IICRC S520
Standard and Reference Guide for Professional Mold Remediation

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Chapter 3

Health Effects from Indoor Exposure to Mold in Water/Moisture-Impacted Buildings

INTRODUCTION

Although the health effects of exposure to certain types of molds in the outdoor environment have been long recognized and described in medical literature, specific effects of exposure to molds in the indoor environment are only a relatively recent area of concern and investigation. The complexity of fungal contamination in indoor environments presents unique challenges in assessing worker and occupant health risks. These complexities include: the variety of molds and co-existing bacteria; changing conditions (e.g., moisture, temperature, building envelope and mechanical ventilation dynamics), and concentrations and components or by-products (e.g., spores, hyphae, glucans). Understanding the types and relative significance of actual health risks is critical to developing and implementing effective remediation methods that adequately resolve occupant health problems that result from occupying a mold-contaminated indoor environment.

MOISTURE, MOLD, AND HEALTH RISK

Summary and Consensus Documents

National and international scientific, research and regulatory organizations have published consensus documents regarding the relationship between water damage in buildings, resultant microbial (mold) amplification on wet building materials, and human health risk from exposure to mold spores and related spore by-products in the indoor living or work environment. These documents are based on varying levels of review and interpretation of clinical case studies, epidemiological, and, to a lesser extent, experimental studies of certain adverse health effects and their association with water intrusion or moisture accumulation in residential, institutional and commercial buildings.

National Academies of Science

The Institute of Medicine (IOM) of the National Academies of Science published its document, *Damp Indoor Spaces and Health*, which was described as, "... a comprehensive review of the scientific literature regarding the relationship between damp or moldy indoor environments and the manifestation of adverse health effects, particularly respiratory and allergic symptoms."[1] The review concluded that, "... excessive indoor dampness is a public health problem."

While neither confirming nor inferring causality, the IOM committee found "sufficient evidence" of an association between the presence of mold or other agents in damp indoor environments, and cough, wheeze, upper respiratory tract symptoms (nasal and throat) and asthma symptoms in allergic and asthmatic persons, with limited or suggestive evidence of an association with lower respiratory illness in otherwise healthy children. However, the IOM panel found inadequate or insufficient

evidence regarding the association between "mold" and a number of disorders including: new-onset asthma, pulmonary hemorrhage in infants, permanent neuropsychiatric symptoms, reproductive effects, and cancer, among others. Although some people may incorrectly interpret the latter to mean that there is no definitive association between these health effects and mold and related microbial contamination, the report actually states that additional research studies are needed to help clarify if an association exists between such health effects and mold and related microbial agents in damp indoor environments.

U.S. Environmental Protection Agency (USEPA)

In *Mold Remediation in Schools and Commercial Buildings* (2001), the USEPA concluded that, "When moisture problems occur and mold growth results, building occupants may begin to report odors and a variety of health problems, such as headaches, breathing difficulties, skin irritation, allergic reactions, and aggravation of asthma symptoms," some or all of which could plausibly be associated with mold exposure.[2] Beyond stating that all molds have the potential to cause health effects through one or more potential mechanism, this document did not provide a detailed review or critique of the medical literature. Nonetheless, the document recommended remediation measures to remove mold growth and its by-products.

Health Canada

Based on intensive review of the research literature to 2001, Health Canada published its findings in *Fungal Contamination in Public Buildings: Health Effects and Investigation Methods.*[3] This review acknowledged the dearth of well-conducted clinical or epidemiological research studies on specific respiratory effects from indoor mold exposure in non-industrial buildings, as have other reviews. However, this document also emphasized that, in spite of the lack of detailed scientific research, damp conditions and mold growth need to be prevented, and that fungal contamination in buildings should be remediated.

ACGIH, ISIAQ, and AIHA

The American Conference of Governmental Industrial Hygienists (ACGIH), in its document *Bioaerosols: Assessment and Control*, stated that, ". . . chronic flooding or leaks will almost always result in microbial growth in the indoor environment."[4] Similarly, the International Society of Indoor Air Quality and Climate (ISIAQ), in its document, *Control of Moisture Problems Affecting Biological Indoor Air Quality*, corroborated that, ". . . the presence of consistently moist or wet materials such as carpet, ceiling tiles, and gypsum board . . . provides a suitable environment for microbial proliferation. The dominance of one or two non-phylloplane mould species is an indication of a moisture problem causing deterioration of the quality of the indoor air."[5]

The American Industrial Hygiene Association (AIHA) in its *Field Guide for the Determination of Biological Contaminants in Environmental Samples* (1996) concluded that: "Although biological contaminants have been given little attention until relatively recently, a substantial proportion of building-related illness (BRI) and sick building syndrome (SBS) . . . is the result of exposure to such contaminants . . . There is abundant evidence from investigations in several countries that symptoms of eye, nose, and throat irritation as well as cough and tiredness and fatigue are present in excess among persons or populations in certain buildings. Although several agents have been suggested as causative, the most extensive evidence is found for dampness and mold."[6]

Centers for Disease Control and Prevention (CDC)

Addressing possible health effects in the aftermath of major hurricanes and floods, the CDC recommends that visible and extensive mold growth should be remediated and that, ". . . excessive exposure to mold-contaminated materials can cause adverse health effects in susceptible persons regardless of the type of mold or the extent of contamination."[7]

HEALTH EFFECTS

Building-Related Disorders

The term "sick building syndrome" (SBS) was coined in the early 1970s to describe the advent of "unexplained" illness among occupants of a building. The first reports came from Europe, Scandinavia, and the United States in which multiple occupants of new office buildings complained of: inflammatory symptoms of the mucous membranes (i.e., eye, nose and throat); upper and possibly lower respiratory tract symptoms, as well as fatigue, headaches, and neurocognitive changes, and notable difficulty with concentration and inattentiveness. These symptoms characteristically improved each time occupants left the building.[8] Most environmental investigations of sick buildings looked for chemical etiologies such as, volatile organic compound (VOC) emissions from paints, adhesives, carpeting and other flooring materials; building materials (e.g., particle-board, plywood); inadequate ventilation, and psychogenic factors.[9,10] Research studies arbitrarily categorized occupant health complaints and described them as "irritant" or "non-specific" symptoms. Simplistic epidemiological methods were employed, which lacked sufficient power or sensitivity to detect and measure the presence of a distinct clinical syndrome. As a result of these methodological shortcomings, none of these studies demonstrated a consistent etiology that adequately explained the illnesses reported by occupants, nor, in most cases, did reduction or removal of the suspected environmental problem or agent result in clinical resolution. AIHA corroborated this critique by stating that while, ". . . no serious case can be made that sick building syndrome does not exist . . . a review of the literature to 1992 indicates that most studies of this problem have been poorly designed . . ."[6] SBS continues to be the major IAQ occupant health problem today in multi-occupant, non-industrial workplaces, and residential buildings.

The term "building-related illness" (BRI) has been used to describe medically recognized diseases (disorders) for which specific diagnostic criteria and testing can confirm the presence or absence of the condition. Diseases in this classification were categorized as: allergic/immunological (e.g., asthma, hypersensitivity pneumonitis or HP); infectious (e.g., Legionnaire's disease), and toxicological (e.g., carbon monoxide toxicity, fiberglass-induced dermatitis, and organic dust toxic syndrome [ODTS]). Although these conditions are well recognized and can be readily diagnosed in individuals, collectively they account for a disproportionately small percentage of documented adverse health effects observed in mold-contaminated buildings.

This definitional distinction between SBS -- the most prevalent occupant health problem for the past 40 years -- and BRI, has paradoxically hindered recognition and scientific understanding of the relationship between mold exposure and occupant illness. ACGIH has referred to the most prevalent occupant health complaints (e.g., runny nose, sore throat, headache, fatigue, difficulty concentrating.) as "building-related symptoms" (BRS), for which the most likely etiology is fungal toxins or spore wall components.[4] AIHA has proposed the specific medical entity of, ". . . building-related illness arising

from microbial contamination of building materials caused by condensation and leaks . . ." and notes that several plausible mechanisms of disease related to exposure to fungal agents (e.g., mycotoxins, glucans) are the most likely cause.[6] The specific role of construction-related defects leading to water intrusion into buildings also has been recognized as a likely cause of SBS,[11] while the association between specific fungal agents and SBS also has been established.[12,13]

More recently, the relationship between SBS, BRS, BRI, and indoor mold exposure in water-impacted buildings has been recognized by several investigators as a distinct symptom complex of mucous membrane, upper, and possibly lower respiratory tract inflammation, fatigue, and neurocognitive symptoms, with the important features of temporality (discrete onset after occupying a particular building or after a particular event, such as a flood or leak), consistency (among multiple occupants), and reversibility (symptoms abate when away from the indoor environment).[14,15] The unique feature of "building-relatedness" distinguishes these so-called "non-specific symptoms" not only from other common, non-building-related disorders, such as allergic rhinitis or respiratory tract infections, which have some overlapping symptoms (primarily upper respiratory tract), as well as, but also from potential building-related illnesses, such as asthma or HP, which are limited to the lower respiratory tract. Studies have demonstrated that respiratory symptoms in occupants of sick buildings are unrelated to atopy (allergic predisposition) and are not explained merely by the diagnosis of asthma.[16, 17, 18]

Building "Dampness" and Mold

In general, building dampness (i.e., moist or wet conditions), and the resulting surface and airborne mold contamination, have significant potential impact on the health of occupants. A review of 61 peer-reviewed articles by a European consortium concluded that dampness in buildings is consistently associated with an increased risk for symptoms in the respiratory tract, as well as self-reported tiredness, headache and respiratory tract infections.[19] An updated literature review by the same group confirmed these associations, though most of the studies cited were cross-sectional in design and either focused on asthma or on health effects only in children.[20] Another review of case reports, case-control studies and cross-sectional studies from a 15-year period concluded that, ". . . evidence of an association between respiratory problems and the presence of fungi and dampness is strong."[21] A study of occupants of 19 office buildings measured a dose-response effect for dampness and symptoms of eye irritation, cough, and lethargy or fatigue,[22] while another study of 231 buildings found that dampness and odorous compounds are associated with an increase in occupants' symptoms consistent with SBS.[23] Other literature reviews have similarly concluded that, while signs of mold growth and dampness and certain BRS are consistently associated with one another, the measures of indoor mold contamination (i.e., airborne spore or CFU concentrations) are not consistently correlated with symptoms, thus underscoring the limitations of such exposure measurements.[6,24] The predominance of atypical molds and their by-products or components in the indoor environments, especially those associated with water intrusion and chronic dampness, presents an increased health risk through one or more plausible mechanism(s) of disease.

Mechanism(s) of Illness

The aforementioned consensus statements and research collectively acknowledge that there is a consistent, positive association between: water damage in buildings, mold contamination on water-impacted surfaces (with dispersal of mold spores into the occupied spaces) or exposure of occupants to these mold contaminants, and subsequent risk for certain adverse health effects among occupants.

Current controversy about the validity and severity of mold-related health effects (largely debated in the context of construction defects litigation and insurance-related flooding events in the U.S.) stems from a scarcity of scientific research into the pathophysiology and mechanism(s) of illness, including the actual agent(s) of disease, and methodological limitations in quantifying occupants' exposure and its causal association with specific health effects. Furthermore, questions about whether health effects are transient or permanent, and whether certain populations are predisposed or more susceptible to certain health effects, remain incompletely studied. A robust research agenda has been recommended by all of the aforementioned organizations, but thus far there has been little substantive funding in the United States to address the many scientific questions that remain outstanding.[25] The significance of such limitations in scientific understanding, versus the immediate need for public health measures to prevent occupant illness (along with methods for adequate building remediation solutions), is addressed at the end of this chapter.

Allergy/Immunological Mechanisms

The IOM has previously stated that, ". . . all fungi probably produce allergens that will cause disease with appropriate exposure."[26] In the general outdoor environment, certain molds that arise naturally from soil and plants are associated with development of allergic rhinitis (AR) and the related condition, allergic conjunctivitis (watery, red, itchy eyes). The principal outdoor fungi associated with AR include *Cladosporium, Alternaria*, certain species of *Penicillium*, and other genera that are typically found as the dominant outdoor molds in North America and in other parts of the world. Although these same taxa are commonly found indoors in non-problem buildings at concentrations lower than outdoors, they are rarely found as predominant taxa in modern buildings with water damage or where occupants complain of BRS. The presence of these normal background fungi in homes and office buildings is, therefore, not a health hazard unique to the indoor environment, though their presence can sometimes confound interpretation of indoor sampling data that relies upon total spore counts.

Allergic respiratory disease (i.e., immediate hypersensitivity) can occur when indoor microbial contaminants, primarily fungal and bacterial spores and growth fragments, are deposited in the nasal or sinus cavities and upper or lower airways. Symptoms may develop rapidly or may take weeks or months, depending upon the extent of the exposure and an individual's immunological sensitization to the agent(s). Allergic reactions occur only in selected genetically susceptible individuals (as opposed to the entire population) and require prior exposure for sensitization. Once allergic sensitization occurs, an occupant's symptoms may be initiated by very low exposures. Therefore, it would be expected that a relatively small percentage of occupants in a particular building would develop an identical allergic sensitization to the same agent at the same time - in contrast to the common finding of a high percentage of building occupants complaining of BRS, of which non-respiratory and non-mucous membrane (i.e., non-allergic) symptoms are a prominent part of the symptom complex. The most commonly described allergic diseases attributed to indoor mold exposure are AR (i.e., watery eyes, runny nose, or nasal congestion) and asthma (i.e., reversible inflammation and increased airways reactivity, manifested by symptoms of shortness of breath, wheezing, chest tightness, and cough). However, the actual evidence that mold contamination in buildings produces a specific allergic response is indirect and inconsistent,[24,26] though it is clear that individuals with underlying asthma are at increased risk of worsening when they reside or work in mold-contaminated buildings.

Another disease that commonly is considered important in relationship to indoor mold exposure is hypersensitivity pneumonitis (HP). HP is an immunologically mediated (i.e., delayed-type) reaction to specific biological antigens from plants, insects, bacteria and fungi. Acute HP develops 6-12 hours

after a relatively high-intensity exposure, and is marked by symptoms including shortness of breath, cough and fever. HP does not cause runny nose, watery eyes, headaches, or neurocognitive symptoms. Only those individuals, who are immunologically sensitized to the particular antigenic agent of exposure, become symptomatic; thus, among groups of workers with similar exposures, only a small percentage are actually at risk of developing HP. HP has been well described in certain occupations in which high-dose exposure to a specific causal organism has been identified. Such exposures and disease are not limited to the indoor environment. Examples include HP caused by thermophilic bacteria, or *Aspergillus* mold species in contaminated hay among farmers (i.e., "farmer's lung"). However, in most cases where HP has been diagnosed in mold-contaminated buildings, the basis of the diagnosis did not meet generally accepted, diagnostic criteria for HP.[29,30,31] Furthermore, studies of immunological markers of exposure for HP in mold-contaminated buildings have not demonstrated consistent immunological responses.[32,33] A recently convened occupational medicine physician panel corroborated that HP has been reported in some mold-contaminated buildings, but that the condition is uncommon.[25]

In summary, for molds in the normal outdoor environment, and for certain occupational settings where high-dose exposures or certain specific allergic or other immunological hazards to exposed individuals are present, the risk of the above cited diseases in mold-contaminated, water or moisture-impacted indoor environments appears to be limited. These allergic or immunological disorders do not appear to explain the preponderance of BRS/SBS-related health complaints most commonly observed in mold-contaminated, water-damaged buildings.

Toxicological Mechanisms

A considerable amount of research information indicates that the growth and dissemination of fungi in water-damaged buildings results in the production of certain toxins that may be responsible for BRS or certain other putative health effects. Although there are hundreds of genera of molds that can appear in indoor environments, only a relatively small number of them (and a limited number of species within each genus) are of concern in terms of disseminating mold in water-impacted buildings. Such molds appear to cause significant occupant health effects unique to the indoor environment. While much attention has been given to health concerns regarding *Stachybotrys chartarum*, certain species of *Aspergillus* (notably *A. versicolor*), *Penicillium*, *Chaetomium*, *Trichoderma*, *Phoma*, and *Fusarium* (all of which are commonly observed colonizing water-damaged, carbon-containing building materials) are also capable of producing a class of compounds known as mycotoxins.[34] Mycotoxins form the basis for the term "toxic mold," however, a more appropriate term is "toxigenic mold," which indicates the capability of producing toxins.

Mycotoxins are a group of metabolic byproducts often produced by a variety of molds growing on various organic substrates in damp building environments.[35] When present, mycotoxins typically are found on mold spore walls and fungal growth fragments. A particular class of mycotoxins of medical concern is the trichothecenes, which have been shown to produce adverse health effects in experimental animals at high exposure concentrations under conditions not representative of actual human indoor environments.[36] Mycotoxins are not always produced by actively growing molds, as production is dependent upon the physiology and genetics of the organism, as well as the amount of moisture, light and temperature.[37] In *Damp Indoor Spaces and Human Health*, the IOM states that the research data it reviewed, ". . . shows that molds that can produce mycotoxins under the appropriate environmental and competitive conditions can and do grow indoors."

Fungal spores may contain significant amounts of mycotoxins, and while various diseases, symptoms and syndromes have been associated with inhalation of probable mycotoxin-containing spores,[30, 32, 34, 38, 39] a causal association has not been demonstrated.[36] The ability of molds to produce mycotoxins under the appropriate environmental and competitive conditions on wet indoor building materials, is acknowledged in the aforementioned organizational consensus documents; however, all of them conclude that the specific role that mycotoxin exposure may have in producing BRS and other putative human health effects remains somewhat poorly understood. Understanding the health effects of mycotoxins is further limited by a lack of commercially available environmental assays, relatively wide ranges of background concentrations for mycotoxins in the normal indoor environment, and a lack of human toxicology and pathophysiology research into specific exposure routes and mechanisms of disease causation. The ability to establish dose-response relationships is complicated by limitations in the reliability of air samples for fungal particles, current air-data interpretation guidelines, which rely primarily on comparison of total outdoor vs. indoor spore counts, and the constantly changing conditions of mold growth and spore dissemination in indoor environments.[6]

In addition to mold growth, water-impacted indoor environments may also facilitate the growth of bacteria that can have toxic and inflammatory effects.[1] Bacterial endotoxins are generated particularly in agricultural settings from cell walls of bacteria or certain fungi. Occupational exposure to high concentrations of endotoxins has been recognized to cause specific health effects (i.e., ODTS), which are inconsistent with the more subtle, multi-system symptoms seen in BRS. In general, bacterial contaminants associated with indoor water/moisture intrusion are not considered significant as agents of occupant illness.

The question of whether infants are at risk for developing idiopathic pulmonary hemosiderosis (IPH) with exposure to *Stachybotrys chartarum* has evoked much controversy regarding the health hazards of indoor mold exposure in water/moisture-impacted buildings. Numerous mold-contamination cases, experimental research and time (nearly 10 years) have not replicated this finding in a consistent manner. A subsequent reassessment of the original Cleveland study addressed many methodological issues, which may have skewed the interpretation of the data toward a causal association.[40] While the cause of this particular life-threatening disease in infants is not definitively understood, the available information to date indicates that this condition - popularized even today by the media in reports of mold-related health effects - represents a relatively minor, if not negligible risk for occupants of mold-contaminated buildings.

Regardless of the unclear clinical effect and lack of established methods for mycotoxin exposure assessment, as discussed above, it has been generally recognized in environmental health and industrial hygiene fields that the predominance of these "toxigenic" molds in water-damaged buildings is consistently associated with occupant health complaints described above as BRS.[4,6] AIHA's recommendation that, " . . . the confirmed presence of *Stachybotrys chartarum, Aspergillus versicolor, A. flavus, A. fumigatus* and *Fusarium moniliforme* requires urgent risk management decisions to be made . . ." is based on the association between mold growth resulting from water damage to a building, and the likelihood of spreading mold contaminants throughout a building, with the resulting risk of occupant exposure and illness.[6] Other toxigenic fungi, such as *Trichoderma*, *Chaetomium*, and certain species of *Penicillium*, may also be applicable to this recommendation. Recently addressing this issue, the U.S. Centers for Disease Control and Prevention (CDC) stated that, "Although the potential for health problems is an important reason to prevent or minimize indoor mold growth and to remediate any indoor mold contamination, evidence is inadequate to support recommendations for greater urgency of remediation in cases where mycotoxin-producing fungi have been isolated."[7]

Microbial volatile organic compounds (MVOCs) are gas-phase metabolites that typically are recognized by the human nose as "musty, moldy and mildewy" odors. While their presence is often an indicator of active microbial growth and moisture problems inside wall or other building cavities, the aforementioned occupant health effects do not appear to be toxicologically associated with exposure to one or more MVOCs.

INFECTIOUS MECHANISMS

Specific occupationally acquired fungal infections (e.g., invasive aspergillosis) and hypersensitivity disorders (e.g., allergic bronchopulmonary aspergillosis) have been described for particular occupations that entail recurrent, intense exposure to certain fungal agents. Some fungal infections (including, but not limited to those resulting from molds) can theoretically be acquired by any person with exposure, whereas other infections are opportunistic; that is, they occur only in individuals with certain underlying immunocompromising diseases or conditions (e.g., HIV, certain cancers, chemotherapy, organ transplants, chronic renal failure, high-dose corticosteroid therapy).[41,42] In some cases, these infections and their underlying conditions make them life-threatening. These infectious diseases can be diagnosed by history, physical examination, and, in most cases, certain diagnostic tests, including culture of infected tissue, immunoassays (to antibodies), and molecular methods (e.g., polymerase chain reaction or PCR). One such occupational, highly infectious and potentially fatal disease is histoplasmosis, which results from the inhalation of spores of *Histoplasma capsulatum*. This fungus does not arise as a result of building water damage and resultant mold contamination, but it may be encountered when removing bird and bat droppings from building spaces. Guidance relative to this type of remediation has been published elsewhere.[43]

Environmental molds commonly found in both indoor and outdoor environments, which include those that tend to colonize water-impacted building materials, have been reported to opportunistically infect immunocompromised individuals in hospital settings.[44] Exposure to such fungi (e.g., *A. fumigatus, A. flavus, Rhizopus*, and *Fusarium*) otherwise does not present a risk of opportunistic infection in immunocompetent individuals (the vast majority of the population). Additionally, immunocompetent occupants of mold-contaminated buildings have not been shown to have increased susceptibility to common and chronic (clinically proven) bacterial or viral respiratory tract infections, (even though their symptoms may be misdiagnosed as, or mimic, infectious diseases, such as the common cold or bacterial sinusitis).[45]

Immunological studies of occupants in heavily mold-contaminated buildings have failed to demonstrate significant immunocompromised states in those occupants, either as clinical infections or through markers of immune status.[29,32,33] Some laboratory research on certain mold mycotoxins has suggested that immunological effects can occur from exposure; but these effects have not been demonstrated in occupants of mold-contaminated buildings. The rationale that infants and the elderly are at increased risk from infectious diseases from indoor mold exposure, due to varying degrees of immune dysfunction, appears to be based more on conservative public health principles rather than definitive clinical or epidemiological studies.

Occupant Health Investigation and Response

Clinical Investigation

Investigation of mold contamination in buildings, or of "sick" buildings where the source, extent, and distribution of occupant health problems remains unclear, should include not only assessment of water intrusion and measurement of mold contaminants, but also - and preferably beforehand - clinical assessment of symptomatic as well as asymptomatic occupants. Such clinical evaluations are best conducted by physicians with appropriate training and experience in the area of indoor air quality exposures, who can evaluate environmental, epidemiological and statistical data, and who can communicate risk in an unbiased manner. At present, no commercially available, reliable diagnostic tests have been developed to measure past or present exposure or illness related to SBS or BRS in mold-contaminated buildings.[46,47] Currently available antibody panels for *Stachybotrys* serology, as well as immunological cell profiles, have not been demonstrated to be reliable or predictive of exposure or illness in indoor mold exposures.[48] Standard allergy skin tests for ordinary, outdoor fungal allergens (e.g., *Cladosporium, Alternaria*) also have not been demonstrated to be reliable markers of exposure to, or illness from specific fungi associated with water- or moisture-impacted buildings.[49] For individuals with a history of asthma, or when physical examination findings strongly indicate a specific BRI, such as asthma or HP, additional diagnostic tests are available.

A recent document, intended for physicians without expertise in IAQ to evaluate and treat individuals with illness related to indoor mold exposure, has been published by the University of Connecticut, with funding from USEPA.[50] The document affirms that, ". . . there is strong evidence that significant disease can result from dampness or fungi in the home or workplace . . ." and it corroborates the aforementioned conclusions regarding the limited scientific understanding of mechanisms and exposure assessment. This medically-oriented guideline, however, virtually ignores BRS and SBS, and thus does not address the prominent, non-respiratory symptoms from indoor mold exposure that are well described in the literature. Instead, the Connecticut document focuses on what it deems to be "serious" allergic disorders, such as asthma and HP, which, as discussed above, are readily diagnosed but disproportionately uncommon and often over-diagnosed in occupants of mold-contaminated buildings. Although this document also ignores the significance and importance of corroborating symptoms among other multiple, similarly exposed occupants (which, when present, collectively, make the diagnosis of allergic disorders highly unlikely), it nonetheless recommends the same approach as advised herein: namely that the physician document symptoms and signs of illness, obtain a detailed environmental history, and ". . . look for links between the exposure and the symptoms or illness . . ." emphasizing the temporal pattern of symptoms. It also advises that removing affected occupants and environmental remediation are the keys to treatment. Evaluating patients before and after exposure to the environment of concern is emphasized as an important diagnostic method to demonstrate a causal connection between symptoms and exposure; whereas immunological tests are noted to be of questionable value. Thus, the Connecticut document provides the same recommendations for medical management of mold-exposed individuals as those provided herein.

Epidemiological Investigation

In multi-occupant buildings - specifically workplaces - an epidemiological study is sometimes indicated to clarify whether there is a building-related problem, and if so, its nature, which may have implications for resolution.[4] This approach is equally applicable to residential structures, such as

apartment buildings, condominiums, and single-family housing developments. Properly conducted epidemiological studies also serve as a baseline for comparison of occupant health after remediation or other interventions (or decisions not to intervene) have been made. Epidemiological studies, when called for, include methodological features that minimize and measure sources of collection bias, and avoid arbitrary clinical definitions that can result in disease misclassification.[4, 24]

Treatment

Regardless of the incomplete understanding of the mechanism of SBS, BRS, and other building-related disorders, it is generally recognized that definitive treatment of symptomatic occupants almost always requires removing them from the mold-contaminated indoor environment, either temporarily or permanently. This may cause, or be hindered by, significant economic, social, and logistical complications and barriers. Long-term health effects from indoor mold exposure have not been studied, but no clinical or epidemiological research to date indicates that permanent health effects are likely to occur in most typical mold contamination situations. Neither antibiotics for presumptive bacterial upper respiratory tract infections, nor commonly prescribed antihistamines, nasal corticosteroid sprays, or various corticosteroid medications for allergic rhinitis, have been demonstrated to produce long-term resolution of building-related symptoms in occupants of mold-contaminated buildings. Individuals with clinically demonstrated asthma exacerbations may benefit from increased use of asthma medications, however, this cannot necessarily be relied upon in lieu of relocation from mold-contaminated areas.

Ultimately, remediating the contaminated environment (as set forth in this Standard) is the only reliable, established method to ensure that occupants can safely return to the building. Properly conducted mold remediation will result in acceptable indoor environmental quality for most or all occupants, which may be objectively assessed clinically or through follow-up epidemiological study.[51] It is important to convey documentation of the scope of remediation and post-remediation evaluation or verification not only to occupants, but also to their treating physicians, so that occupants can be safely reintroduced into the remediated structure and monitored to determine whether their prior BRS is or is not recurring.

Occupational Risk for Health Effects

Unprotected mold remediation workers are at increased and potentially significant risk from dermal, inhalation and ingestion hazards resulting from frequent, high-intensity exposures to mold-contaminated environments, and the practices and procedures required to mitigate such conditions.[2] Such workers shall have appropriate training and medical clearance (per OSHA requirements) before being provided with appropriate personal protective equipment (PPE); see Chapter 5, *Equipment, Tools and Materials*, and Chapter 6, *Safety and Health*. Until further research addresses the mechanisms of disease and health risks to certain, theoretically "high-risk" populations, mold remediation workers with a history of chronic respiratory disease, and those who have been diagnosed with AIDS, or who or are undergoing immunosuppressive or long-term antibiotic therapy, or who are pregnant, should be evaluated and counseled by a qualified, unbiased occupational medicine physician on a case-by-case basis. Formal guidelines regarding pre-employment screening and medical evaluation have not been developed by medical or industrial hygiene organizations beyond regulatory requirements.

Relevance of Health Effects to Remediation Methods

The entire foregoing discussion of what is currently known and unknown about mold health effects of exposure to molds arising in water-impacted buildings is directly pertinent to the rationale behind the principles and methods of remediation recommended in this Standard and Reference Guide. Much more sophisticated and relevant clinical and epidemiological research is needed to explain and understand the mechanisms of illness, actual agents of disease and dose-response relationships, as well as to improve exposure assessment. In spite of these current knowledge gaps, it is crucial to recognize that, ". . . laboratory testing and theoretic speculation about possible mechanisms are important, but no more so than direct, straightforward observation of what actually happens in human populations." [52]

Public Health Rationale

It is a generally accepted public health principle that, in the absence of explicit, complete scientific understanding of a particular risk, conservative measures are appropriate to ensure that risk to occupant health is minimized. There is sufficient information at present to justify remediating mold contamination, including not only mold growth at the site of water intrusion or accumulation, but also mold contaminants (e.g., spores, fragments, and other byproducts) that are disseminated from the mold growth source to distant sites in the building, including floor coverings, bedding materials, other furnishings, HVAC systems, and other contents. In these areas distant to the site of water damage and surface mold growth, temporary relocation of occupants may be required in conjunction with containment, to preclude exposures to contaminants during remediation activities.

There is no scientific evidence to support the assertion that only immunologically susceptible individuals are at increased risk from mold exposure in residential and workplace environments. In some buildings where prevalent occupant illness has been adequately documented, consideration of temporary relocation of *all* occupants during remediation (as opposed to just those who vocally complain or seek medical attention) is warranted from a public health perspective. In hospitals and other health care facilities where infectious diseases are of particular concern, the approach to mold remediation may require additional precautions for occupant health.

Post- Remediation Occupancy and Health Outcomes

In the event that occupants complain of recurring BRS, or other previously documented health effects, after re-occupying the remediated building, those complaints may warrant a detailed review of the remediation process (facilitated through documentation by the remediator), along with an appropriate sampling and analysis protocol designed and overseen by an IEP. In the interim, occupants can be offered alternative living or work conditions. If the validity of occupant health complaints is questioned, then evaluation by a qualified, unbiased physician, who can document whether or not reversibility of respiratory health effects occurs upon re-occupancy, is recommended.

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