New Protocol for the Assessment and Remediation of Indoor Mold Growth

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SUMMARY
The effectiveness of current response procedures for addressing mold growth is evaluated, and the authors recommend a new protocol for building assessment and remediation. Assessment based primarily on mold testing has significant limitations and may fail to identify sites with mold growth. Microbiological testing is replaced by engineering evaluation with a focus on site moisture dynamics. Critical performance objectives for remediation are to restore the site to conditions preceding water damage while preventing occupant exposure to airborne mold generated by the repair process. Hazardous material abatement procedures are generally not needed for mold remediation.

IMPLICATIONS
This study questions assumptions underlining commonly used strategies for building assessment based on microbiological investigation and mold remediation incorporating procedures for handling hazardous materials. An alternative approach is suggested for meeting both restoration and public health objectives.

KEYWORDS
bioaerosols, damp buildings, restoration, building investigation, moisture

INTRODUCTION
Indoor mold growth has long been considered unacceptable because of health, structural, and aesthetic concerns. Prior to the late 1990's, the presence of mold growth was not considered a health hazard, and assessment of indoor mold growth was generally based on visual inspection. Corrective recommendations generally included controlling moisture, repairing water damage, and sanitizing affected surfaces with dilute bleach. With increased attention to indoor air quality, regulatory agencies and professional organizations issued new guidelines for addressing indoor mold growth (IICRC, 2008; NYCDoH, 2001; TSDoHealth, 2007; U.S. EPA, 2001). These guidelines are often based on the assumption that mold can be toxic to occupants and thus treat it as a hazardous material. Field practice now often includes mold testing for building assessment and incorporates hazardous material handling procedures into the repair process.

This paper summarizes the results of a critical review of current field practice and recommends a new protocol for more cost-effective building assessment and water damage repair.

METHODS
Field performance with respect to mold assessment was evaluated based on findings from twelve water-damaged sites where opposing litigation experts conducted separate investigations. One study was based on site history and observed conditions (visual inspection only). The parallel investigation was based primarily on mold testing (Light, 2009).

Findings and recommendations presented in this study are also based on a review of the relevant scientific literature and the authors' experience managing water damage restoration projects and evaluating the work of other field practitioners.

RESULTS

Assessment: Microbiological vs. Moisture-Based Approach

Current mold guidelines prescribe differing approaches to assessment. While these protocols generally refer to surface inspection, moisture evaluation, and hidden mold access, little detail is provided on how to accomplish this. Many practitioners now include air and surface tests as an integral part of their assessment process.

Interpretation of mold test data is based on many different criteria. Types and concentrations of airborne or surface spores vary substantially as they are influenced by many natural and manmade factors. Interpretation of airborne mold data by many field practitioners does not recognize normal background. Outdoor mold levels can exceed 50,000 spores per cubic meter (AAAAI, 2009). Analysis of airborne mold concentrations in dry, well maintained buildings (U.S. EPA, 2006) found airborne mold up to 874 spores/m^3, with cultureable mold up to 3489 cfu/m3 (Haas et al., 2010). A similar study of homes without significant water damage measured total airborne mold up to 1200 cfu/m^3 (Horner et al., 2004). Considering this wide range of background concentrations in buildings without water damage, setting specific air quality standards differentiating acceptable from contaminated is not feasible.

A similar conclusion can be drawn regarding the feasibility of setting health-based standards for mold exposure. Because health effects are generally limited to sensitive individuals, dose/response cannot be established.

An engineering approach to building assessment guided by moisture dynamics is more informative than a microbiological investigation. A detailed moisture survey not only facilitates locating mold growth, but also identifies the underlying source of water damage and is the only way to assess damp building exposure. In general, moisture dynamics can be determined from construction prints, site history, visual inspection, and use of a moisture meter. Diagnostic procedures for building moisture are well documented (Treschel et al., 2009).

Remediation: Hazmat Procedures vs. Basic Restoration

In the past, effective water damage restoration projects generally included the following elements:

- identifying and eliminating the moisture source(s)
- isolating the work area
- locating all water-damaged surfaces for removal or treatment
- cleaning and sanitizing all potentially affected surfaces
- clearing the area for reconstruction based on visual confirmation

Recently issued mold guidelines promote the addition of more stringent control procedures to this process. A recent survey of contractors responsible for mold remediation found general support for:

(a) testing mold before remediation;
(b) containing work under negative pressure;
(d) avoiding use of chemical sanitizers; and
(e) basing acceptance on air testing (Dixit, 2009)

Although it is generally accepted that exposure to airborne mold represents one trigger for allergic reactions and infection in sensitive individuals, research has not established that occupant exposure to indoor mold growth causes other health problems (IM, 2004). However, many mold remediation projects now incorporate procedures used to handle hazardous materials (i.e., full containment) based on an assumed risk of occupant mycotoxicosis.

Until recently, it was common practice to apply a dilute bleach solution to areas with suspect growth in the water damage repair process. Mold guidelines now generally advise against the use of chemical sanitizers, citing health risks to workers and occupants and its lack of effectiveness against allergenic fungal residue left after disinfection (U.S. EPA, 2001). Review of the literature suggests, however, that damp wiping moldy surfaces without a sanitizer is not as effective (Gupta et al., 2002) and that bleach application does denature fungal proteins (Martyny et al., 2005). Field experience demonstrates that workers are protected by following label safety requirements and that occupant exposure can be controlled by sanitizing after-hours or when the area is vacant.

Many mold remediation projects now rely on air and surface tests to clear remedial work (verify that the area has been restored), mirroring the protocol used for asbestos abatement. However, the inherent limitations of mold sampling (see above) makes it an unreliable indicator of remedial efficacy. Restored areas can fail based on data consistent with normal background. Conversely, contaminated areas are cleared where the presence of mold growth is not detected by mold testing. The authors have re-assessed a number of sites remediated under full containment and subsequently cleared by air testing and have identified residual suspect growth and ongoing moisture problems.

Relationship of Study Conclusions to Building Assessment Methodology

To illustrate the impact of varying assessment procedures and criteria on conclusions, the results of opposing experts evaluating the same twelve water-damaged sites were compared. At each site, one investigator's findings were based on a detailed inspection, while the parallel investigation was primarily based on mold testing. Results are summarized as follows:

(a) Collection of air and surface samples failed to identify mold growth beyond that observed during inspection;
(b) At half of the sites, the inspector located hidden mold growth undetected by sampling;
(c) Where the inspection-only assessment concluded that airborne mold concentrations measured by the opposing expert was consistent with normal background, the investigator conducting the tests considered these same levels to be elevated and to present a significant health risk to occupants;
(d) On the other hand, water damage was identified at sites where negative findings had been supported by low airborne mold concentrations;
(e) At all water damaged sites, investigations based on a detailed inspection recommended localized remediation. Conversely, recommendations based on mold testing often involved remediation of the entire structure (Light, 2009)

AUTHORS' MOLD PROTOCOL

Assessment

In view of the limitations of currently available mold guidelines, the authors have developed a new protocol for resolving concerns related to indoor mold growth. The basic goals of building assessment are to identify the extent of mold growth and damp building conditions. General principles for accomplishing this include the following:

1. The first step in building assessment is a survey to identify the origin, extent, and dynamics of excess moisture.
2. Building inspection focuses on suspect areas suggested by a detailed moisture survey, construction drawings, and site history.
3. Discoloration observed during visual inspection is classified as to whether it is considered suspect growth based on guidance which differentiates biological material from other stains.
4. The inspection also notes damp surfaces and water staining/damage.
5. Where mold growth has been disturbed, surfaces potentially impacted by settled dust are identified.
6. Covered (hidden) surfaces susceptible to mold growth are identified and opened for inspection where feasible.
7. Assessment findings identify moisture sources, mold growth locations, and other water damage.

Remediation

The basic goals of remediation are to restore the site to conditions preceding water damage while protecting occupants from exposure to airborne mold generated during the repair process. The authors' performance standards guiding mold remediation include the following:

1. Initiate drying as soon as possible.
2. Control the source(s) of excess moisture
3. Protect occupants during the remediation process by either conducting work after-hours, evacuating the area around the worksite, or containment.
4. Perform work under partial containment (i.e., dust barriers/air scrubber) or full containment (i.e., isolated under negative pressure) as needed to protect occupants and to facilitate cleanup.
5. Replace water-damaged materials which are not structurally sound (non-porous materials with surface mold growth can be sanitized).
6. Clean all surfaces in the remediated area until they are free of visible demolition dust.
7. Wipe surfaces with a sanitizing solution following appropriate worker safety precautions and keep occupants out of the area until the product odor has dissipated.
8. Address non-exposed (hidden) surfaces suspected to support mold growth by removal or maintaining in a dry condition.
9. Remediate suspect growth inside HVAC equipment following procedures consistent with the above principles.
10. Dry impacted contents and then either restore (repair and sanitize) or discard.
11. Base post-remedial verification on visual inspection and confirmation of work practices.
12. Allow reconstruction of the remediated site after all water damage (including mold

growth) has been removed or treated, all surfaces are dry, clean, and sanitized and all moisture sources have been resolved.

Flexibility is allowed in meeting these performance standards, with specifications developed on a site-specific basis.

CONCLUSIONS

1. Characterization of site microbiology alone is insufficient to locate mold growth, assess occupant exposure, and specify remedial measures.
2. Incorporation of procedures used for handling hazardous materials is generally not justified for the remediation of mold growth.

RECOMMENDATIONS

1. Consider general principles 1-7 (see above) when assessing buildings for mold growth and dampness,
2. Consider performance standards 1-12 (see above) when remediating mold.

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