Indoor Environmental Professionals Panel of Surviving Mold CONSENSUS STATEMENT

Medically sound investigation and remediation of water-damaged Buildings in cases of CIRS-WDB

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ABSTRACT

This consensus statement on the prevention, assessment, and remediation of water damaged buildings and the maintenance of indoor environmental quality follows a companion medical consensus statement written by physician colleagues ("SM Certified Physicians") of the Professionals Panel of www.survivingmold.com. The prior consensus focuses on medical issues found in patients who have a chronic inflammatory illness syndrome acquired following exposure to the interior environment of water-damaged buildings (CIRS-WDB). In cases of CIRS-WDB, we recommend methods for (i) finding causes of and preventing water damage to built environments; (ii) investigating and remediating WDBs when occupants suffer from CIRS-WDB; (iii) maintaining indoor environmental quality (IEQ) over the long-term; and (iv) determining that a damp indoor environment has been remediated and treated successfully such that occupants with CIRS-WDB may safely re-occupy the remediated space.

INTRODUCTION

We discuss qualitative and quantitative information on environmental variables that impact both the medical treatment of CIRS-WDB as well as the long-term maintenance of IEQ. We also address the various microbial sources of damp building contaminants able to initiate the persistent innate immune system inflammatory response seen in cases of CIRS-WDB. We conclude that there is compelling evidence to (i) support additional steps in the investigation and remediation of WDBs; and (ii) support the maintenance of IEQ to meet the special needs of persons with CIRS-WDB. If remediation is adequate to protect the "eggshell patients," then those same remediation techniques will also be sufficient to protect less affected people. Use of the reverse of this approach – protecting less affected patients without protecting the most affected, is no longer tenable.

To the best of our knowledge, of all the remediation guidelines, suggestions, and attempts at standards, including but not limited to the 2008 NYC Department of Health and Mental Hygiene for Assessment of Fungi in Indoor Environments; the 2008 Version of Guidelines on Assessment and Remediation of Fungi in Indoor Environments; the 2001 EPA publication-Mold in Schools and Commercial Buildings; the 2015 ANSI/IICRCS520 newly revised mold remediation standards; is that none of these documents link the remediation methods to the effects of exposure(s) on human health. These position statements are designed for populations with either unknown or low medical risk as stated in each document. In the absence of any definition of "low medical risk," however, the disclaimers are hardly robust.

Our consensus is the first publication that links the success of remediation methods to human health effects. Our consensus is supported by peer reviewed references as well as anecdotal studies performed by SM Certified Physicians in conjunction with the Professionals Panel of Indoor Environmental Professionals.

The indoor environmental professionals (IEPs) of the Professionals Panel of the SM organization all have extensive experience in mold investigations and remediation. Each member of this group is aware of the steps necessary to accomplish the level of cleaning that our CIRS clients require to safely re-enter their home, office or school. This document is designed to educate stakeholders to accomplish the tasks required to (i) assess a structure prior to remediation; (ii) describe environmental cleaning efforts; (iii) perform a post-remediation verification (PRV) test using the methods described below. Key to the overall success of our approach is a working relationship with CIRS Certified Physicians who rely on accurate field data to help guide treatment of CIRS-WDB patients.

To succeed at remediation that meets the special needs of CIRS-WDB occupants an IEP must first identify and address the sources of water or moisture intrusion. Second, an IEP must follow proven remediation techniques, including those cited in the ANSI/IICRCS520 Standard and Reference Guide for Professional Mold Remediation for past and/or current water damage, noting the prominent exceptions noted in Appendix A of this document.

Based on an assessment by an IEP of the structure and specialized test results, they may also call for Small Particle Remediation (SPR) and the use of specialized fogging or misting air treatment in the building, as described below.

OBJECTIVES

Our primary objective is to establish modified standards for the evaluation and management of WDBs to be applied to all buildings, not just those where occupants meet diagnostic criteria for CIRS-WDB. The purpose of these modified standards is to help IEPs in their efforts to assess and establish a safe indoor environment for occupants with CIRS-WDB. Such standards will necessarily also correct indoor conditions that are encountered by less adversely affected occupants. We believe that medically sound methods of diagnosis and treatment should be accompanied by medically sound methods of WDB investigation and remediation. As more information is learned and more quantitative data are developed, we will update and improve the techniques required to serve the special needs of CIRS-WDB patients. We believe that advancements in IEQ methods will help occupants of damp buildings who also suffer from allergies, asthma, respiratory infections, chronic obstructive pulmonary disease, restrictive lung disease, congestive heart failure, chronic rhinosinusitis, other conditions including Th17/T reg cell imbalances, fibromyalgia, autoimmune conditions and chronic fatiguing conditions, among others. The benefits of more thorough remediation and cleaning methods are not limited to occupants with CIRS-WDB. We acknowledge that many patients with the above diagnoses have been shown to actually have CIRS-WDB.

IEPs and remediators must be aware that CIRS-WDB patients show a pattern of abnormality based on NeuroQuant volumetric analysis of brain MRI studies. These include microscopic interstitial edema in forebrain parenchyma, cortical gray matter and pallidum, as well atrophy of the caudate nucleus [1].

An additional objective is to support the need to monitor and maintain corrected conditions in remediated WDBs to protect present and future occupants with CIRS-WDB. We also note an urgent and growing need to upgrade the quality of education, training, and certification of IEPs to include (i) the evidence for the special needs of occupants with CIRS-WDB; and (ii) the investigation and remediation steps that currently best serve those needs.

POTENTIAL SCOPE OF THE CIRS-WDB PROBLEM

Up to 50% of homes and workplaces in the US have past or current water damage [2, 3]. Approximately one in four people are genetically susceptible to develop CIRS-WDB following exposure to the interior environment of a WDB [4]. We cannot extend the epidemiological concept of relative risk to any one component of the mixture of antigens and particulates found in WDB [2].

If we assume that *all* of the 50 percent of WDBs in the U.S. have provided conditions conducive for the growth of toxigenic microbes and other contaminants capable of triggering systemic inflammation in persons with CIRS-

WDB, then the number of CIRS-WDB cases could number 40 million people. If only 20 percent of WDBs support this type of growth of toxigenic organisms and inflammagenic contaminants, then the prevalence of CIRS-WDB could exceed 16 million people. Without large-scale population studies to demonstrate a census of CIRS patients, we can only conclude that reasonable estimates suggest that the number of CIRS-WDB patients is large.

BACKGROUND

Indoor water damage supports the growth of toxin-producing fungi and a host of other contaminants that are invariably found in WDBs in a variety of permutations [5-25]. See Table 1 below:

Table 1

Range of toxins, inflammagens, and microbes found in WDBs		
Mycotoxins[5]	Gram-negative bacteria[11,13,14]	Hemolysins[7,11]
Bioaerosols[6]	Gram-positive bacteria[11,13-15]	Proteinases[7,11]
Cell fragments[7]	Actinomycetes[16]	Chitinases[7,11]
Cell wall components[7]	Nocardia[11]	Siderophores[7]
Hyphal fragments[8]	Mycobacteria[17]	Microbial VOCs[20-21]
Conidia[8]	Protozoa[18]	Building material VOCs[20]
Beta Glucans[7,9]	Chlamydia[18]	Coarse particulates[11]
Mannans[10,11]	Mycoplasma[18]	Fine particulates[11]
Spirocyclic drimanes[7]	Endotoxins[11,13]	Ultrafine particulates[24-25]
Inorganic xenobiotics[12]	Lipopolysaccharides[13]	Nano-sized particulates[24,25]

Microbial metabolites and fragments present to the innate immune system as pathogen associated molecular patterns (PAMPs) [22]. In those genetically susceptible to poor clearance of these contaminants, the resultant ongoing inflammation can lead to the production of danger associated molecular patterns (DAMPs). This uncontrolled inflammation involves multiple bodily systems in a well-described sequence that can lead to multiple symptoms in a matter of hours [26-29].

In addition to their symptoms seen with re-exposure to WDB, patients with CIRS-WDB often react adversely to multiple chemicals. While no mechanism to understand this common observation is confirmed, a possible mechanism has been described [27].

The methods of evaluation recommended by the IEP should be based on knowledge or suspicion of the presence of CIRS-WDB in one or more of the building occupants plus inspection and test results. If CIRS-WDB has already been diagnosed, then with the occupant's approval, results of indoor environmental evaluation should be shared with the occupant's physician.

If CIRS-WDB is suspected, the occupant should be informed of a list of physicians who are certified to evaluate and manage CIRS-WDB. In documented cases of CIRS-WDB we recommend that with the occupant's permission, the IEP share the results of the inspection and test results with the patient's physician.

Several factors that impact on safety of WDB safety in CIRS-WDB

1. The CIRS-WDB patient's degree of inflammation, as reflected by laboratory studies, including genetic markers, levels of inflammatory compounds and levels of the regulatory neuropeptide hormones.

2. The CIRS-WDB patient's roster and severity of symptoms.

3. Scores for the Environmental Relative Moldiness Index (ERMI) [30,31] and the Health Effects Roster of Type Specific (Formers) of Mycotoxins and Inflammagens-2 (HERTSMI-2) [32]. Research on CIRS-WDB has found them to be the best current predictors as to whether or not a given WDB is safe enough or has been made safe enough to make clinical progress using a published, peer-reviewed protocol for the treatment of CIRS-WDB [33]. A new study in 2016 correlates ERMI and HERTSMI-2 scores with relapse and building types that incorporate data where N=618. (See Appendix B)

4. Measurement of VOCs, particle counts, and identification of bacterial species may provide needed information in determining safety for a given CIRS-WDB patient. In some cases testing may be warranted for other contaminants, such as actinomycetes, bacterial endotoxins and other extracellular products of secondary microbial metabolism as a way to clarify particular environmental risks. This determination is made by the collaboration of the occupant, IEP, and the SM certified physician.

General Considerations in WDB Evaluation and Management

A number of considerations apply when considering the scope of remediation in the face of CIRS-WDB. The complexity of decision-making involves both environmental and medical perspectives.

1. Air is a fluid, which takes materials into solution. Because the molecules of air are much farther apart than molecules of water, air can hold a much greater amount of materials in solution or suspension, especially in humid indoor environments. In such cases, particles tend to suspend in the air for longer periods of time, though some settling of dust will occur. Air can also hold a large volume of gases and chemicals, both organic and inorganic.

2. Microbes and spores can be airborne or settled. If they settle onto damp or wet surfaces that contain wood or cellulose, the fungi and bacteria may grow based on the unique water activity [A(w)] required by each microbial species.

3. Contaminants may also settle into microscopic surfaces below the apparent smooth "solid" material surfaces. It may take higher energy disturbances to force these contaminants to become bioaerosols.

4. During microbial growth, metabolic byproducts and contaminants are dispersed into the air and eventually aggregate with dust particles as well as on structure and contents.

5. The inflammation seen in CIRS-WDB in each case may be caused by the totality of contaminants listed in table 1.

6. Because of spore settling rates, variable airflow and pressure patterns in the sampled environment, and the results provided only from the time of testing, the use of spore trap air cassettes (short term "grab samples") alone, to determine the IEQ will fail to meet the needs of patients with CIRS-WDB and does not fit the protocols set within the Surviving Mold Professionals Panel (SMPP)

7. Sampling the indoor "living spaces" does not necessarily tell the IEP or client if a hidden contaminant may be present in a nearby floor cavity, wall cavity, ceiling cavity, attic space, crawl space, or basement.

8. Some types of sample collection methods (i.e. swab, bulk, tape lift, cavity samples) are used to locate a "mold source" rather than indicate a level of contamination throughout the living spaces.

9. The specialized testing preferred in cases of CIRS-WDB uses qPCR testing of carefully collected dust samples. The qPCR method (surface sampling) captures a history over a potentially long period of time versus what is presently done with spore trap cassettes (laboratory analysis method: direct examination), which captures only a truncated snapshot in time (5-10 minutes).

10. During mold assessments, an IEP may recommend collecting long-term qPCR air samples. Not all mold spores/fragments behave the same in an indoor environment due to variations in airflow/pressure patterns, as well as indoor activity created by the occupants/pets. As a result, some mold spores/fragments can easily become and stay airborne while other spores/fragments will remain settled. Smaller and lighter particles will stay suspended for longer periods of time. Human activity will "kick-up" contaminants into the air.

More research is needed into each of these general considerations. Since each of a broad range of contaminants could play an inflammatory role in any given water

damaged building, treatments to remove all types of contaminants may be required to make indoor spaces safe for persons with CIRS-WDB.

How Medically Sound Remediation Differs from Traditional Remediation

1. Use of DNA analysis of systematically collected dust samples to obtain mold speciation data that confirms presence of specific non-toxigenic and toxigenic fungi (ERMI and HERTSMI-2 testing).

2. Greater reliance on small particle cleaning.

3. Systematic calculation of a WDBs propensity for growth and control of mold and bacteria.[43]

4. Assessment of organization within the living space. Extraneous possessions (clutter) can dramatically increase the exposed surface area in a living, work, or school space that has suffered water damage. All surfaces collect and hold dust containing toxins, antigens, inflammagens, and other micro, ultrafine, and nanoparticulate contaminants. We arbitrarily and qualitatively describe clutter on a scale of none, little, moderate and heavy (hoarding).

5. The contractor must not deviate from the IEP's plan unless authorized by the IEP. Medically sound remediation does not allow some of the common current practices; for example, such as fogging disinfectants and HEPA vacuuming surfaces followed by wiping and HEPA vacuuming a second time, known as a "HEPA Sandwich."

The Three Phases of Work Flow to Make a Building Safe

There are three major phases of planning and execution required to make a built environment safe for occupation

Phase 1. Inspect and investigate to detect water intrusions, leaks, and/or condensation problems. Also investigate the HVAC system for potential cross contamination issues. A plan for correcting problems and preventing recurrences follows, including a plan for remediation of water damaged structures. In cases of CIRS-WDB, detection, correction, and prevention should begin with an interview of the occupant(s) that includes a symptom-based assessment of risk for CIRS-WDB, followed by specific methods for inspecting and investigating the home, depending on the presence or index of suspicion for CIRS-WDB in one or more occupants.

Phase 2. Perform the planned corrections required to achieve moisture control and remediate water damaged building materials. In cases where occupants suffer from CIRS-WDB or other medical conditions affected by WDB

contaminants, remediation should include in-depth cleaning of all reservoirs of bioactive particulates inside the affected building.

Phase 3. Perform maintenance procedures to sustain high-quality indoor air over the long-term. In cases of CIRS-WDB or other medical conditions affected by WDB contaminants, maintenance protocols should involve more frequent and intensive monitoring of water damage risks. In addition, pro-active measures can be considered for the structure to help improve on the overall IEQ in the home. Examples of this are, but not limited to: optimal air filtration, ventilation and pressurization of the structure. The Surviving Mold Professional Panel (SMPP) can help provide support/direction regarding this recommendation.

CIRS-WDB HOME INSPECTION AND INVESTIGATION METHODS

The Interview

This interview is to be conducted by the IEP with the client/patient to obtain a history of WDB events that are known as well as any relation between symptoms and the home. See Appendix C for additional suggested questions

Explain how you are going to conduct your assessment and with what type of instruments and sampling methods you plan to use and why. ERMI and HERTSMI-2 dust sampling currently offer the best predictive value for CIRS certified physicians in cases of CIRS-WDB. (See Appendix B)

The IEP should speak with the client about contaminants produced by molds and bacteria growing on damp building materials that can cause systemic inflammation. A symptom survey can help determine whether or not building occupants are at risk. We recommend that the IEP point out that the scope of work focuses on diagnosis of WDBs, not people.

The Inspection Protocol

1. *Exterior Inspection.*
Walk around the entire exterior of the home and examine from both close-up and from afar. When close-up, examine flashing and caulk around windows, doors and other exterior penetrations. From a distance, carefully and thoroughly examine the overall structure (using binoculars to assist in roof assessment, for example), roofing, pitch gutters, roof valleys, attic ventilation, topography, pitch of soils at the foundation and more. Note recommendations for corrective actions, and include observational data collection for input into the MPI (Mold Propensity Index) assessment.[43].

2. *Interior Inspection*.
Inspect all levels using visual and non-destructive instruments, a moisture meter, an infrared imaging system, a meter to measure relative humidity and a laser

particle counter. Both moisture meters and laser counters require professional knowledge and training for accurate use. There may be situations requiring additional types of non-destructive instruments.

Start at one level and work toward the other levels of the home; for example, start with the attic, then the next floor down, and the next floor down until the basement and/or crawlspaces. Note: take care to consider whether you the IEP, are entering a contaminated environment such as a moldy attic, and may be cross contaminating other areas of the home. Take protective action to prevent such contamination.

In the living spaces, use an infrared imaging system to examine exterior walls from the interior as well as the ceiling of the highest level to see if there are any hidden or trapped moisture anomalies; and check for under-insulated areas which may lead to condensation. Sunlight in windows may impact the accuracy of infrared and thermal imaging technologies. Sun-heated bricks can hold temperatures much higher than the outdoor temperature which for example will raise the surface temperatures and be seen as an anomaly on the infrared device. IEPs should be certified to use these methods of inspection. Abnormal infrared or thermal imaging anomalies should then be verified using a moisture meter that reads not only measurement by pins placed into the material, but also by non-destructive surface moisture readings. Anomalies should be noted and recorded.

In the living spaces use a moisture meter on floors around the base of all plumbing fixtures such as toilets, baths, bath/shower surrounds, underneath windows, on floors around dishwashers, clothes washers or any other water using appliances. Any anomalies should be reported and recorded into the report with recommendations for corrections.

Because persons with CIRS-WDB may be highly sensitive to airborne materials, we recommend measuring particle densities in the air of a particle size of 0.5 microns and smaller followed by use of condensation particle counters for smaller sizes 0.1 micrometers and smaller. This method of investigation can help pinpoint problem areas within a WDB.

We recommend taking particle density readings in each room and area of the home as well as an outdoor reading. We recommend comparing (i) indoor levels to outdoor levels; (ii) indoor levels to usual and customary indoor levels for that geography and climate; (iii) looking for substantial spikes in any particular rooms or areas of the home, which then need to be reconciled. The types of particulates measured are characteristic of dust, pollen, dander and mold spores. Keep in mind that indoor living conditions such as air filtration, ventilation, pressurization, and indoor activities may influence these readings.

In some cases an area may warrant destructive testing. We do not recommend performing destructive testing in homes of patients without proper containment

and control of air in the contained area. Such testing should be done in conjunction with a mold remediation contractor for containment and prompt cleanup of exploratory work.

We recommend that the IEP inspect the underside of a carpet; however, if a contractor is available, we recommend they perform this for you. Gently lift carpeting at the perimeter areas to see conditions on the tack strips, the underside of carpeting, padding and the subflooring. This method is minimally invasive. A flat bar can be used to look behind baseboards. Inspected areas should then be cleaned using a HEPA vacuum.

The Outcomes of WDB Inspection and their Indicated Protocols

1**.** No evidence of excessive moisture or microbial growth: No action required.

2. Evidence of past excessive moisture and microbial growth: Medically sound correction of a past remediation if warranted, including small particle cleaning as warranted.

3. Evidence of only current, or past and current excessive moisture and microbial growth: Medically sound correction of a past remediation if warranted, correct the cause(s) and remediate the effect(s) of current moisture problems, including in-depth cleaning of all reservoirs and small particle cleaning as warranted.

Pre-Remediation Testing

Dust collection is the primary source of information regarding mold and mycotoxin production in the building, when laboratory processed by qPCR methods at licensed laboratories meeting required methods. These methods offer the highest correlation with CIRS patient outcomes. qPCR testing will not identify mycotoxins, but do identify selected mold species, some of which have a higher propensity to produce mycotoxins.

How and where dust is collected is critical to obtain results realistically representative in the home or building. Dust contains variable ranges of aggregated particulates. There are areas in a home where the dust has been settled for longer periods of time. These areas might be on the top of doorframes, cabinets or shelving areas that are not normally dusted in the routine of usual housekeeping. The dust found on surfaces of tables and furniture, for example, is more likely newer dust.

All IEP practitioners must collect dust samples in a thoughtful, organized, and meaningful protocol to achieve results reflecting the true conditions in the home

or building. They must be guided by their own experience, but also taking into account issues associated with the building and the health symptoms provided by the client.

Depending on the client concerns and site conditions, the IEP may choose to collect dust samples from specific areas or sources in the structure. It is common practice to collect dust samples in areas where the client(s) spend the majority of time or where the client reports greater health concerns. It may be useful for the IEP to collect samples for analysis on each level of the home to help assist in determining where small particle remediation may be needed.

Post Remediation Testing

In the post-remediation setting, the IEP must also consider and determine the quantity and types of testing to be performed. If possible, the IEP should be communicating with their client's physician to find out any known medical CIRS sensitivities that the client may have. Based on this information and the general scope of work (regarding the inspection and testing), the IEP should develop a testing regimen that helps answer any related questions or concerns. This regimen will be coupled with an understanding of any limitations established by the client such as budget or agreed-upon scope of remedial work. For example, given Remediation & Environmental-Cleaning (REC) projects may only include a portion of the entire structure. Other RECs may include addressing the entire home.

Many clients with CIRS-WDB may also be sensitive to mVOCs, building material VOCs, bacteria or their exometabolites and other contaminants; and PAMPS such as those described in Table 1. If testing beyond qPCR for mold DNA is used, the IEP should suggest additional treatment options based on those results and contaminants of concern. Some of these treatment options may involve air treatment devices as well as surface treatments.

There are a variety of tests available to measure these contaminants. For example, mVOCs usually use a method of thermal desorption/gas chromatography. Swabs, Andersen impactors, biocells, and other collection devices may detect bacteria. Glucans are typically analyzed in samples of sedimented floor dust or airborne dust collected on filters. One method of analysis uses antibodies formed by rabbits injected with glucans; another uses a derivative of the Limulus amoebocyte lysate preparation.

Although laboratory testing is needed, for many persons with CIRS-WDB the optimal level of cleanliness to reach and show with post-remediation testing will (i) have no odors including fragrances or strong smelling chemicals; and (ii) have no visible dust seen with a bright light. The surfaces should be generally white glove clean. Blue painter's tape can be pressed onto smooth surfaces to show if residues and dust have not been removed with cleaning. These are test methods that can be used by workers, customers, and consultants and are not medically conclusive.

One method of collecting "new" dust for a HERSTMI-2 or ERMI test is to tape large black or green garbage bags on horizontal and vertical surface to attract new dust on them for a sample. This may take 3-5 weeks.

At the end of a small particle remediation, remove the furnace filter on a forced air system, replacing it with a new one after duct cleaning has been performed following the guidelines of National Association of Duct Cleaners. The filter should be at least a rating of MERV 6 to MERV 8 (Minimum Efficiency Reporting Volume). This rating system was developed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) as standard 52.5 in 1987, which is included in the 2013 ASHRAE Handbook.

METHODS OF MEDICALLY SOUND REMEDIATION
Also see Appendix **D**

Habitibility During Remediation

Based on the IEPs judgment considering qPCR test results and other factors of the building and investigation, the IEP may recommend that the family move out of the home during the remediation process.

Personal Protective Gear

The IEP will give a recommendation to the remediator for workers' personal protective gear. In severe cases, full-face respirators of NIOSH rated P100, also protecting against organic vapors, is recommended. A standardized fitting and testing procedure of respirators with their workers must be performed to ensure that there are no leaks from surrounding air into the respirator system.

Use of disposable, protective suits with head and shoe covers, and nitrile gloves, should be determined and specified by the IEP based on the unique variables of each case. When workers go in and out of the contained area, they should "don and doff" the personal protective equipment in the entry chamber of the contained area before going into the home or back into the entry chamber.

We recommend that either a tacky plastic or a vinyl carpet floor runner be laid down from the contained entry chamber to the chosen entrances and exits of the home.

Important Safety Measures

All workers and occupants should be protected with engineering controls and personal protective equipment as necessary and required by occupational safety, environmental and building code regulations or laws.

Workers should address safety issues such as electrical, falls, slips, trips and heat exposure in worksites. Knowledge of construction is required to avoid costly (and sometimes dangerous) mistakes.

Negative Air Pressure Differentials and Filtration

These are the most common techniques used for containments by creating a minimum negative pressure differential measuring 0.02 inches of water column, or more (negative 5 Pascals) as measured by a differential pressure gauge (manometer) [34]. The measurement might not be uniform along the perimeter of the containment due to other pressure sources and the proximity of the negative air machines (NAMs).

Decontamination chambers or vestibules are used when workers can't enter and leave with exterior doors in cases where the contractor is not addressing the whole structure. They generally need to be large enough for two workers to HEPA vacuum each other as they remove protective suits that may have high levels of construction dust. This is the point where waste material is double-bagged and equipment cleaned/sealed before leaving the work area.

Positive air pressure differentials may be necessary for airlocks separating occupied areas from demolition areas or when working with building envelope areas such as crawlspaces, exterior walls, windows, doors, attics and roofing. In a crawlspace for example, typically a positive air pressure would be used inside of the structure so that any contaminants from the crawlspace will not enter the structure via any available pathways (gaps/cracks/opening/etc.)

Another example could be a bedroom, contained off from the rest of the house, with an exterior window that is left open while a positive pressure is being utilized inside of the bedroom containment. The opening of the window can provide a pathway of least resistance for contaminants to exit without risking cross-contamination concerns to the rest of the containment or other areas

outside of the containment. This is a particularly efficient design when the areas being abated run the same exterior wall as the window.

Other uses of positive air pressures inside of the defined space include areas where microbial growth hidden on the exterior side of the sheathing may be present and could gain access to the interior when removing a window. Air infiltration around the window will create air currents that may cause pollutants to be pulled into the interior from the exterior. This situation is also an example in which creating negative air pressure differentials inside of the defined space would *increase* pollutant particles in the work area making it (i) harder to clean; and (ii) harder to protect against cross-contamination. See Appendix A for additional discussion.

A room contained with positive air pressure differentials can usually be brought to negative air pressure differentials after hidden concern areas are addressed if indoor demolition is necessary. Care should be taken to consider whether or not a negative or positive pressure containment plan might cause cross-contamination concerns.

Air cleaning with filtration is the most common method used to clean the air by removing particles with HEPA filters before discharging the cleaner air. Negative air machines (NAMs) and air scrubbers are generally rated as HEPA filtered to capture 99.997% of particles measuring 0.3 micrometers or greater in diameter. These devices are critical equipment for mold remediation projects when used correctly.

HEPA filtered air scrubbers and NAMs, however have limited capture zones due to a lack of air velocity on the intake side where the HEPA filter is located. This is due to Bernoulli's Principle [35], where the intake side of the fan has high pressure and low air velocity while the exhaust side has low pressure and high air velocity. If the capture zone is limited, use slow speed air mover fans in addition to the HEPA filtered air scrubbers and NAMs to move the air in a circular pattern to help make the particulates more homogeneous and also reduce "dead" zones thereby increasing particulate removal.

Fan equipment must be cleaned from prior use before bringing them into the work areas. When possible, HEPA filters are most effective with unidirectional or laminar air flow with a minimum of 60 feet per minute air velocity moving in one direction without obstructions if all the air in the work chamber is involved [36].

In 1961, Willis Whitfield (37) found that 90 feet per minute to be the minimum air velocity in cleanrooms with obstructions to effectively control particles measuring 0.5 micrometers and smaller.

Air scrubbers and NAMs should be used primarily for localized exhaust where dust and possible contamination is created into the air during demolition

Microbial Cleaning

In some situations, the IEP may recommend the personal contents to be cleaned be moved out of the home for that process and then moved back into the home after the home has been treated. Specific treatment methods for various items of porous and nonporous items will be provided by the IEP.

In all applicable sections we describe methods that will achieve maximum cleaning of surfaces and air including references to methods used in clean room applications. These methods may not be feasible in all situations due to constraints of workspaces and finances. The IEP should take all factors in consideration to achieve the maximum effect and benefit.

Microbial remediation is the effort needed to clean and correct a structure to a normal microbial ecology. Past efforts have been focused on mold spores or conidia that settle with gravity. Microbial contaminants may consist of any or all of the items in Table 1.

Clients of IEPs are individuals who range from hardly impacted to greatly impacted. With the client's permission, the IEP consultant should communicate with the client's CIRS certified physician to obtain a better understanding of the client's condition on the CIRS-WDB severity spectrum.

Certified consultants and contractors can then learn whether their remediation efforts are falling short by following the changes in the clients' medical data. Only physicians can diagnose who is at risk, which makes it hard to confirm what each person may need to tolerate a remediated indoor environment. While it is not practical to set up any home typical mold remediation project to "clean room standards" it should be the focus of the mold professional to follow the best practices mentioned in this document (i) to minimize any cross-contamination concerns; and (ii) maximize the effectiveness of the remediation in the environmental-cleaning efforts.

Removal is the best option for all materials impacted by microbial growth and water staining, as well as porous items. These include paper-faced gypsum board, ceiling tiles, carpeting and upholstered material. Some customers may

attempt to save these materials. In those cases, consultants will warn those customers that attempts to save possessions must be balanced against the real risk of preventing an adequate remediation.

Killing or suppressing mold growth will not address the adverse health effects caused by other microbial components such as endotoxins, exotoxins, beta glucans and mannans, among others. It is folly to advocate use of antimicrobial compounds as the "remedial solution" when the inflammagens, toxins and antigens are still present even if the mold itself is "dead." Removing all toxigens and inflammagens, not simply focusing on killing what is or isn't alive, is the only route to successful remediation.

Cleaning agents that don't leave residues are better than cleaning agents that leave residues and particles. Using products with strong odors or fragrances may offend the chemically sensitive while masking hidden problems that are part of the problem. Some people may not know they are chemically sensitive until they have been exposed to the products used by a contractor. It is better to assume chemical sensitivity to avoid costly surprises.

Replace inexpensive flexible ducting or fiberboard junction boxes rather than attempt to clean. Flexible ducting may have folds or wrinkled plastic that makes cleaning impossible. Fiberboard can be damaged by abrasive cleaning methods. Fiberboard should never be used in close proximity to the cooling coils, since the moisture will lead to microbial growth on and in the porous material.

Duct cleaning according to the National Air Duct Cleaner's Association (NADCA) will fail to remove particles measuring 0.5 micrometers and smaller due to a lack of air velocity using the recommendation of their 2013 standard. This problem is also due to Bernoulli's Principle (described earlier). IEP can address a correction by pumping HEPA filtered air in the end of each duct run simultaneously after the surface cleaning has been performed and the ducting is under a negative air pressure differential.

Air Cleaning by Fogging/Misting

After a remediation and/or small particle remediation, there will be contaminants in the air that are smaller and lighter than what HEPA filters can control which will not settle quickly due to their light weight. Fogging (droplets below 50 micrometers or misting over 50 micrometers) to clean the air (US Patent #9,149,754) will address the suspect areas that are not adequately addressed by HEPA filtration. This method can also address the area immediately outside containment for a smaller remediation job when the whole structure is not cleaned.

Water fog droplets alone cannot do the job since beta glucans are water repellent. Surfactants are used to lower the surface tension in order for particles to attach to them. Slow evaporating compounds increase working time for surface cleaning once attached to particles in the air to settle to surfaces.

Fogged water droplets with surfactants and other constituents will go through evaporation when the fogging stops. Any condensation nuclei remaining will potentially cause trouble unless a second fogging occurs with water only. The second fogging allows the condensation nuclei from the fogged product to grow to droplet sizes settling with gravity (40 micrometers or larger). Therefore, the air is essentially rinsed, leaving air and water vapors with much lower levels of particulates and chemicals.

Capture efficiency is enhanced with a slow, sweeping motion, which creates a complex form of "gradient or shear" coagulation. Filling a room with a fog without moving the plume around the room will take much longer and have poor performance with submicron particles with kinematic coagulation [40].

Temperature will also impact fogging to clean the air. Dehumidification may be necessary due to water damage or fogging in high humidity climates. The air conditioning system can remove some moisture. Locations with high humidity may need portable dehumidifiers after fogging/misting. Professional dehumidifiers should be cleaned prior to placement in work areas.

All HEPA vacuuming should occur before fogging or misting. Only damp wiping, using dry Swiffer cloths on dry and smooth surfaces, or encapsulation should occur after the fogging/misting method to clean the surfaces. Bare drywall should be sealed to prevent mold DNA in the paper backing from causing confusion on post testing efforts.

To minimize encapsulation kicking up particulate, consider using a pump-up garden sprayer following up with brushes and rollers to even the coat. Airless sprayers may cause problems and are expensive to maintain. They may create "paintballs" in the air that may be inhaled.

Achieving a Safe, Long Term Post CIRS-WDB Remediation

Consider that once a remediation and cleaning has been performed, and the client and/or their family have moved back into the home, changes will occur. For example, doors and windows will be opened, and family members will come and go into the home. Pets will move inside and out of the home; external environmental events will occur. The home will rapidly change its indoor

environmental condition to a point of steady state equilibrium based on the lifestyles of the family.

It is a goal of this consensus to ensure that at the point that steady state equilibrium is achieved that the home has indoor air quality that is safe for occupants with CIRS-WDB. Remediation plans, use of available assets of the clients, consultation with the IEP and the physician are each required bringing the building to equilibrium after maximum cleaning levels.

Limitations on Creating Optimally Safe Indoor Environments for WDBs

Not all building owners or occupants are able to or willing to carry out the methods that are recommended by CIRS-aware IEPs. The IEPs must consider the resources required to attempt to create an optimally safe indoor environment. If an ideal indoor environment is not attainable, the patient with CIRS-WDB must discuss with the IEP and the health professional alternative (if any exist) pathways for reducing innate immune inflammation.

Because of unique variables in homes, offices and schools, the IEP must be willing to modify an ideal work plan. Such situations tend to require innovative thought and preparation. Removal of clutter and the performance of basic small particle cleaning require only assistance from family and friends. In some cases the client will need IEP input on the merits of different alternatives for treating the indoor air by means of negative and/or positive ventilation, filtration or other suitable air treatment methods.

If the CIRS-WDB occupant is also the building owner, the IEP must provide education about remediation and testing on the building before deciding to sell the property. If the occupant is renting, relocation is usually an easier solution. The testing and reporting of the water damage and microbial growth may be sufficient for tenants to terminate their current lease. Minimizing the health, financial, and emotional damages caused by CIRS-WDB must not occur. Trivializing the consequences of CIRS-WDB by medical or environmental professionals, especially in the absence of peer-reviewed, published data, is unacceptable.

Challenges for IEPs in Cases of CIRS-WDB

If medically sound remediation is performed, then a report of inspection results, test results and other evaluated variables should be presented to the patient. A signed permission from the client/patient should be given to the IEP and their physician so that their needed medical and environmental information may be

shared. We recommend that the IEP's report will review all findings and make a recommendation regarding the readiness of the IAQ of the home.

All known methods of correcting indoor air quality issues involve one or a combination of the source, filtration, and/or ventilation. These issues may additionally be addressed by specialized and effective filtration and/or ventilation as well as other air treating devices. This category may include specialized filters for particulates, VOCs, use of electrically charged particle generation and more. We feel there is insufficient data to judge the effectiveness of these devices at this time.

Post-Remediation Maintenance Planning

CIRS-WDB occupants are likely to relapse should water damage recur after remediation is completed. A maintenance plan designed to minimize the risk of future water damage must be provided. Since settled dust can contain contaminants, the maintenance plan must address the importance of good housekeeping. CIRS-WDB patients will also need to live in clutter-free homes.

The IEP will give the client a maintenance protocol including suggestions for re-inspections. This maintenance protocol will raise client awareness about (i) the need to monitor moisture control conditions and (ii), the requirement to be observant of water damage risks to the property. A maintenance protocol aimed at establishing a safe, long-term, post-remediation indoor environmental equilibrium for occupants with CIRS-WDB must focus on many factors that affect the mold propensity of a built environment.

Mold and Insurance

Few mold-related property insurance claims were filed before 2000. But when high publicity cases in Texas and California led to multi-million dollar awards, publicity about the dangers of water damage-related indoor mold growth led to a steep rise in mold-related claims [41].

In the U.S. and Canada in 2001, 5,000 toxic mold suits were filed against insurers claiming bad faith, 2,000 cases against homeowner associations for improper maintenance, 2,000 cases against builders for construction defects, and 1,000 cases against former owners of sold homes [42].

The property insurance industry responded by calling the publicity a case of mold hysteria, claiming that most molds are benign and that while some people may experience allergies and asthma, there was no scientific support for claims that "toxic mold" was producing debilitating medical conditions. The CDC supported this position. To be fair, often claims of serious health effects from

toxic mold exposure were not well substantiated at that time. But the CDC defends the same position to this day despite a peer-reviewed prospective study on the pathophysiology, diagnosis, and treatment of CIRS-WDB [32].

To stem the rising tide of mold claims, property insurers put caps on mold-coverage ranging from $1,000 to $10,000 per water-damage claim. To further stem their losses, they ruled out coverage for mold growth related to homeowner negligence and created a separate market for flood insurance. The legal problem migrated to commercial and government buildings and spread beyond property insurance to business, liability and worker's compensation insurance. As a result of this second tide of claims, architects, builders, contractors, and subcontractors, employers and school boards frequently became defendants in legal actions [41].

State insurance departments had little choice but to approve mold exclusions for various types of insurance. Homeowners' insurance rates hit record highs. New home construction rates fell along with construction-related employment. The costs of mold-related water damage had affected multiple markets and business models in ways that raised costs for consumers, but for businesses as well, including risk management costs for remediation contractors and subcontractors. Insurers developed a risk management strategy based on risk avoidance. They now issue over 100 million exclusions annually, shifting mold damage losses elsewhere in the economy [42].

Consumers were told not to hire uninsured contractors, which subjected remediation methods to closer scrutiny. Remediators turned to their professional societies for guidelines that would set remediation method standards for the industry. The EPA, New York City, the American Conference of Governmental Industrial Hygienists (ACGIH), and the Institute of Inspection Cleaning and Restoration Certification (IICRC) issued guidelines for remediation methods.

In one project where ACGIH guidelines were followed, pulmonary functions were tested for personnel before and after remediation of a hospital with a moldy indoor environment []. The post-remediation environmental testing looked good according to the guidelines but hospital personnel showed worse pulmonary functions after remediation. The post-remediation testing for the study involved air samples for culturing and spore traps. This example of the lack of correlation between adverse human health effects and putative objective measures of remediation indicates how adherence to published remediation guidelines can fail. In the field, we have seen this experience repeated multiple times in cases of CIRS-WDB.

We understand the economic impact of WDB remediation on multiple sectors of the economy and the pressures they place on insurers, builders, contractors,

subcontractors, and remediators. We sympathize with those who have incurred higher insurance costs to manage their legal and financial risks when it comes to mold. But it is our duty to raise awareness about the scientific evidence indicating that current post-remediation standards are failing persons with CIRS-WDB, persons whose special health needs require a more aggressive post-remediation standard for establishing safe conditions for habitation after water damage.

It appears to us that the only way to avoid ongoing rounds of cost shifting, which disproportionately affect those with the fewest resources, is for all parties involved to turn their focus toward prevention through better moisture control in building design and construction. In addition, there needs to be better monitoring of mold propensities as a part of building maintenance with better methods of remediation to protect those most vulnerable to the adverse health effects acquired by exposure to the many toxigenic and inflammagenic biocontaminants produced by microbes growing on damp building materials.

CONCLUSIONS

We believe that medically sound methods of medical diagnosis and treatment be accompanied by medically sound methods of WDB investigation and remediation. The number of persons with CIRS-WDB is likely to be large. As a result, the implications for health care professionals, insurers, builders, IEPs and remediators warrant a shift toward medically sound standards for preventing and correcting indoor water damage. Achieving the levels of indoor air quality required by CIRS-WDB treatment protocols will provide benefits for the many who suffer from debilitating forms of chronic illness caused by their WDB exposures.

IEP APPENDIX A
RECOMMENDED DEVIATIONS FROM THE 3rd EDITION OF THE IICRC S520 STANDARD FOR MOLD REMEDIATION

Based on the following reasons and the references cited by the Indoor Environmental Professional (IEP) panel of Surviving Mold in their Consensus document, we offer the following recommendations to achieve greatest results in medically sound remediation:

Negative air pressure versus positive air pressure differentials

In many past and current remediation projects, the remediation company incorporates some engineering controls to help contain the remediation work they perform. The use of negative air pressure (NAP) inside of containments is common. In many applications, one of the concerns by the remediation company and the IEP involves the potential for cross-contamination of areas outside of the containment (and inside of the structure). To minimize any cross-contamination, remediation companies will incorporate negative air pressure (NAP) to produce an area of lower

air pressure inside of the containment. This air pressure relationship helps prevent contaminants that are generated/disturbed inside of the containment from exiting to the areas outside of the containment (i.e. areas of higher air pressure).

NAP controls, however, are not appropriate for every remediation project. There are situations in which a positive air pressure (PAP) is preferred over a NAP. Examples of where PAP is preferred over NAP include, but are not limited to, the following:

i. While working in a crawlspace or basement, putting the living spaces above under a PAP will help prevent contaminants being generated/disturbed from the crawlspace/basement from entering the workplace from below.
ii. While working on an exterior wall with a window, if the exterior wall of the building envelope is the affected area, leaving the window open while under a PAP will help prevent contaminants that are located on the exterior wall from entering further into the containment area.
iii. While removing an affected ceiling tile, consider operating the containment under a PAP to help prevent contaminants that may be located in the unconditioned upper (including attic) space from entering into the containment area. The remediation company should ensure that the upper space/attic is vented before operating the contained area under a PAP.

This deviation from the IICRC S520 Standard 3rd Edition is necessary because a negative air pressure differential containment would only pull higher levels of contamination into the indoor environment from surrounding contiguous areas described in this Appendix. This deviation is also in addition to, but not stated in the uses of negative air pressure in the IICRC S520 (section 12.2.6). The IEP should use professional judgment when designing the proper pressure relationships for each project based on the specific conditions addressed. These design criteria should be stated clearly in the remediation protocol; consultation with the remediation contractor must be included to ensure proper performance.

There will be situations where neither a NAP nor a PAP provides the best engineering control solution for all or a portion of the remediation project (typically during the remediation phase). In this situation, it is up to the remediation company and the IEP to determine the best use of any NAP or PAP in the containment during any phase of the remediation project. The goal is to prevent contamination and cross-contamination.

HEPA air scrubbers

Stand-alone HEPA air scrubbers should only be used in contained workspaces to capture and exhaust aerosols that are created during demolition. HEPA air scrubbers have a small capture zone due to limited air velocity, which decreases their ability to move airborne particles to the HEPA air filter.

As a means of validation of this limitation, one method is to sample the air flow from the farthest location from the HEPA air scrubber using an anemometer. If the airflow is less than 60 feet per minute (fpm), laminar flow is not present. Without laminar flow, there will be (1) reduced capture rate; and (2) ineffective filtration of airborne particles. Another method is to use a smoke pencil to confirm the distance at which smoke no longer goes into the HEPA filter.

The use of HEPA air scrubbers is only part of the larger remediation and environmental-cleaning efforts recommended in this consensus.

Operating HEPA air scrubbers inside of the contained area would help remove some of the particles of greatest health concern. Adding lay-flat hose to the exhaust end of the HEPA air scrubber will help increase air movement inside of the containment, thereby increasing the removal of total airborne particulates (via the HEPA air filter). Lay-flat can be run around the inside perimeter of the containment. This panel recommends sealing the end of the lay-flat as well as adding small slits (~4-8") to the slides of the lay-flat. The number and location of the slits depend on the layout of the containment and size of the HEPA air scrubber. The remediation company must be familiar with the use and operation of lay-flat.

Another method to help increase air movement inside of the containment is to add air movers in areas where "dead (air) spots" are suspected to exist.

HVAC duct cleaning

HVAC ducting should be cleaned according to the National Air Duct Cleaners Association (NADCA) 2013 standard. Please note we recommend one modification. We recommend a HEPA filtered supply of clean air be added to the end of each duct line as cleaning occurs to push the particles to the HEPA filtered device creating negative air pressure differentials at the fan coil unit; without pulling contamination across the coil assembly. There is no need for use of antimicrobials.

We recommend that flex ducting be replaced where accessible since the dust in the plastic wrinkles cannot be cleaned satisfactorily. This deviation from the IICRC S520 3rd Edition is based on having a lack of laminar airflow with enough velocity (60 feet per minute or greater) to control or suspend particles that float with Brownian motion equal to or less than 0.5 microns in diameter.

HEPA vacuums

HEPA vacuums are known to perform poorly with small electrically charged particles; HEPA must not be used to clean surfaces after wiping. Surfaces should only be vacuumed if they have visible dust that can't otherwise be moved with compressed air outdoors (example: furniture) or in a containment area within the capture zone of a HEPA air scrubber vented to the exterior.

Additional considerations regarding HEPA vacuuming

- "Energetic cleaning methods" such as dry sweeping or the use of compressed air should be avoided (or only used with precautions) that assure that particles suspended by the cleaning action are trapped by HEPA air filters. If vacuum cleaning is employed, care should be taken that HEPA filters are installed properly; bags and filters must be changed according to manufacturer's recommendations (http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf)

- While vacuum cleaning may be effective for many applications, the following issues should be considered. (i) Forces of attraction may make it difficult to entrain particles off surfaces with a vacuum cleaner. (ii) The electrostatic charge on particles will cause them to be attracted to oppositely charged surfaces and repelled by similarly charged surfaces. (iii) A similarly charged vacuum brush or tool may repel particles, making it difficult to capture the aerosol or even causing it to be further dispersed. (iv) Vigorous scrubbing with a vacuum brush or tool or even the friction from high flow rates of material or air on the vacuum hose can generate a charge. (v) The vacuum cleaners recommended for cleaning copier and printer toners have electrostatic-charge-neutralization features to address these issues" (http://www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf).

Fogging

Section 12.1.7 allows fogging to clean the air. The IEP Surviving Mold Professionals Panel (SMPP) recommends the following:

- Negative air pressure differentials with four air changes per hour cannot be operating or the liquid droplets will evaporate 4 times faster to create high moisture on surfaces without cleaning the air.
- Droplets need to be 40 micrometers or larger to settle with gravity. (Note: A 36 micrometer droplet will evaporate in 6 seconds at room temperature and 50% relative humidity. Further, four air changes would accelerate that evaporation time to a little more than 1 second. This accelerated evaporation would leave the condensation nuclei with much higher concentrations of surfactants, fragrances and any antimicrobial chemicals if someone chooses to fog disinfectants. This may lead to higher concentrations of the chemicals than recommended and tested for toxicology and reviewed by the US EPA.)

IEP APPENDIX B

HERTSMI-2 and ERMI: Correlating Human Health Risk with Mold Specific qPCR in Water-Damaged Buildings

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SUMMARY

In this large study of fungal DNA testing by MSQPCR, we present the findings that support use of low cost HERTSMI-2 testing to inform objectively interested parties

- **If WDB conditions exist; and**
- **Where the problems are likely to be found; as well as**
- **Whether the remediated building is likely to be safe for re-occupancy by previously affected patients with CIRS-WDB who meet the GAO case definition.**

PRACTICAL IMPLICATIONS

While high scores of both ERMI and HERTSMI-2 accurately predicted markedly increased risk of recrudescence, only low HERTSMI-2 predicted safety from re-exposure for patients who had prior CIRS-WDB. Use of HERTSMI-2 is inexpensive, reproducibly reliable and predictive of mold associated re-exposure from water damaged buildings (WDB), especially for sub-optimally remediated buildings.

KEYWORDS

WDB Water Damaged Buildings
CIRS-WDB Chronic inflammatory response syndrome acquired following exposure to the interior environment of water-damaged buildings (WDB)
ERMI Environmental Relative Moldiness Index
HERTSMI-2 Health Effects Roster of Type Specific (Formers) of Mycotoxins and Inflammagens, Version 2
MSQPCR Mold Specific Quantitative Polymerase Chain Reaction

1. INTRODUCTION

In the absence of published governmental guidelines setting criteria for safety in buildings with a history of water intrusion and microbial growth (WDB), clinicians caring for patients sickened by chronic inflammatory response syndrome (CIRS-WDB) have used a variety of building parameters to predict safety of re-exposure, without acceptable predictive success.

Previously, no single building index has consistently shown reliability to predict absence of recrudescence with re-exposure. Therefore, patients with a history of CIRS-WDB have often needlessly experienced recurrence of symptoms following re-exposure to WDB, even with exposures as short as 30 minutes.

Previous studies have shown that the Environmental Relative Moldiness Index (ERMI) has use in predicting re-acquisition of abnormal inflammatory markers of CIRS-WDB with re-exposure to buildings with an ERMI equal to or greater than 2.01 but no assessment of ERMI to predict absence of relapse with re-exposure has been forthcoming. Moreover, ERMI has been criticized as having methodological and mycological problems. In an attempt to improve predictive value of fungal MSQPCR data as the basis for an accurate building safety index, a derivative of ERMI, called HERTSMI-2, was developed.

HERTSMI-2 uses a weighted scale applied to the concentration in Spore Equivalents/mg of each target mold's DNA, detected by MSQPCR, present in collected dust for just five species of fungi. This index was developed following statistical assessment of 1010 ERMI results from the homes of treated patients (Shoemaker, 2011). Prospectively, HERTSMI-2 was compared to ERMI in the assessment of 807 consecutive patients for whom health effects of re-exposure to buildings were known. These data showing the relevant predictive value of each index is now presented. 618 buildings had ERMI done, from which HERTSMI-2 is calculated; these data were compared to those from buildings where HERTMI-2 alone was performed (N=189).

Published data has confirmed that the diagnosis, through blood tests of patients sickened following exposure to the interior environment of a water-damaged building (WDB), is readily achievable (Shoemaker, 2013). Use of a standardized treatment protocol, confirmed by double blinded, placebo controlled clinical trial (Shoemaker, 2006), has not only provided resolution of the chronic inflammatory response syndrome (CIRS-WDB) but also provided an opportunity to employ re-exposure trials to determine if the gold standard of remediation, confirmation of absence of recrudescence of illness with re-exposure following thorough remediation, has been met. With increasing use of MSQPCR testing by physicians treating CIRS-WDB patients, we sought to determine a method of measuring successful remediation based on maintenance of resolution of symptoms and laboratory measures in previously affected, but treated CIRS-WDB patients, after re-entry. This method focuses on patient health parameters as a measure of safety of occupation of a building**.**

The search for a new, objective method to assess safety of remediation for previously affected patients was spurred by failure to see objective, patient-driven data that showed benefit from measures derived from air sampling. Problems with air sampling with spore traps have been reported (GAO, 2008 & WHO, 2009). Low sample volumes and the absence of the ability to microscopically determine the species of spores collected by spore trapping have been amongst the reported causes. While spores of *Chaetomium* and *Stachybotrys* are obvious to skilled microscopists reviewing spore trap material, separation of *Penicillium* from *Aspergillus* is not possible, nor is there a routine mechanism to similarly identify *Wallemia sebi* in spore trapping by microscopy. However, methods to overcome these issues have been evolving**.**

BACKGROUND to PCR

PCR was invented in 1985 by Kary B. Mullis; use of PCR has become widely applied in almost every field of biological endeavour, truly revolutionizing molecular biology. Its specificity, efficiency and fidelity have turned it into a key technology that has made molecular assays globally accessible. It underpins most of the spectacular advances that are now commonplace in every biological disciplines, ranging from microbial detection and microbiological quality assurance, through the detection of genetically-manipulated organisms in crops and foods, to molecular and veterinary medicine.

Conventional PCR is a qualitative assay, giving a binary presence/absence result, while quantitative, real-time PCR (qPCR or MSQPCR) is a powerful technique that enables both qualitative, as well as quantitative, measurements of specific sequences in a nucleic acid sample. Since various experimental parameters can have a significant impact on the quality of results (in some cases erroneous), it is particularly important to employ standardized best practices. Those include the use of rigorous controls, validation and non-subjective data interpretation.

ERMI INTERPRETATION OF MSQPCR DATA

To interpret the data offered by MSQPCR in a WDB context, the Environmental Relative Moldiness Index (ERMI) has been developed and validated as a means of interpreting results from MSQPCR of house dust. ERMI was developed by the *U.S. Environmental Protection Agency* (Haugland & Vesper, 2002; Vesper, 2007). The method employs Mold Specific Quantitative Polymerase Chain Reaction (MSQPCR) methods to detect and quantify species of fungi found in WDB compared to those found in buildings without a history of water intrusion.

The MSQPCR method follows defined steps. During the annealing step, the primers and probe hybridize to the complementary DNA strand in a sequence-dependent manner. Because the probe is intact, the fluorescent reporter and quencher are in close proximity and the quencher absorbs fluorescence emitted. In the extension step, the polymerase begins DNA synthesis, extending from the 3' ends of the primers. When the polymerase reaches the probe, the exonuclease activity of the polymerase cleaves the hybridized probe. As a result of cleavage, the fluorescent dye is separated from the quencher and the quencher no longer absorbs the fluorescence emitted by the dye. This fluorescence is detected by the real-time PCR instrument. Meanwhile, the polymerase continues extension of the primers to finish synthesis of the DNA strand.

CLINICAL APPLICATION OF ERMI & EMERGENCE OF HERTSMI-2

Use of ERMI was clearly helpful clinically as elevated ERMI scores indicated absence of safety of homes for those patients with CIRS-WDB. For ERMI scores less than 2.1, the value of ERMI was less likely to correlate with safety.

In order to address this, HERTSMI-2 was initially presented (Shoemaker, 2011), based on a review of over 1000 ERMI test results. Patients were stratified by total ERMI score finding that scores over 2.0 were associated with illness for those with levels of melanocyte stimulating hormone (MSH) < 35 pg/ml or those with HLA DR from one of six genetically predisposing haplotypes (Shoemaker, 2005).

In an effort to find significance of differences between high versus low ERMI, ratios of Spore Equivalents/mg dust derived by MSQPCR were compared for each species listed in Group I of ERMI. The goal was to isolate the minimum number of filamentous fungal species routinely associated with damp buildings that made susceptible patients ill with re-exposure.

Any ratio less than 10/1 for a given species was not considered to be strong enough to be an indicator of worsening building health. Nine species with ratios of greater than 10

where identified. Of these, the five with the highest ratios were (in order) *Wallemia sebi*; *Aspergillus versicolor*; *Aspergillus penicillioides*; *Stachybotrys chartarum* and *Chaetomium globosum*.

Of interest, these organisms stratify water activity (A_w,), with A_w, ranging from near xerophilic (*Wallemia*) to approaching saturated (*Stachybotrys* and *Chaetomium*).

HERTSMI-2 IS MORE PRACTICAL

In theory, HERTSMI-2 values could provide an inexpensive, objective measure of organisms routinely found in WDB, known to be associated with adverse human health effects. These data could also serve as indicators for remediators as to what conditions and locations were present that were consistent with the A_w of the identified organism. If no conditions were identified that suggested the presence of excessive levels of *Wallemia*, for example, then additional searching for such conditions must be enjoined.

A further concern is that residences were solely included in the development and validation of ERMI, while other buildings, such as workplaces and schools are no less affected by water intrusion. These have been rarely studied, so there is no data published on any patients re-exposed to workplaces and schools that would contradict the hypothesis presented in early CIRS studies (Shoemaker, 2005) that "wet buildings are wet buildings".

HERTSMI-2 IN CONTEXT

In "Consensus of Medical Professionals' Panel" (2015), accessed on **www.survivingmold.com**, Table 2 shows a fully referenced list of the toxins, inflammagens and microbial products found in WDB. Many of those bio-markers are analyzable but have not been supported by published validation for the purposes of developing a building index. In addition, they are expensive and not widely in demand.

HERTSMI-2 –PROSPECTIVE DATA COLLECTION

Alternatively, here we present a study showing results of fungal DNA testing by MSQPCR and our findings that support use of readily available and low cost HERTSMI-2 testing to inform objectively all interested parties (i) if WDB conditions exist; and (ii) where the problems are likely to be found; as well as (iii) whether the remediated building is likely to be safe for re-occupancy by patients who meet the case definition (GAO, 2008).

2. MATERIALS/METHODS

A total of 807 consecutive MSQPCR studies were collated from charts of patients evaluated in one clinic specializing in diagnosis and treatment of patients affected by WDB. Written informed consent was provided by all participants. Dust samples were collected according to established criteria (Haugland & Vesper, 2002). The MSQPCR analyses were performed by Mycometrics, Inc, Monmouth Junction, NJ. ERMI scoring was supplied by Mycometrics. HERTSMI-2 scoring performed using

2011 algorithm (www.survivingmold.com; HERTSMI-2 scoring table). Patients were admitted to the study only when diagnosed as CIRS-WDB, having met the case criteria established by the US GAO.

The criteria include:

(1) confirmation of exposure;
(2) presence of symptoms seen in patients in peer reviewed papers;
(3) presence of relevant laboratory abnormalities seen in patients, as published in peer reviewed papers; and
(4) response to treatment, previously present before treatment with the standard protocol, but absent after treatment.

The study was double-blinded; neither patients nor investigators were aware of MSQPCR scores before building re-entry.

Patients were treated with initial steps of a standard protocol (Shoemaker, 2013) including removal from exposure; use of anion binding resins for at least one month and treatment of commensal, biofilm-forming, multiply antibiotic resistant coagulase negative staphylococci (MARCoNS) if found in deep aerobic nasal space. Patients were considered to have relapsed with re-exposure within four hours if they noted reappearance of at least four symptoms.

3. RESULTS

Table 1 provides data representing 618 ERMI scores were identified. No ERMI result was listed for 186 qPCR results as these were resulted using HERTSMI-2 only. Comparison of data obtained with HERTSMI-2 calculated from ERMI is compared to data from HERTSMI-2 without performance of ERMI (Table 2).

Table 1 Grouped ERMI Scores, correlated with Relapse & Building Type

ERMI	N=	Relapse	No Relapse	Relapse %	Building Type 1 N=	Building Type 2 N=	Building Type 3 N=
-8.39-0	49	5	44	10.2	44	2	3
0.01-2.00	40	7	33	17.5	33	3	4
2.01-5.00	87	21	66	24.1	82	3	2
5.01-8.00	89	35	54	39.3	75	3	11
8.01-11.00	77	52	25	67.5	67	4	6
11.01-14.00	82	74	8	90.2	68	8	6
14.01-17.00	65	59	6	92.3	54	5	6
> 17.01	129	127	2	98.4	118	3	8
	618	380	238		541	31	46

Of the ERMI patients < 2.01, 77 did not relapse and 12 did. For ERMI ≥ 2.01, 368 relapsed and 161 did not.

Table 2 Grouped HERTSMI Scores, correlated with Relapse

HERTSMI-2	From ERMI N=	Relapse N=	% Relapse	From HERTSMI-2 only N=	Relapse N=	% Relapse
0-10	181	5	2.7	60	1	1.7
11-15	98	47	48	28	12	42
>15	339	339	100	101	99	99
TOTAL	618	391		189	112	
Total relapse = 503. No relapse = 304						

807 HERTSMI-2 scores are presented, with 618 in ERMI and 189 without ERMI. Low scores (≤ 10) correlated with absence of relapse in 235; relapse was seen in 6 (Table 2). For indeterminate HERTSMI-2 scores (11-15), 59 relapsed and 67 did not. For high HERTSMI-2 (>15), all but 2 of 438 patients relapsed. There were no differences between HERTSMI-2 calculated with or without performance of ERMI. There were no differences between building types 1, 2, 3 (data not shown but similar to Table 1).

The distribution of building types strongly favored residences, with 705 buildings being residences (Building Type 1). 52 workplaces (Building Type 2) and 40

schools (Building Type 3) are also represented in the data set. Relapse and absence of relapse was not significantly different for any building type ($p<0.01$). Mean ERMI and HERTSMI-2 scores were not significantly different for any building type ($p< 0.01$) (see Table 3).

Table 3 Mean ERMI Scores, correlated with Building Type

Building Type	1	2	3
Mean ERMI	7.3	8.4	10.2
Mean HERTSMI-2	17.6	15.5	17.8

4. DISCUSSION

Indoor Air Quality professionals and health care providers alike continue to search for definitive criteria that can identify a building as safe for human use, or not. Understanding that only 24% of the population at large carries the HLA DR haplotypes associated with increased relative risk for illness following exposure to the interior of WDB (Shoemaker, 2005), it is difficult to apply a specific health effects criterion to all individuals. Further, we cannot use any one single element of those found inside WDB as specifically causing human illness, given the multiple possible sources of antigens, toxins and inflammagens that can each lead to CIRS-WDB. Against the seemingly impossible task required to assign criteria to patients and also to buildings, each for their own reasons, we studied previously affected patients who voluntarily re-entered buildings during medical supervision.

Both ERMI and HERTSMI-2 do not provide information regarding bacteria, actinomycetes and microbial volatile organic compounds (mVOCs). ERMI has a high percentage of errors when predicting absence of relapse (12/89 incorrect) and prediction of relapse (161/529 were incorrect). Total errors were 173/618 (28%). For HERTSMI-2 below 10, there were far less errors when predicting absence of relapse found (6/241); and errors predicting definite relapse at 2/438. However, HERTSMI-2 scores between 11 and 15 were shown to be unreliable for prediction, as such scores showed 59 relapsers and 67 non-relapsers. Such values deserve the appellation of indeterminate.

5. CONCLUSIONS

The evidence presented confirms that data from MSQPCR testing can alert patients with CIRS-WDB and their health care providers to possible problems with re-entry to previously affected WDB. Use of HERTSMI-2 is confirmed to show predictive accuracy of over 97% for patients with low or high scores. Indeterminate values demand additional building evaluation and remediation before permitting re-entry of patients with previously confirmed CIRS-WDB. Given the low cost (~US $150) and rapid turnaround provided by mycology labs that satisfy all MSQPCR testing requirements, HERTSMI-2 testing can avoid dangerous exacerbation of health effects for buildings with high HERTSMI-2 scores and provide reasonable

expectations for safety with cautious re-entry when the HERTSMI-2 scores are low (<10).

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IEP APPENDIX C
SUGGESTED CLIENT INTERVIEW QUESTIONS

ABOUT THE PROPERTY:

What is the age of the property?

What is the construction? (brick, frame, finished or unfinished basement, crawlspace)

Are you the original owner/s?

How long have you lived in the property?

If you are not the original owners, did you have a home inspection performed when you purchased it?

If so, was there any water damage, intrusion, or mold found or suggested from that inspection?

Were there any comments on the seller's property disclosure regarding water events (roof leaks, plumbing leaks, flooding, toilet problems, other)? And if so what were they?

If so, was professional water removal performed, and if so by whom and how as you remember? Are any reports available regarding these efforts?

Was mold remediation performed, and if so, where, how and by whom? Any reports available regarding these efforts (if applicable)?

If mold remediation was performed, was there any follow-up (clearance testing) mold testing performed? Are any reports available regarding these efforts?

Have you witnessed or had any water intrusions, flooding or condensation on windows, walls or air conditioning (AC) vents while you have lived here? If so, please describe what and when.

Do you know what the humidity is in your home and if so, how do you measure it?

Do you have your AC system serviced annually?

What type of filtration does your HVAC system have and how often is it inspected and changed?

ABOUT THE CLIENT/S:

If we had not been recommended by your physician, how did you hear of us?

Have you been examined by a CIRS certified physician?

Have you been diagnosed as having CIRS-WDB syndrome and or Lyme disease by any physician? If so who was the physician?

If you have been diagnosed with either of those conditions, have you been prescribed medication and are currently taking those medications, and if so for how long? What medications are they?

Are other family members suffering the same symptoms, and if so who are they and their ages?

If so, what medications are they taking?

Do you experience any positive results from the medications, and have you had CIRS blood tests performed since you have been on the medications. If so did the results improve or not?

If you have not been examined, tested and diagnosed, can you share with us the most prevalent symptoms you experience?

Do you recall how long ago the symptoms may have started? Do you recall a sensitizing event that resulted in the onset of symptoms?

Do you ever experience any symptoms when you enter buildings other than your home?

Do the symptoms ease when away from the home and increase when you return or are in the home for periods of time?

Are there parts of the home where symptoms are more pronounced?

In what room or area of the home do you feel better than others?

Are symptoms worse when heat or air conditioning is running?

Are symptoms worse during certain weather or seasons?

Did you previously live in a residence you know was water damaged? And if so, did you bring furniture and property (contents) from there to this residence?

Were the contents professionally cleaned prior to moving into this home?

If so, what kind of furniture and property was it?

Can you think of any other condition or event that may have impacted the operation of your home such as remodeling or other changes?

IEP APPENDIX D
GENERAL IEPSs DOs and DONTs

DOs:

Always consider the following when collecting samples (air or surface):

- Predominant airflow patterns
- Areas of higher and lower pressures
- Sample location in reference to any identified microbial sources
- Complaint areas versus non-complaint areas
- HVAC system and the layout (strong drivinf force in structure)
- outside influences that could affect an indoor sample (i.e. high winds, rain, humidity, etc.)

When possible, forward the client questionnaire in advance to the client prior to the investigation.

Perform a thorough evaluation of the exterior building envelope based on the areas of concern determined during the initial interview. Also perform a site drainage evaluation and other items questioned on the mold propensity index assessment, (MPI) [42]

Perform a thorough inspection of the home using necessary meters, cameras and infrared, and other diagnostic testing.

Identify and document sources of water or moisture challenges within the building. Be thorough. Consider documenting information on the interior portions of the MPI uptake questionnaire.

After inspection and interview with the clients, perform a dust collection based on the results of those for surface ERMI testing or HERTSMI-2 testing.

Provide a copy of the testing along with an interpretation and opinion of what the client should or should not do as a result.

Provide the client with a report that outlines observations, opinions, recommendations, and specific treatments or cleanup plans along with a list of qualified contractors, at arms length, that would be able to perform the necessary corrections. Follow up with the phone consultation as part of your responsibility.

If the client has a physician, with the client's permission, forward a copy of the report and laboratory results to the physician along with an opinion regarding the environmental safety of the home.

If remediation is been performed, offer a plan for post testing primarily based on a HERTSMI-2 test on new dust and report the results to the client and their physician with your opinion.

DONTs:

We diagnose buildings, not people. Limit your recommendations to the building and direct any health questions the client may have to a qualified physician or practitioner especially one certified in CIRS-WDB evaluations.

Don't underestimate the potential for water or moisture intrusion through the exterior building envelope in any climate. Water or moisture intrusion may be seasonal and not active during your inspection; however, the evidence will be there. It is your job to find it. This may require multiple site visits. Developing a scope of work is important during initial communication with the client.

Don't miss the opportunity to gather as much information as your professional judgment requires for a thorough inspection.

Don't assume anything without a thorough investigation. From basement/crawlspace to attic and wall cavities, exterior building envelope, roof and chimney flashings; the sources may be present and need to be investigated.

It is better to under promise and over deliver them provide information that will be very difficult for a client to accomplish. Always provide information that is useful and specific to the project. Don't provide cookie-cutter recommendations that don't fit with this line of investigation. Try and think outside the box.

Competing Interests:
LS: Mold Propensity Index, testimony for plaintiffs in mold litigation. GW: patent, Aerosolver Pure. MS: none. WS: testimony for plaintiffs and defendants in mold litigation. KB: none. RS: testimony for plaintiffs in mold litigation.

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