Concerns about health effects caused by molds growing in the indoor environment of water-damaged buildings (WDB) affect many people. Just picture the questions that accompany thinking about occupying a new living space. Is this musty smell a warning? Can I trust the joints of the flexible duct work attached to the air handler in the crawlspace to be airtight? And what about that bubbling of the paint in the living room ceiling by the chimney? Is this basement play room next to the dirt crawlspace safe for my children?

Mold illness comes from any indoor environment that is damaged by water intrusion and not just by natural disasters. Yet there are been no standardized, objective methods available to quantify the indoor mold burden in homes.

What would you do if you faced the concerns of three actual patients? (1) You are a new home buyer. You have a history of unusual fatigue, cognitive problems and chronic respiratory problems. Your doctor says indoor mold makes you sick. How can you tell if the beautiful home across town is safe? (2) Now make yourself a 55 year old secretary at a large manufacturing site. Your office had visible mold growth; you were proven to be made ill by re-exposure to the office. Your employer assures you the office has been cleaned thoroughly. (3) Now have three sick kids in a riverfront town in Massachusetts. Your children were told they had Lyme disease, but they didn't get better with tons of antibiotics. Another physician says your kids are sick from exposure to WDB.

How do you know if toxigenic molds are in your indoors? Spend a chunk of cash to bring in an industrial hygienist who takes a few air samples? Spend more money on more samples? When do you pay big bucks for mycotoxin testing?

Face it: Human illness that follows exposure to WDB has moved into daily medical practice, in part because confirmation of causation of human illness is backed by intense scientific research (1, 2, 3). Now that physicians can diagnose mold illness using simple tests and treat mold illness effectively, prospective inhabitants of dwellings all want to know: How can I be assured of safety?

Research has come a long way from earlier thoughts that exposure to WDB wasn't confirmed to be dangerous. A recent paper from the CDC on molds in New Orleans states, "Molds, endotoxins and fungal glucans were detected in the environment after Hurricanes Katrina and Rita in New Orleans at concentrations that have been previously associated with health effects (4)." And in the paper's acknowledgments, "We are indebted... to the US Department of Health and Human Services for ensuring the safety of the sampling teams (4)."

We're glad the CDC has caught up with current research on mold illness. Thankfully, that research gives us answers for the questions posed by our three patients. They can do home sampling for fungal DNA. For less than $500 and in less than 10 days, prospective occupiers of new building spaces have a chance to avoid inhabiting risky interior environments by first using the Environmental Relative Mold Index (ERMI). We know that the DNA testing, will not replace either industrial hygienists or careful home inspection as the best way to ensure safety but now no one interested in safety of a building can skip doing an ERMI.

Why Develop ERMI?

The tests we have used for years to assess mold contamination are flawed. Air samples taken for a few minutes were just a snapshot in time; they didn't actually represent a complete picture of ongoing health risks for occupants. We compared levels of organisms found indoors to outdoors, not distinguishing between genera found. "Mold is mold" was the underlying concept here; we all know that some genera of molds won't cause illness and others do. We tried to establish thresholds for levels of indoor molds but there are so many variables that impact on sampling that reproduction of results is difficult. Spore counts? Not when NIOSH told us that there were toxins on 500 tiny fragments of molds we missed for every spore we found (5). Why not test for mycotoxins alone? Mycotoxin testing has to be thorough, with multiple samples for multiple compounds. Talk about costs!

Thanks to the pioneering work of Dr. Stephen Vesper (6,10) and scientists at the Microbial Exposure Laboratories of the EPA, Cincinnati, we believe the problems involved with indoor testing may be solved. Just look for the DNA!

The development of Mold Specific Quantitative Polymerase Chain Reaction (MSQPCR) and its application called the Environmental Relative Moldiness Index (ERMI) has brought the light of illuminating science into the darkness of indoor mold testing. ERMI is an objective, standardized DNA-based method that will identify and quantify molds. The science behind this breakthrough that led to MSQPCR is continued on page 34.
now patented (US Patent No. 6,387,652). In 2006, the Department of Housing and Urban Development (HUD) used this technology to complete the American Healthy Homes Survey (AHHS). Based on this national survey and MSQPCR analysis of the settled dust in these homes, a national Environmental Relative Moldiness Index (ERMI) was developed.

In the American Healthy Homes Survey, dust was collected in a nationally representative sampling of 1096 homes by vacuuming an area three feet by six feet in the living room and bedroom for 5 minutes, each with a dust sampler-fitted vacuum (Figure 1). The settled dust is collected in a special in-hose device that is sent to a reference laboratory. At the lab, the individual samples are evaluated for quality and reliability against internal standards. Each satisfactory sample is then mixed and sieved through a 300 micron screen. The samples are each analyzed for DNA of 36 species of molds that can distinguish between molds found in WDB from molds found in non-WDB. ERMI doesn't measure DNA of all fungi, just those that describe "relative mold burden" that has validity anywhere in the country.

**WHAT IS THE ERMI**

These 36 species were divided into 26 species/clusters associated with WDB (Group 1) and 10 common species/clusters not associated with WDB, called Group 2. The number calculated as the ERMI is actually the sum of the logs of the concentrations of the DNA of the different species. The "mold index" is the difference between Group 1 and Group 2. The laboratory will report the concentration of the 36 species in your sample (Table 1). The computed ERMI values are graphed from lowest to highest (Figure 2). The scale ranges from -10 to 20. On the y-axis, the percentage of homes that fall into different ERMI percentages is shown. For example, an ERMI of 14 is in the top 25% of homes for relative mold burden. An ERMI of -6 would be in the lowest 25% of homes. Each value is plus or minus three.

**USING THE ERMI**

The ERMI scale was derived from the analysis of the settled dust in the common living room plus bedroom of a home. Even if most of a water-intrusion problem in a home comes from the basement, we won't suggest sampling the molds in the basement first, as all the national standards are derived from sleeping areas and living areas.

So what should our patients do? The ERMI costs several hundred dollars, providing information that is potentially
far better than limited testing done by
an expert whose time can be a large part
of the bill. Each of our patients did home
samples. The beautiful home across
town had a bargain price tag because of
its multiple problems with the roof flashing
by the chimney. An ERMI of 18
saved the patient a mountain of trouble.
The secretary found an ERMI of 0.02.
She has done well after remediation.
The Massachusetts Mom found that her
home was terribly contaminated, even
without visible mold, musty smells or
abnormal air sampling from two prior
mold inspectors. She says to this day that
ERMI saved her children's lives. Maybe
that is too much credit, but the truth is
that her family only now is well.

Make no mistake; presence of health
effects shown by a protocol that evalu-
ates health will always trump an ERMI.
ERMI is a mold index, not a health in-
dex. If the ERMI is elevated, you have
mold trouble. If the ERMI is low and
there are people in the home with a typi-
cal mold illness, consider repeating the
ERMI in different areas. If the ERMI
is low and no one is ill, your sense of
security increases. If you are not ill, an
ERMI helps determine if your home is
safe for visitors and loved ones who
might have a different genetic suscepti-
bility to mold exposure than you do. If
the ERMI value suggests the home is in
the upper 25% of the scale (i.e. ERMI
above 5), then an investigation for wa-
ter damage could be health-saving.

The Institute of Medicine's report (8) on
dampness and health expressed the op-
ion that there was scientific evidence
linking molds and damp environments
with respiratory symptoms. The cut-off
for literature to be considered by the
IOM was 2003; the pace of mold illness
research has long ago outstripped the
earlier IOM recommendations. ERMI
isn't discussed in the IOM.

**ERMI is useful in clinical studies**

In a recent paper (7), ERMI values were
correlated with laboratory assays, symp-
toms, neurotoxicological studies and
measurement of brain metabolites, lactic
ate (indicating capillary hypoperfusion)
and ratios of glutamate to glutamine (in-
dicating the balance of excitation ver-
sus inhibition of neurotransmission).
There was a clear association between
an elevated ERMI and elevated levels
of lactate measured by magnetic reso-
nance spectroscopy (MRS), in hip-
campus (memory) and frontal lobes (ac-
quision), together with reduction of
normal ratios of glutamate to glutamine.
An elevated ERMI was closely linked
to brain fog, memory deficits and ab-
normities in executive cognitive func-
tion.

Do high levels of mold, therefore, trans-
late in genetically susceptible patients
into inflammation that reduces blood
flow in particular parts of the brain such
that the brain doesn't work? Yes! Even
better, (i) following treatment abnormal
brain metabolites are reduced and (ii) the
benefit of treatment maintained with re-
occupancy of the home provided the
post-remediation ERMI is less than 2.
Relapse occurs if the ERMI is higher.

In a study conducted on homes of asth-
matic children by Case Western Reserve,
remediating water-damaged, moldy
homes significantly reduced the asth-
matic child's need for medical interven-
tion (9). In a prospective study of atopic
infants (6), measuring the mold burden
with MSQPCR was a better predictor
for development of wheeze/rhinitis than
the home inspection.

Air samples can be useful to pin-point
the location of a hidden mold problem.
In order to take air samples for
MSQPCR analysis, the polycarbonate
filter is useful with either 0.45 or 0.8
micron pore size. The flow rates range
from 2 to 16 liter/minute. The holder for
the filter can be a button sampler or cas-
cette. In MSQPCR analysis, the filter
cannot be overloaded, meaning air
samples can be taken for prolonged pe-
riods. However, there is no ERMI scale
for air samples; dust is preferred.

**What do we do with the ERMI kit?**

Help is always just a few clicks away at
www.mycometrics.com. First, locate
the most commonly used area in the liv-
ing room. Using a tape measure and
masking tape, mark a 3-foot by 6-foot
sampling area on the floor. Record what
these dimensions were and where you
took them for later comparison. Next,
do the same in the main bedroom.

Take off the protective caps of the sam-
pler. Insert the filter into the dust sam-
pler and place the sampler inside the
vacuum hose. Use a separate dust sam-
pler for each area sampled. Vacuum for
5 minutes, pull out the sampler and cap
it. Send in a sealed bag for an ERMI
analysis at an EPA-licensed ERMI lab-
atory. You should ask for a repeat
ERMI, taken in the same spots as be-
fore remediation to assure clearance.

No sampling can replace the skill of
the experienced mold inspector in investi-
gating mold problems. ERMI is a help-
ful tool. As further research refines the
use and application of ERMI we will
have greater ability to direct use of
ERMI testing.

**Summary:**

Identification and accurate quantitation
of indoor molds to the species level is
now available, using DNA analysis, the
MSQPCR. This automated analysis provides for rapid, reproducible results that can be reliably interpreted. For patients, prospective home-buyers, industrial hygienists and remediation alike, ERMI shows great promise for the future.

Conflicts of interest: Dr. Lin is an employee of Mycometrics. Dr. Shoemaker has none.

References
7. Shoemaker R, Maizel M. IACFS meetings 1/14/07, Fort Lauderdale, Florida.

Ritchie C, Shoemaker, MD is a Family Practice physician from Pocomoke, MD. He writes from his experience of diagnosing and treating the world’s largest series of 5500 patients with acute and chronic illness caused by exposure to biotoxins made by molds, spirochetes, dinoflagellates, and blue-green algae. His practice experience is the foundation that enables him to challenge much of what we hear about chronic illnesses from agencies and academics that don’t treat the illnesses. For more information, contact Ritchie C. Shoemaker, MD, 500 Market St, Suite 102 Pocomoke, Md 21851.

King-Teh Lin, PhD is Laboratory Director at Mycometrics, LLC, Monmouth Junction, NJ. He earned his PhD in Molecular Genetic and Microbiology from Robert Wood Johnson Medical School. Soon after his postdoctoral fellowship, he continued on at the same University as a faculty, up till recruited by P&K Microbiology Services as a Director of R&D, where he was the first to commercialize the EPA-licensed mold QPCR technology and invented a new DNA testing for wood decay fungi. He has analyzed more than 10,000 PCR samples for both fungi and Legionella. His works have been published in many leading peer-reviewed Journals. In 2005, he established Mycometrics, LLC.

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Early Warning System

Hach Company announced it has received Safety Act Designation and Certification from the Department of Homeland Security (DHS) for GuardianBlue— the warning monitoring system designed to help cities protect their drinking water systems from terrorist contamination attacks and real-world events. The Safety Act provides litigation protection for users and their contractors. Their certification signifies the Department of Homeland Security approved the system as anti-terrorist technology. Hach’s certification is based on a review of three years of test data including government testing using actual warfare agents. This Early Warning System is now available for installation into water distribution systems. The early warning monitoring is designed to detect, alert and classify contaminants from cyanide and pesticides to ricin and VX. The system can also detect, alert, classify and study real-world events and unknown contaminants in water distribution systems. This breakthrough capability means that operators can be alerted to threat agents, contamination and operational issues before they spread or impact the entire water system. The GuardianBlue Event Monitor integrates multiple sensor outputs from the Water Panel and TOC Analyzer – the advanced water quality sensors. Every 60 seconds, the system applies a patented algorithm to the sensor measurements, calculating a site’s water quality baseline. The system sends an alert when the trigger signal exceeds a user-set threshold, indicating a water quality deviation. The Agent Library contains many fingerprints of contaminants, including cyanide, pesticides, ricin and VX. The system is also equipped with a Plant Library that learns and reports the reoccurrence of operational events.

As part of the Homeland Security Act of 2002, Public Law 107-296, Congress enacted the Safety Act to provide “risk management” and “litigation management” protections for end-users and manufacturers of qualified anti-terrorism technologies and others in the supply and distribution chain. The Act creates certain liability limitations for “claims arising out of, relating to, or resulting from an act of terrorism” where qualified anti-terrorism technologies have been deployed. For more information contact the Hach Homeland Security Technologies Division, Ph: 800-604-3493 (1-800-604-3493).

New Indicating Transmitter

The new, Model 121 provides a simple, low cost loop powered 8-28Vdc two wire 4-20mA Transmitter for a variety of applications. The new unit features a 1/2” NPT interface with an easy to wire industrial terminal strip and a removable cover.

Accuracy is +2% from 20% to 100% of full scale. Temperature operating range is -20°F to 150°F (-20°C to 65°C). Model 121 also has a push button zero reset feature. Model 121 is available in aluminum or 316 S.S. pressure housing with 316 S.S. and internal ceramic parts. Safe working pressure is 6000 PSIG (0-400 bar) Units are available in different pressure ranges from 0-5 PSID (0.3 bar) to 0-110 PSID (0.7 bar). Benefits Include: Two Wire 4-20mA Transmitter; Easy to Wire Terminal Strip; Weather Resistant Gauge Front For Corrosion Resistance. For more information contact Mid-West Instrument, Ph: 586-254-6500 or Fax: 586-254-6509, Toll Free: 800-648-5778. Say you saw it in Filtration News!