves.
- At a minimum, a fitted respirator with N95 filter protection, eye protection, and gloves should be worn when small mold remediation projects are undertaken.
- Larger projects require more respiratory protection and the uses of practices that separate the area contaminated with mold from other spaces in the home or work environment (full containment).
- When working with dry, dusty mold use a HEPA vacuum rather than a regular vacuum cleaner (including a wet/dry vac); they can emit allergens in the exhaust.

Checklist for physicians investigating health problems potentially related to mold Indoors

ELEMENTS OF EXAMINATION IMPORTANT FINDINGS

Medical history and previous exposures
Atopy: familial and personal*
Presence of chronic diseases
Habits: tobacco use, passive smoking, alcohol, etc

Occupational exposures:
Dust, smoke, solvents, etc

Symptom questionnaire†
Allergic symptoms: respiratory irritative symptoms: eyes, nose, throat, upper airways
Recurrent infections: otitis, sinusitis, pneumonia
Fatigue, lack of energy
Anemia
Skin problems
Cognitive problems

Environmental history
History of water infiltration, leaks, or other water damage
Presence of visible molds
Condensation on windows, walls, or other structures
Musty odors
Complaints from other occupants of the same environment

Physical examination
Evaluate for:
rhinitis
asthma
sinusitis

otitis
skin disease
hematologic disease
neurologic disease

Resources
Medical specialists: pediatrics, pulmonary, otolaryngology, dermatology, neurology, preventive medicine
Public health department

Websites:
- New York City Department of Health (http://www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html)
- McMaster Institute of Environmental Health (http://www.mcmaster.ca/mieh/furpt.htm)

**Skin tests can be carried out to establish patients' atopy with respect to molds. Because exposure to fungi routinely occurs both indoors and outdoors, however, this information is of limited value.*
In addition, molds common in Canadian homes do not correspond to the extracts of fungal species available from major companies for allergy testing.
†*Symptoms that do not respond to traditional treatment or that disappear with cessation of exposure suggest that indoor environments are important in their etiology.*
http://www.cfp.ca/cgi/reprint/48/2/298

10. RESOURCES

GUIDELINES:
Storey E, Dangman KH, Schenck P, et al. **Guidance for clinicians on the recognition and management of health effects related to mold exposure and moisture indoors.** Farmington, CT: University of Connecticut Health Center, Division of Occupational and Environmental Medicine, Center for Indoor Environments and Health, 2004.
http://oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf (Accessed December 1, 2008)

World Health Organization, 2009. WHO guidelines for indoor air quality: dampness and mould.
http://www.euro.who.int/document/E92645.pdf

GENERAL INFORMATION:
http://www.cdc.gov/mold/links.htm
http://www.cdc.gov/mold/

EPA RESOURCES:
A Brief Guide to Mold, Moisture and Your Home
http://www.epa.gov/mold/pdfs/moldguide.pdf

Indoor Air-Mold
http://www.epa.gov/mold/
http://www.epa.gov/iaq/molds/moldresources.html

MOLD CLEAN UP:
http://www.cdc.gov/mold/cleanup.htm
http://www.epa.gov/mold/moldresources.html
http://www.epa.gov/iaq/molds/mold_remediation.html

Fact Sheet on Mold Remediation
http://home2.nyc.gov/html/doh/html/epi/moldrpt1.shtml#factsheet

PATIENT EDCUATION:
Patient facts sheets on mold
http://www.fvhd.org/documents/MoldWebResources.pdf

National Institute of Environmental Health Sciences
http://www.niehs.nih.gov/health/topics/conditions/asthma/mold.cfm

American Lung Association – Flood Clean Up Fact Sheet
http://www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=35694

ASSESSMENTS:
Taking an occupational/environmental history
http://npic.orst.edu/RMPP/rmpp_ch3.pdf
http://www.neefusa.org/pdf/primer.pdf

Pediatric Environmental History Primer
http://www.neefusa.org/pdf/primer.pdf (Accessed May 16, 2009)

FROM THE GUIDELINES: SEE APPENDIX BELOW
1. Sentinel Conditions
http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf *Table A, page D-2*

2. Questions for Patients with Common Symptoms
http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf *Table B, page D-3*

3. Environmental Questionnaire
http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf Table C, page D-4

4. Current Symptoms
http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf Table D, Page D-6

11. APPENDIX – ASSESSMENTS FROM THE GUIDELINES

TABLE A. SENTINEL CONDITIONS

Table A: Sentinel Conditions* **Symptoms and Syndromes That May Suggest Mold or Moisture in the Absence of an Alternative Explanation Conditions of Concern Precursor Conditions**	
Conditions of Concern	**Precursor Conditions**
New onset asthma Exacerbated asthma Interstitial lung disease Hypersensitivity pneumonitis Sarcoidosis Pulmonary hemorrhage in infants**	Mucosal Irritation Recurrent rhinitis/sinusitis Recurrent hoarseness
* "Sentinel condition" has great utility as a concept in the broader area of occupational and environmental health. The diagnosis of an individual with a "sentinel" illness associated with exposures in a particular environment may indicate that these exposures may also deleteriously act on others. Intervention in the environment to limit identified exposures is an opportunity for primary prevention. A broader list of conditions that suggest a pertinent occupational exposure is found in Rutstein 1984. Bracker and Storey present a detailed discussion on exposure	

characterization and hazard identification for physicians whose patients have occupational and environmental asthma, inhalation injury, and granulomatous disease where bioaerosols as well as other agents in the environment are a concern (Bracker and Storey 2002).

**The American Academy of Pediatrics has developed a policy statement advising pediatricians when treating infants with pulmonary hemorrhage to inquire about mold and water damage in the home and, when mold is present, to encourage parents to try to find and eliminate sources of moisture (American Academy of Pediatrics 1998). Suspected cases should be reported to State Health authorities (CDC 2004).
http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf Table A, page D-2

TABLE B. QUESTIONS FOR PATIENTS WITH COMMON SYMPTOMS

Table B. Questions for Patients with Common Symptoms
1. What is your current occupation?
2. What are your current job and job tasks?
3. Do you notice any change in symptoms at home, work, or in any environment in particular?
4. Do you associate your symptoms with any activity or hobby?
5. Are you exposed to chemicals, fumes, or dusts at work?
6. Are there areas of your home or work that have recurrent moisture problems?

http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf Table B, page D-3

TABLE C. ENVIRONMENTAL QUESTIONNAIRE

Table C. Environmental Questionnaire
(For Patients with Sentinel Conditions, Symptoms that Vary by Environment, or a History of Recurrent Moisture Incursion)

About your home
Do you have a **central humidifier or air conditioner**?
Yes
No

If yes, is the system cleaned infrequently?
Yes
No

Do you have **room humidifiers or air conditioners**?
Yes
No

If yes, is the system cleaned infrequently?
Yes
No

Is there **wall-to-wall carpet** in your bedroom?
Yes
No

Do you **regularly see mold on tiles, ceilings, walls, or floors** in your bathroom (other than occasionally on the shower curtain or tub enclosure)?
Yes

No

Do you see **mold** in your **basement on walls, ceilings, or floors**?
Yes
No

Do you **usually smell a musty odor** anywhere in your home?
Yes
No

Does your **roof leak**?
Yes
No

If yes, how often?
_ Daily
_ Yes
_ Monthly
_ No
_ Once a year

Does the **plumbing in your kitchen or bathroom leak**?
Yes
No

If yes, how often?
_ Daily
_ Yes
_ Monthly
_ No
_ Once a year

Are there **wet spots anywhere in your home, including your basement**?
Yes
No

Do you often see **condensation (fog) on the inside of windows and/or on cold inside surfaces**?
Yes
No

Environmental Tobacco Smoke*
How many people who live in your home, or visit it regularly, smoke on a daily basis?
___Adults
___Children
*We include this question because of the broad and often synergistic health effects from exposure to environmental tobacco smoke.

About other environments
Sometimes people experience symptoms in places other than the home. Children spend considerable time in school environments. For adult patients, please consider the locations and work environments where you spend most of your time outside your home to answer these questions. For children or their parents, please answer about the child's school.

Outside the home, I (or my child) spend(s) most time at:

_____

For adults, my occupation is:

_____

How many days a week are you at your workplace or are you (or your child) at school?
___Days per week

How many hours each day are you at your workplace or are you (or your child) at school?
___Hours per day

Do you see **mold** anywhere (including ceilings and walls) in this place or general work area?
Yes
No

Do you usually **smell a musty odor** anywhere in this place or general work area?
Yes
No

Are there areas with recurring **wet spots** in this place or your general work area?
Yes
No

Has there been **a history of leaks or flooding** in the building at this place or at work?
Yes
No

Do you often see **condensation (fog) on the inside surface of windows and/or on cold inside surfaces such as metal shelves**?
Yes
No

Is there **carpet** in this place or classroom, or at your **general work area?**
Yes
No

If Yes, has it been **frequently wetted** by spills and/or leaks?
Yes
No

Positive responses to the questions on Table C indicate that further discussion with the patient on the environment would be helpful to explore if it is contributing to symptoms or disease. Negative responses to the questions regarding moisture and mold reassure the provider and the patient that mold is unlikely to be playing a significant role in the patient's presenting problem.

http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf Table C, page D-4

TABLE D. CURRENT SYMPTOMS

Table D: Current Symptoms - History and Relationship to Home, Work, or School (For Patients in Which a Potential Exposure to Mold Exists)		
Symptoms that may	**Please circle your response**	

be related to mold **Are you troubled by:**		**How is it at home?**	**How is it at work or school?**	**Comments**
Wheezing or whistling in your chest?	Yes No	Better Worse Same	Better Worse Same	
Waking up first thing in the morning with a feeling of tightness in your chest?	Yes No	Better Worse Same	Better Worse Same	
Waking up during the night with shortness of breath?	Yes No	Better Worse Same	Better Worse Same	
Shortness of breath when you are not doing anything strenuous?	Yes No	Better Worse Same	Better Worse Same	
Waking up during the night by an attack of coughing?	Yes No	Better Worse Same	Better Worse Same	
Chest tightness when in a dusty part of the house or with animals (e.g., dogs, cats, or horses) or near pillows (incl quilts)?	Yes No	Better Worse Same	Better Worse Same	
Chills or fever?	Yes No	Better Worse Same	Better Worse Same	
Aching all over?	Yes No	Better Worse Same	Better Worse Same	
Runny, blocked, or stuffy nose?	Yes No	Better Worse Same	Better Worse Same	
Headaches?	Yes No	Better Worse Same	Better Worse Same	
Extreme or unusual lethargy and/or tiredness?	Yes No	Better Worse Same	Better Worse Same	
Frequent sinus congestion?	Yes No	Better Worse Same	Better Worse Same	
Frequent nose bleeds?	Yes No	Better Worse Same	Better Worse	

			Same	
Hoarseness?	Yes No	Better Worse Same	Better Worse Same	
Feelings of unsteadiness when walking?	Yes No	Better Worse Same	Better Worse Same	
Memory loss?	Yes No	Better Worse Same	Better Worse Same	
Difficulty recalling names of people you know?	Yes No	Better Worse Same	Better Worse Same	
Nausea?	Yes No	Better Worse Same	Better Worse Same	
Vomiting?	Yes No	Better Worse Same	Better Worse Same	
Diarrhea?	Yes No	Better Worse Same	Better Worse Same	
Skin conditions?	Yes No	Better Worse Same	Better Worse Same	

http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf Table D, Page D-6

12. REFERENCES

1. May JC & May CL. The Mold Survival Guide. Baltimore: The Johns Hopkins University Press, 2004.

2. Storey E, Dangman KH, Schenck P, et al. Guidance for clinicians on the recognition and management of health effects related to mold exposure and moisture indoors. Farmington, CT: University of Connecticut Health Center, Division of Occupational and Environmental Medicine, Center for Indoor Environments and Health, 2004.
http://www.oehc.uchc.edu/clinser/MOLD%20GUIDE.pdf

3. http://www.niehs.nih.gov/health/topics/agents/mold/index.cfm

4. http://www.cdc.gov/mold/dampness_facts.htm

5. Hardin BD, Kelman BJ, Saxon A. Adverse human health effects associated with molds in the indoor environment. J Occup Environ Med. 2003 May;45(5):470-8.

6. Mazur LJ, Kim J; Committee on Environmental Health, American Academy of Pediatrics. Spectrum of noninfectious health effects from molds. Pediatrics. 2006 Dec;118(6):e1909-26.

7. Chapman JA. Update on airborne mold and mold allergy. Allergy Asthma Proc. 1999 Sep-Oct;20(5):289-92.

8. Williamson IJ, Martin CJ, McGill G, Monie RDH, Fennerty AG. Damp housing and asthma: a case-control study. Thorax 1997;52:229-34.
9. Institute of Medicine. Clearing the air: asthma and indoor air exposures. Washington, DC: National Academies; 2000.
10. WHO, 2009. WHO guidelines for indoor air quality: dampness and mould. http://www.euro.who.int/document/E92645.pdf
11. Cho SH, Reponen T, LeMasters G et al. Mold damage in homes and wheezing in infants. Ann Allergy Asthma Immunol. 2006 Oct;97(4):539-45.
12. Klitzman S, Caravanos J, Deitcher D et al. Prevalence and predictors of residential health hazards: a pilot study. J Occup Environ Hyg. 2005 Jun;2(6):293-301.
13. Dales RE, Burnett R, Zwanenburg H. Adverse health effects among adults exposed to home dampness and molds. Am Rev Respir Dis. 1991 Mar;143(3):505-9.
14. Brunekreef B, Dockery DW, Speizer FE et al. Home dampness and respiratory morbidity in children. Am Rev Respir Dis. 1989 Nov;140(5):1363-7.
15. Krieger JW, Song L, Takaro TK, Stout J. Asthma and the home environment of low-income urban children: preliminary findings from the Seattle-King County healthy homes project. J Urban Health. 2000 Mar;77(1):50-67.
16. Sahakian NM, White SK, Park JH, Cox-Ganser JM, Kreiss K. Identification of mold and dampness-associated respiratory morbidity in 2 schools: comparison of questionnaire survey responses to national data. J Sch Health. 2008 Jan;78(1):32-7.
17. Tortolero SR, Bartholomew LK, Tyrrell S et al. Environmental allergens and irritants in schools: a focus on asthma. J Sch Health. 2002 Jan;72(1):33-8.
18. Galant S, Berger W, Gillman S et al. Prevalence of sensitization to aeroallergens in California patients with respiratory allergy. Allergy Skin Test Project Team. Ann Allergy Asthma Immunol. 1998 Sep;81(3):203-10.
19. Corey JP, Kaiseruddin S, Gungor A. Prevalence of mold-specific immunoglobulins in a Midwestern allergy practice. Otolaryngol Head Neck Surg. 1997 Nov;117(5):516-20.
20. Simon-Nobbe B, Denk U, Pöll V, Rid R, Breitenbach M. The spectrum of fungal allergy. Int Arch Allergy Immunol. 2008;145(1):58-86.
22. Husman T. Health effects of indoor-air microorganisms. Scand J Work Environ Health 1996;22:5-13.
23. Zock JP, Jarvis D, Luczynska C et al; European Community Respiratory Health Survey. Housing characteristics, reported mold exposure, and asthma in the European Community Respiratory Health Survey. J Allergy Clin Immunol. 2002 Aug;110(2):285-92
24. Saijo Y, Kishi R, Sata F et al. Symptoms in relation to chemicals and dampness in newly built dwellings. Int Arch Occup Environ Health. 2004 Oct;77(7):461-70. [Japan]
25. Institute of Medicine. Damp indoor spaces and health. Washington, DC: National Academies Press, 2004.
26. Bush RK, Portnoy JM, Saxon A, et al. The medical effects of mold exposure. J Allergy Clin Immunol, 2006; 117(2): 326-333.
27. Sarva M, Polosa R, Palermo F, Lisitano N, Crimi N. 2002. Allergic rhinitis as an independent risk factor for asthma: Effect of specific immunotherapy. American Academy of Allergy, Asthma and Immunology 58th Annual Meeting. New York (March 1-6). Abstracts, J Allergy Clin Immunol 109(1).
28. Nickel R, Lau S, Niggemann B, Sommerfeld C, Wahn U. 2002. Comparison of bronchial responsiveness to histamine in asthma, allergic rhinitis and allergic sensitization at the age of 7 years. Clin Exp Allergy 32(9):1274-7.
29. Virant FS. 2000. Allergic rhinitis. Immunology and Allergy Clinics of North America 20(2):1-16.
30. Husman T. Health effects of indoor-air microorganisms. Scand J Work Environ Health 1996;22:5-13.
31. New York City Department of Health, Bureau of Environmental and Occupational Disease Epidemiology. Guidelines on assessment and remediation of fungi in indoor environments. New York, NY: New York City Department of Health; 2000.
32. Hope AP, Simon RA. Excess dampness and mold growth in homes: an evidence-based review of the aeroirritant effect and its potential causes. Allergy Asthma Proc. 2007 May-Jun;28(3):262-70.

33. Portnoy JM, Kwak K, Dowling P, VanOsdol T, Barnes C. Health effects of indoor fungi. Ann Allergy Asthma Immunol. 2005 Mar;94(3):313-9; quiz 319-22, 390.
34. Robbins CA, Swenson LJ, Nealley ML, Gots RE, Kelman BJ. Health effects of mycotoxins in indoor air: a critical review. Appl Occup Environ Hyg. 2000 Oct;15(10):773-84.
35. McMaster Institute of Environment and Health (CAN). Expert Panel on Fungal Contamination Indoors. Hamilton, Ont: McMaster Institute of Environment and Health; 1999.
36. Fisk WJ, Lei-Gomez Q, Mendell MJ. Meta-analyses of the associations of respiratory health effects with dampness and mold in homes. Indoor Air. 2007 Aug;17(4):284-96.
37. Lasley M, Shapiro G. 1999. Rhinitis and sinusitis in children. Ped Allergy and Immunology 19(2):437-452.
38. Portnoy JM, Barnes CS, Kennedy K. Importance of mold allergy in asthma. Curr Allergy Asthma Rep. 2008 Mar;8(1):71-8.
39. Zock JP, Jarvis D, Luczynska C et al; European Community Respiratory Health Survey. Housing characteristics, reported mold exposure, and asthma in the European Community Respiratory Health Survey. J Allergy Clin Immunol. 2002 Aug;110(2):285-92
40. Zureik M, Neukirch C, Leynaert B, Liard R, Bousquet J, Neukirch F. 2002. Sensitisation to airborne moulds and severity of asthma: Cross-sectional study from European Community respiratory health survey. BMJ 325(7361):411-4.
41. Hagmolen of Ten Have W, van den Berg NJ, van der Palen J, van Aalderen WM, Bindels PJ. Residential exposure to mold and dampness is associated with adverse respiratory health. Clin Exp Allergy. 2007 Dec;37(12):1827-32.
42. Mudarri D, Fisk WJ. Public health and economic impact of dampness and mold. Indoor Air. 2007 Jun;17(3):226-35. [EPA]
43. Venn AJ, Cooper M, Antoniak M et al. Effects of volatile organic compounds, damp, and other environmental exposures in the home on wheezing illness in children. Thorax. 2003 Nov;58(11):955-60.
44. Stark H, Roponen M, Purokivi M et al. Aspergillus fumigatus challenge increases cytokine levels in nasal lavage fluid. Inhal Toxicol. 2006 Dec;18(13):1033-9.
45. Huang SW, Kimbrough JW. Mold allergy is a risk factor for persistent cold-like symptoms in children. Clin Pediatr (Phila). 1997 Dec;36(12):695-9.
46.Rocha O, Ansari K, Doohan FM (2005). Effects of trichothecene mycotoxins on eukaryotic cells: a review. Food Additives and Contaminants, 22:369–378.
47.Edmondson DA, Nordness ME, Zacharisen MC, Kurup VP, Fink JN. Allergy and "toxic mold syndrome". Ann Allergy Asthma Immunol. 2005 Feb;94(2):234-9.
48. Gunnbjornsdottir MI et al. (2006). Prevalence and incidence of respiratory symptoms in relation to indoor dampness: the RHINE study. Thorax, 61:221–225.
49. Jaakkola JJ, Hwang BF, Jaakkola N (2005). Home dampness and molds, parental atopy, and asthma in childhood: a six-year population-based cohort study. Environmental Health Perspectives, 113:357–361.
50. Matheson MC et al. (2005). Changes in indoor allergen and fungal levels predict changes in asthma activity among young adults. Clinical and Experimental Allergy, 35:907–913.
51. Pekkanen J et al. (2007). Moisture damage and childhood asthma: a population based incident case-control study. European Respiratory Journal, 29:509–515.
52. Husman T. Health effects of microbes. Proc Healthy Build 2000;3:13-24.
53. Ebbens FA, Georgalas C, Fokkens WJ. The mold conundrum in chronic hyperplastic sinusitis. Curr Allergy Asthma Rep. 2009 Mar;9(2):114-20. [The Netherlands]
54. Lanza DC, Dhong HJ, Tantilipikorn P et al. Fungus and chronic rhinosinusitis: from bench to clinical understanding. Ann Otol Rhinol Laryngol Suppl. 2006 Sep;196:27-34.
55. Etzel RA, Montana E, Sorenson WG, Kullman GJ, Allan TM, Dearborn DG, et al. Acute pulmonary hemorrhage in infants associated with exposure to Stachybotrys atra and other fungi. Arch Pediatr Adolesc Med 1998;152:757-62.
56. Dearborn DG, Iwona Y, Sorenson WG, Miller MJ, Etzel R. Overview of investigations into pulmonary hemorrhage among infants in Cleveland, Ohio. Environ Health Perspect 1999;107(Suppl 3):495-9.
57. Update. Pulmonary hemorrhage/hemosiderosis among infants—Cleveland, Ohio, 1993-1996. MMWR Morb Mortal Wkly Rep 2000;49(9):180-4.

58. Flappan SM, Portnoy J, Jones P, Barnes C. Infant pulmonary hemorrhage in a suburban home with water damage and mold (Stachybotrys atra). Environ Health Perspect 1999;107(11):927-30.
59. Elidemir O, Colasurdo GN, Rossman SN, Fan LL. Isolation of Stachybotrys from the lung of a child with pulmonary hemosiderosis. Pediatrics 1999;104:964-6.
60. Novotny WE, Dixit A. Pulmonary hemorrhage in an infant following two weeks of fungal exposure. Arch Pediatr Adolesc Med 2000;154(3):271-5.
61. Jacob B, Ritz B, Gehring U, Koch A, Bischof W, Wichmann HE. 2002. Indoor exposure to molds and allergic sensitization. Environ Health Perspect 110(7):647-53.
62. Bush RK, Portnoy JM. 2001. Guidelines for control of indoor allergen exposure: The role and abatement of fungal allergens in allergic diseases. J Allergy Clin Immunol 107(3):S430-40.
63. Seuri M, Husman K, Kinnunen H, Reiman M, Kreus R, Kuronen P. 2000. An outbreak of respiratory diseases among workers at a water-damaged building—A case report. Indoor Air 10(3):138-45.
64. Chao HJ, Schwartz J, Milton DK, Burge HA. 2003. The work environment and workers' health in four large office buildings. Environ Health Perspect 111(9):1242-8.
65. Karvala K, Nordman H, Luukkonen R et al. Occupational rhinitis in damp and moldy workplaces. Am J Rhinol. 2008 Sep-Oct;22(5):457-62.
66. Mendell MJ, Fisk WJ, Kreiss K et al. Improving the health of workers in indoor environments: Priority research needs for a national occupational research agenda. Am. J. Public Health. (2002) 92:1430–1440
67. Laumbach RJ, Kipen HM. Bioaerosols and sick building syndrome: particles, inflammation, and allergy. Curr Opin Allergy Clin Immunol. 2005 Apr;5(2):135-9.
68. Brightman HS, Moss N. Sick Building Syndrome Studies and the Compilation of Normative and Comparative Values (2000) New York: McGraw-Hill.
69. Rotter BA, Prelusky DB, Pestka JJ. Toxicology of deoxynivalenol (vomitoxin). J Toxicol Environ Health. 1996 May;48(1):1-34.
70. Belmadani A, Steyn PS, Tramu G et al. Selective toxicity of ochratoxin A in primary cultures from different brain regions. Arch Toxicol. 1999 Mar;73(2):108-14.
71. Kwon OS, Slikker W Jr, Davies DL. Biochemical and morphological effects of fumonisin B(1) on primary cultures of rat cerebrum. Neurotoxicol Teratol. 2000 Jul-Aug;22(4):565-72.
72. Islam Z, Harkema JR, Pestka JJ. Satratoxin G from the black mold Stachybotrys chartarum evokes olfactory sensory neuron loss and inflammation in the murine nose and brain. Environ Health Perspect. 2006 Jul;114(7):1099-107.
73. Stockmann-Juvala H, Naarala J, Loikkanen J, Vähäkangas K, Savolainen K. Fumonisin B1-induced apoptosis in neuroblastoma, glioblastoma and hypothalamic cell lines. Toxicology. 2006 Aug 15;225(2-3):234-41.
74. Ebbehøj NE, Meyer HW, Würtz H et al. Molds in floor dust, building-related symptoms, and lung function among male and female schoolteachers. Indoor Air. 2005;15 Suppl 10:7-16.
75. Fung F, Hughson WG. The fundamentals of mold-related illness: when to suspect the environment is making a patient sick. Postgrad Med. 2008 Apr;120(1):80-4.
76. McNeel SV, Kreutzer RA. Fungi and indoor air quality. Health Environ Digest 1996;10(2):9-12.
77. Committee on Environmental Health, American Academy of Pediatrics, Kim JJ, Mazur LJ. Spectrum of noninfectious health effects from molds. Pediatrics. 2006 Dec;118(6):2582-6.
78. Rockwell W. Prompt remediation of water intrusion corrects the resultant mold contamination in a home. Allergy Asthma Proc. 2005 Jul-Aug;26(4):316-8.
79. Miller DJ. Health effects of fungi in indoor environments: AIHA Task Force proposal for quality assurance following mold remediation. In: Proceedings of the Conference on Assessment, Remediation and Prevention of Mold Growth in Buildings; 2000 Sept 21-23; Baltimore, Md: MidAtlantic Environmental Hygiene Resource Center; 2000.
80. Huss K, Travis P, Huss RW. General principles of asthma management: environmental control. Nurs Clin North Am. 2003 Dec;38(4):609-20. [Johns Hopkins University]
81. Eggleston PA (Johns Hopkins). Environmental control for fungal allergen exposure. Curr Allergy Asthma Rep. 2003 Sep;3(5):424-9.
82. Craner J. A critique of the ACOEM statement on mold: undisclosed conflicts of interest in

the creation of an "evidence-based" statement. Int J Occup Environ Health. 2008 Oct-Dec;14(4):283-98.
83. Park JH, Schleiff PL, Attfield MD, Cox-Ganser JM, Kreiss K. Building-related respiratory symptoms can be predicted with semi-quantitative indices of exposure to dampness and mold. Indoor Air. 2004 Dec;14(6):425-33.
84. Horner WE, Barnes C, Codina R, Levetin E. Guide for interpreting reports from inspections/investigations of indoor mold. J Allergy Clin Immunol. 2008 Mar;121(3):592-597.e7.
85. http://www.cdc.gov/mold/dampness_facts.htm
86. Johnson D, Thompson D, Clinkenbeard R, Redus J. Professional judgment and the interpretation of viable mold air sampling data. J Occup Environ Hyg. 2008 Oct;5(10):656-63.
88. Platts-Mills T, Leung DY, Schatz M. The role of allergens in asthma. Am Fam Physician. 2007 Sep 1;76(5):675-80.
89. Kurup VP. Fungal allergens. Curr Allergy Asthma Rep. 2003 Sep;3(5):416-23.
90. Calabria CW, Hagan L. The role of intradermal skin testing in inhalant allergy. Ann Allergy Asthma Immunol. 2008 Oct;101(4):337-47.
91. Chapman JA. Update on airborne mold and mold allergy. Allergy Asthma Proc. 1999 Sep-Oct;20(5):289-92.
92. Fisk WJ et al. (2002). Performance and costs of particle air filtration technologies. Indoor Air, 12:223–234.
93. Li Y et al. (2007). Role of ventilation in airborne transmission of infectious agents in the built environment — a multidisciplinary systematic review. Indoor Air, 17:2–18.
94. Seppanen O, Fisk W, Mendell M (1999). Association of ventilation rates and CO2 concentrations with health and other responses in commercial and institutional buildings. Indoor Air, 9:226–252.
95. Sundell J, Levin H (2007). Ventilation rates and health: report of an interdisciplinary review of the scientific literature. Final report. Atlanta, American Society of Heating, Refrigerating and Air-conditioning Engineers.
96. Seppanen OA, Fisk WJ (2002). Association of ventilation system type with SBS symptoms in office workers. Indoor Air, 12:98–112.
97. Kercsmar CM, Dearborn DG, Schluchter M et al. Reduction in asthma morbidity in children as a result of home remediation aimed at moisture sources. Environ Health Perspect. 2006 Oct;114(10):1574-80.
98. Ebbehøj NE, Hansen MØ, Sigsgaard T, Larsen L. Building-related symptoms and molds: a two-step intervention study. Indoor Air. 2002 Dec;12(4):273-7.
99. Patovirta RL, Husman T, Haverinen U et al. The remediation of mold damaged school--a three-year follow-up study on teachers' health. Cent Eur J Public Health. 2004 Mar;12(1):36-42. [Finland]
100. Meklin T, Potus T, Pekkanen J et al. Effects of moisture-damage repairs on microbial exposure and symptoms in schoolchildren. Indoor Air. 2005;15 Suppl 10:40-7. [Finland]
101. http://www.epa.gov/mold/i-e-r.html (Accessed May 12, 2009)
102. German JA, Harper MB. Environmental control of allergic diseases. Am Fam Physician. 2002 Aug 1;66(3):421-6.
103. Bernstein JA, Levin L, Crandall MS, Perez A, Lanphear B. A pilot study to investigate the effects of combined dehumidification and HEPA filtration on dew point and airborne mold spore counts in day care centers. Indoor Air. 2005 Dec;15(6):402-7.
104. German JA, Harper MB. Environmental control of allergic diseases. Am Fam Physician. 2002 Aug 1;66(3):421-6.