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SUSTAINABLE HOME HEALTH: AN INTEGRATED APPROCH TO ADDRESS MOLD RELATED INDOOR AIR QUALITY AND ILLNESS

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ABSTRACT

Close to half of North American homes contain damp or moldy environments, yet home assessment is not commonly prescribed by health care practitioners in relationship to consequential health effects arising from these poor indoor environmental conditions. To accurately diagnose and treat consequential health impacts a person's health should be viewed holistically as a combined consequence of their genetics, lifestyle, and long term environmental exposures. An integrated, sustainable, systems-based-approach, including home specific medical diagnosis and indoor air quality (IAQ) home assessment should be developed and implemented jointly by the medical profession, the IAQ industry, overseeing organizations, and Governments. If successful, this approach would not only raise awareness and reduce the consequential health effects of indoor mold, but also save significant costs to the affected, the health care system, and to society at large.

Keywords: asthma, damp environments, ill-health, indoor air quality, IAQ, mold.

OBJECTIVES

Residential housing regularly exhibits problems with contaminant hazards such as mold, lead, asbestos, and chemicals stemming from uninformed product selection at the time of construction which can be compounded by improper ventilation and air mixing, insufficient air filtration, water intrusion and extended high internal moisture levels, and lack of habitat care. All these can cause serious health related problems for occupants, but it is the failure to directly address mold and dampness issues that contribute to building-related sickness in indoor environments that has

resulted in hundreds of millions of sick days, emergency room visits, hospital stays and significant reduction in productivity each year (Fisk *et al.* 2001, 2010). The full social impacts have yet to be fully measured.

People in developed nations spend more than 90% of their time indoors with more than half of that time in their home environments (USEPA 1989). Buildings are known to develop long-term IAQ related problems due to poor operation, deferred maintenance, and inadequate building design for pre-described occupant activities (US EPA 2010). Epidemiological studies have shown a link between poor IAQ and asthmatic symptom frequency (NAS 2000, Daisey 2003). A 3 to 15 fold increase was observed in building related disease symptoms and building related asthma from exposure to significant levels of *Stachybotrys chartarum* and *Aspergillus species* from building systems design, construction, and operation protocols that created excess moisture and high humidity levels (Hodgson *et al.* 1998). Dampness is associated with respiratory symptoms (Howden-Chapman *et al.* (2005, 2007). Exposure to indoor molds produced respiratory disease in humans thru both allergic and non-allergic mechanisms (Hope and Simon 2007) and particularly asthma symptoms (Jaakkola and Jaakkola,2004).

The purpose of this paper is to: 1) expose the disjoint between indoor air quality (IAQ) based illness and medical diagnosis; 2) bring awareness to home specific assessment to create a holistic approach to addressing mold related indoor air quality and illness; and, 3) integrate medical, site assessment, and IAQ products and services to develop a sustainable approach to combat mold-related health impacts.

METHODS

A review of the literature was conducted, including peer reviewed journal papers found using the academic search engines, Web of Science, Compendex, Pubmed, Google Scholar, and from specific journal tables of contents, public web-based general literature, and industry sources. Where research lacked, IAQ service and product information was gathered through interview and data collection in the Okanagan, British Columbia, Canada.

RESULTS

Health effects from mold

Of the household environmental issues determined by regulators, mold and its effects are the least defined, but can be a significant cause, and therefore indicator, of present and potential occupant ill-health (CMHC 2011). Qualitative evidence indicates moderate levels of mold types in buildings can cause significant health impacts to otherwise healthy individuals and reduction in mold quantity and type reduces that effect (Fisk 2010). At present, no minimum standard or quantitative prescription exists for acceptable levels of mold or mold types in buildings (Lawrence

and Martin 2001). The lack of a quantifiable disease connection to indoor mold may in part be due to the broad use of the term "mold" which comprises a wide category of specific organisms that may or may not be present or elicit illness in individual humans. Molds are microscopic fungi that are highly adapted to grow and reproduce rapidly in damp to semi-damp environments. Fungal colonies produce spores and hyphae that generate allergens, microbial toxins (mycotoxins or biotoxins), and microbial volatile organic compounds (MVOC) through the mold lifecycle. Specific molds cause allergenic reactions in some humans and pathogenic (a significant health concern) reactions in others. High levels of airborne mold affect most of the population to varying degrees (USEPA 2014); but those who are more seriously affected are the environmentally sensitized, immune compromised, or those with under developed immune systems, particularly the elderly andchildren (Simoni*et al*. 2005, Antova*et al.* 2008, Tischer*et al.* 2011). A higher level of exposure to living molds or a higher concentration of allergens on spores and mycelia results in a greater likelihood of illness, although levels and limits that cause illness are not known (Brandt *et al*. 2006).The term 'mold' refers to all species of microscopic fungi that grow in the form of multicellular filaments, called hyphae (WHO 2009).

Depending on the type and amount of mold present in a home, the amount and degree of exposure, and the health condition of the occupant, health effects can range from insignificant short term effects to significant allergic reaction and illness (CMHC 2011). These consequences include asthma, allergies, hypersensitivity disorders, rhitonitis, and severe respiratory infections (Lawrence and Martin 2001, Jaakkola*et al.* 2002, 2004, Park *et al.* 2004, Jacques 2011). The prevalence of respiratory symptoms was consistently higher in homes with reported molds or dampness, averaging 37.8% in the 13,495 homes surveyed (Dales *et al.* 1991). Statistically, 21% (95% [CI], 12-29%) of current asthma is attributable to mold/ dampness in US homes with a 30-50% increase in respiratory health outcomes (Sahakian*et al.* 2008). Alternately, 4.6 million current US asthma cases of the 21.8 million people reported to have asthma were attributable to dampness and mold. This poses a significant public health risk (Mudarri and Fisk 2007) and social impact. Overall the societal cost in north america is estimated at $61 billion annually.

Indoor Environments

It is recognized that between 20-50% of North American homes have damp or moldy environments (Verhoeff and Burge 1997, Zock 2002). Poor maintenance and substandard construction practices lead to high levels of moisture and the proliferation of toxic molds (Singh 2010). Removal of molds and dampness from homes has a positive effect on the health of occupants. Symptoms of asthma and rhinitis improved and medication use declined following

removal of indoor mold in homes (Burr *et al.* 2007). Toxic mold development from dampness has been identified as a major contributor to poor health as evidenced by the improvement of health upon relocation (Shaw *et al.* 1999, Lawrence and Martin 2001), upon removal of molds and dampness (Kercsmar*et al.* 2006, Bernstein *et al.* 2008), and by ultraviolet (UV) irradiation remediation (Burr *et al.*2007).

From the author's professional experience, household mold fears causing adverse health effects were verified as the primary concern of occupants from 600 hundred site services conducted between 2002 and 2012. Reports of long-term flu-like symptoms were prevalent. These were conducted after the occupant made contact for advice pertaining to concern of potential mold growth and consequential health impacts. For clients who did not pinpoint mold as a primary concern, on subsequent investigation, mold was determined to be a possible cause or potential cause of their health concerns. In approximately 25% of cases, IAQ inspection requests came after failure of medical or hospital visits, subsequent medical testing or after the purchase of IAQ equipment such as ionizers, UV irradiation, and portable HEPA cleaners, to resolve their health concerns. A large proportion of inquiries came from young mothers or mothers-to-be with concerns about potential mold related issues such as black staining that ultimately were not a health concern to the investigator. This suggests an acute awareness of the general public towards mold as a health effect, but also confusion on the cause, proliferation, and effects of mold in indoor environments, in the general solutions available, and on the best methods to be taken towards the development of appropriate health based solutions. Resolving real indoor environmental issues is critical to the health and well-being of occupants. These concerns are now supported by studies that positively associate mold exposure to respiratory ill-health (Koskinen *et al.* 1999, Etzel*et al.* 1999, Bornehag*et al.* 2004, Fisk *et al.* 2007, 2010, Hope *et al.* 2007, Antova*et al.* 2008, Mendell *et al.* 2011).

Illness assessment

In general, poor health from mold exposure is often misdiagnosed as flu-like effects (Bornehag*et al.* 2004, Health Canada 2007, Wu et al. 2007, Palaty and Shum 2009, Mendell *et al.* 2011). The first step in assessing the health of an individual is typically a visit to a family physician. The symptoms typically passed off as flu-related or diagnosed as a general, non-specific allergic reaction, with the treatment tending towards cold, allergy, and flu medication and, initially, a wait and see approach taken. Health assessment in relation to specific indoor mold environments is not generally included in medical curricula nor in the procedures generally laid down in medical practice (Lawrence and Martin 2001). The medical profession, in general, continues to assess the health affected person independent of their environment (Wu *et al.*

2007) which can lead to delay in diagnosis, misdiagnosis or in the worst case, non-diagnosis when the home environment plays a role in the health problem. Table 1 identifies the elements in the provision of a holistic medical patient service considering all aspects of their condition. The absence of professional home IAQ assessment is clear.

Table 1: MEDICAL PROFESSION FOCII

Professional Service Providers	Medical treatment	Home assessment	Mold specific assessment	Environmental focus
Family doctor	yes	no	no	no
Walk in Clinic	yes	no	no	no
Allergy Specialist	yes	no	yes	yes
Naturopath	yes	no	yes	yes
Respiratory therapist	yes	no	yes	yes

There have been some efforts to advance mold related illness awareness within the medical profession. Findings, such as those published by the University of Connecticut in tandem with the US Environmental Protection Agency (US EPA) (Storey*et al.* 2004), assist health care providers in understanding how mold from indoor environments adversely affects the health of occupants. But as of yet these findings are not incorporated into general medical curriculum nor hospital/ medical procedures to positively affect how building related mold issues are being addressed clinically.

Residential IAQ Professional assessment

The use of science-based environmental assessments to remedy regulation failures in commercial/public (i.e. non-residential) environments is necessary by regulation (e.g. Work safe BC). Qualified environmental professionals (QEP) such as Professional Engineers and industrial hygienistsare called upon to determine the extent of environmental impact, prescribe corrective measures based on industry regulations, oversee the cleanup, and certify environmental compliance. This does not translate to the private residence on account of privacy laws. Needless to say, with such a high percentage of damp and moldy homes, this is a serious impediment to quality of life.

In addition, opinions vary widely on what investigative and testing methods are necessary, as well as what constitutes an unhealthy environment based solely on mold level in a home. There is no specific criterion that defines either safe or unsafe mold exposure. Some experts have proposed airborne mold guidelines; however none of these have been adopted by regulatory agencies. For example, CMHC's perspective that a visual only assessment is sufficient to determine IAQ related health issues in a home differs from research that indicates air testing for mold is a good indicator of indoor air quality in building environments (Cabral 2010).There is, though, suggested means and methods that take into account the health and well-being of the occupant prescribed in reference documents such as the New York State IAQ protocol (NYSTMTF2010), EPA IAQ protocol (USEPA 2014), and Canadian construction association document (CCA) 82 to name a few. These outline the cause of mold proliferation, the possible and probable health effects, and describe remedial solutions to reduce or abate health consequences. A proper assessment should take into account these reference documents, while describing the existing indoor environment and how it can be made healthier through prescriptive means.

Specifically, this assessment should include, at minimum, a comprehensive check list conducted by a QEP with issue description and a corresponding ratings scale, and remedy. This, backed up with lab analysis of the indoor molds present, would help to support IAQ recommendations.

Indoor air quality service and product industry

The professional consultant approach can be expensive and complicated, and the health affected occupant usually has neither the willingness or necessary time and money (Wellington 2005, U.S. EPA 2014). The less daunting and increasingly available approach is to seek IAQ related products and services directly. Products include portable air purification systems, self-administered mold testing, air scenting agents, and air "freshness" products. Product services include carpet and duct cleaning and whole house customized air filtration and mechanical ventilation systems. The IAQ product and product service industry have developed and evolved through an unregulated business environment and to some extent is based on lowest price and salesmanship. As such, gathering information to make an informed decision can be fraught with confusing alternatives, competing designations, and value judgments which may lead to misinterpretation of environmental requirements, improper diagnosis, and costly misdirection (Lawrence and Martin 2001). Table 2 is a summary of service providers competencies deduced from industry review.

TABLE 2: HOME IAQ SERVICE INDUSTRY FOCII

Products and Services	Are services science based?	Third party accredited?	Primarily client health focused[2]?	Client health relevant?[3]	Cost range
Envir. Consultant	Yes	Yes	Yes	Yes	$1,000 – 5,000
IAQ Consultants	Yes	Yes	Yes	Yes	$500 – 1,000
IAQ products	Possibly	No	No	No	$ 300 - 2,000
Service providers[1]	Possibly	Possibly	No	Possibly	$ 200 – 5,000

Notes: 1 Service providers install IAQ products, but may not be accredited third party professionals
2 Product and non-accredited service providers are usually not qualified to offer health specific solutions and refer to an Environment consultant or do not include client health assessment in product or service delivery.
3 Product and general service providers tend to focus on generic solution provision where specific client health issue is not addressed.

Consumer marketed IAQ products include: portable and fixed, room and whole house air purification systems; low VOC construction products; non-lead based products; and non-chemical, biodegradable cleaning products. As the marketplace for IAQ products is not generally regulated, unsubstantiated claims can be made. Chemical cleaners may be marketed as "mold killers" for example. Scented consumer products and air freshener/masking agents are found in homes that can directly or indirectly mask mold related indicators and otherwise obvious odours that could indicate an active biologic environment. The efficacy of the use of home air fresheners and scented laundry products were examined by a University of Washington study and found to be potentially health affecting at best and toxic or hazardous by US federal law at worst(Caress and Steinemann 2004).The University of California at Berkeley performed a study on air fresheners and household cleaners that discovered ethylene-based glycol ethers, classified by the EPA as hazardous air pollutants (Science Daily 2006). Without product standards and regulated warnings on those products containing chemicals or masking devices consumer confusion can lead to misinformed decision-making.

Product and service providers have found an increased consumer awareness of indoor environmental issues that could be leveraged into product sales by utilizing indoor air quality terminology. Of significant concern is households that include environmentally sensitive occupants, where IAQ based renovation work was found to be exaggerated due to lack of building science and indoor environmental focus. This supports a concern that IAQ based product and service agents may inadvertently take

advantage of homeowner fears to realize increased business opportunities.

TABLE 3: COST OF SERVICES

SERVICE	Low end cost	High end cost	Average
Duct Cleaning with anti-fungal agent	$200	$ 500	$ 350
Carpet Cleaning with anti-fungal agent	$250	$ 450	$ 350
Air Purification equipment - central	$ 1,000	$ 5,000	$ 3,000
Air purification equipment - portable	$ 500	$ 2,000	$ 1,250
Major mold abatement (2000 sf house)	$ 5,000	$ 25,000	$ 8,000 – 15,000
Light mold abatement (2000 sf house)	$ 1,500	$10,000	$ 4,000
Basic mold testing	$ 300	$ 600	$ 450
IAQ Consultant w/ written site assessment	$ 200	$ 600	$ 400
IAQ consultant incl. air testing for mold	$ 500	$ 1,200	$ 850

The cost of various services is provided in table 3 based on general trade information from the Okanagan valley region of British Columbia. With cost a key driver in the decision making process towards undertaking environmental assessment and product and service purchase, homeowners led to choose the most economical and perhaps less overall capable solutions. Product suppliers provide non-personalized simplistic IAQ based solutions through industry specific products and services denoted above. The adverse effects of IAQ are not a simple or generic problem–solution couplet. In fact determining IAQ solutions is a complex process (Cabral 2010); an

approach that exposes the cause, determines the specific effects, and engineers a solution that endures - a solution that is sustainable. This sustainable solution usually requires house specific professional IAQ input for accurate validation of indoor environmental cause and effect. Understanding environments accurately requires rigor and a thorough assessment using the scientific method. IAQ solutions necessarily include an understanding of all aspects of the building's indoor air quality both by visual assessment and, as required, by lab based sampling methods. This is missing in generic products and product oriented services that are not based on specific homes and occupant conditions. In short, products and services that are obtained without professional environmental assessment likely do not address the underlying problems associated with environmental impacts, leading to continuing failure in resolution of the problem.

Regulation based IAQ solutions

Federal government legislation regulated through the Canadian Department of Justice Occupational Health, and Safety, and, the US department of Labor Occupational Safety and Health Administration makes employers responsible for the health and safety of their workers in workplace environments. However, others do not regulate the residential environment under any active IAQ standards in either Canada or the USA.

Work safe BC (2014) manages the regulation of the health and safety of workers in indoor environments in British Columbia by charging employers with this responsibility. Work safe BC audits employers, and conducts incident assessments to ensure solutions are applied and remedies proven. In the workplace, it is accepted that mold, perceived or visible, can cause sickness and regulations require thorough professional assessment and remediation upon complaint to meet Work safe BC (2014) criteria in commercial and public spaces. For example, the response and recourse for a worker who develops sickness on the job is overseen by a certified occupational health specialist, who takes into consideration the materials of the trade, within the worker's environment. Residential environments have no such regulatory criteria. The residential Tenancy Act and ombudsman do not have sufficient regulatory power or funding to protect tenants from hazardous indoor environments. Local municipal authorities typically will not act on tenant environmental complaints, claiming lack of legal clout. Law enforcement will not intercede between landlord and tenant unless a criminal act has been perpetrated.

This lack of oversight is exacerbated by a lack of awareness of building owners and a limited access by knowledge based organizations for verification and assessment purposes. For example, in 2013 over five million homes transferred ownership in North America (CREA, NAR

2014), with many of those reviewed by professional home inspectors, yet mold identification and assessment is specifically excluded from home inspection protocol (ASHI, CAHPI 2014). Many millions more homes go through municipal permitting for additions and renovations that would allow IAQ assessment to complement the building official inspection and verification process, yet audits are not required.

Government and NGO based IAQ initiatives

If the health affected seeks IAQ solutions directly through internet search engines, they will find that government agencies such as CMHC, Health Canada, HUD, EPA, state websites, and non-government organizations (NGOs) have now added significant IAQ support information to their websites (Google 2014). The sites in general deliver to the observer "how to" knowledge on various defined indoor air quality subjects that provide guidance towards better IAQ in the home in general. Refer to Table 4 for a relevant list of reference websites and Table 5 for Government and NGO literature references. The general web searching population identifies "mold" as the most significant public health issue in terms of 'web hits' at 16.1 million (Google 2014). The significant term "asbestos" registered less, at 5.7 million web hits compared to 1.6 million for volatile organic compounds (VOC) and 1.0 million for radon, with other serious and significant IAQ subject matter lagging far behind. The author believes this is a relevant indicator of awareness concern levels between these hazards. Yet, most residential clients with mold related health concerns have little knowledge as to how their mold problem was caused or how it could be remedied. There is concern but little knowledge. This appears to indicate that consumer awareness programs have been effective in creating awareness to the point of concern, but are ineffective in transferring relevant knowledge to those affected to assuage ill-conceived concerns.

There have been breakthroughs though as healthy homes initiatives are being promoted in a broader US Federal Healthy Homes program. This includes the effects of mold and asthma triggers that have shown some effectiveness in modifying individual's traits towards internalizing IAQ initiatives (Brown *et al.* 2010). As well, the US Department of Housing and Urban Development (HUD 2003), the EPA, and state legislators appear to be set to codifyat least the environmental mold aspect of IAQ (Indoor Environment 2012). Florida and Virginia, and other states have recently enacted (and then repealed due to cost cutting measures) a law regulating mold assessors that may ultimately require the setting of minimum specific fungal count levels as the regulations get tested legally (Indoor Environment 2012). Note that this regulation was not for the overall IAQ of a home; but only pertains to mold testing assessment. Regulation, even to a limited extent, can ensure indoor environments meet a standard that can be measured. This can

then support the development of a sustainable initiative for better IAQ in homes.

In 2008, the Government of Alberta instituted a regulation of residential tenancies that included identifying and directing the remedy of poor IAQ environments specifically due to mold growth. The initiative had no punitive force behind it and recently has been reduced to providing recommendations only. Moreover, no assessments or studies have been conducted to verify whether prescribed remedies were undertaken or whether tenants were better off after the intervention. This information is useful to validate what is already confirmed and proven in commercial environments: base line indoor air quality standards must be met; and when not, remedy is necessary for the health of the occupants.

In addition to federal, state/ provincial IAQ regulations, the ideal of IAQ residential building assessment for the public good can be found in a few municipality level initiatives and studies. One such program is outlined in HUD's *Healthy Homes – Assessing Your Indoor Environment* which introduced a program in New York State called the "Cooperative Extension Office" (HUD 2007). Within this outreach, educators respond to resident indoor air quality concerns by visiting the home, conducting a visual assessment with the homeowner, advising them of health and safety hazards, and making specific recommendations to correct described IAQ issues. Further research on the costs associated with the initiative should assist in developing an overall social cost benefit value to the program. This could form the basis for a sustainable community-based IAQ resource program.

Although these types of consumer education programs are available in the US, they have limited effect, as many regions, municipalities, and districts cannot enforce regulatory limitations towards any type of home intervention. Government regulations and intervention programs to correct residential hazards have long been rebuked by civil liberties groups, private citizens, landowners, and the courts. There have also been many Government funded pilot projects and studies throughout the years that have introduced homeowners to indoor environmental issues and how to economically improve their indoor environments (US EPA 2007). Unfortunately, pilot projects have unsustainable long term funding models and built-in short term focus with little to no monitoring, assessment, or strategic follow-up.

An integrated approach utilizing the health care system

An integrated approach to bridging the gap between patient medical requirements, medical and industry support methods, and home indoor environment realities could include a framework that would focus the

medical profession on an indoor home environment data capture diagnosis approach and the IAQ service industry on a health-based approach both based on good science (population health and epidemiological data) and regulation. Proactive measures to the challenges facing mold affected occupants can also be solutions that may well reverse spiraling health care costs by reducing reactive treatments. Moreover, by taking a proactive approach to identifying patients that may be environmentally affected and undertaking on-site prescriptive measures that positively reduce their health impacts due to mold and dampness, the cost of their healthcare may be significantly reduced. To facilitate this proactive approach the medical profession can more thoroughly prepare medical practitioners through enhanced education and training and by providing key insights to indoor mold related issues to better demonstrate the effects of environmental impacts on their patient's health. Supporting methods in the developmental stages, such as, use of flow charts and decision trees that describe cause and effect relationships between mold exposure and ill-health, could assist front-line doctors in increasing precision and accuracy of diagnosis and treatment.

The home inspection industry and other service providers who undertake residential inspection programs can be trained and better resourced to identify environmental indicators of potential ill-health conditions with simple yet effective protocols and general solution based recommendations undergirded by developing science based assessment methods. A standard environmental assessment protocol, taking into account criteria set out above, can be developed for site condition and for test results assessment. Importantly, though, accurate medical evaluation is required to establish the validity of site assessment protocols (Lawrence and Martin 2001).

Further, literature shows that where clinical tests failed to identify cause, site air testing did find the cause of ill-health in patients (Cabral 2010). This underlines the interdependency as well as importance of a symbiotic professional relationship between medical and IAQ professionals in assuring the most accurate and useful diagnosis for the affected person is provided. Training municipal building officials to identify poor indoor environments and giving them the means and methods to address tenant health and environmental complaints with enforceable measures can help to resolve long standing issues with substandard housing stock in our communities. Further, adding mold assessment criteria (perhaps the same decision tree protocol noted above) to the municipal building permitting and verification process would help identify homes that require environmental upgrading based on existing occupant health impact characteristics. Using Government policy oversight by enacting regulations in the form of standards of practice and codes of conduct for product service providers for home environments, substandard living

conditions can be brought to light for remedial repair. The extent of substandard indoor environments can only be broadly estimated, but can be significant. All these methods, early awareness and accurate diagnosis, professional assessment and medically aligned prognosis based on of indoor environments, regulation of IAQ products and services, and Government and industry oversight, can form an integrated, systematic approach towards the reduction of mold affected environments and occupant ill-health.

Concluding remarks

The prevalence of mold and damp environments in North American housing stock can be a significant source of ill-health in occupants. Manifestation of mold related ill-health can take the form of influenza-like respiratory symptoms that can mask mold related disease as a primary cause. This can delay site verification and accurate diagnosis for an extended period of time if not indefinitely. Inadequate and disjointed responses involving health care professionals, health authorities, government policy analysts, IAQ professionals, IAQ products, and IAQ service providers exacerbates the challenge in identifying and remediating unhealthy indoor environments and misses the mark in educating and training the public at the most appropriate time – when they are being affected by their indoor environment.

Access for building occupants to permanent residential IAQ solutions to ill-health is contingent on

1) proper initial direction,

2) accurate medical responsiveness,

3) regulation of the products and services directed at the home environment,

4) better awareness of IAQ industry product and service pitfalls,

5) affordability,

6) availability of proper professional investigative services, and

7) lifelong training and education.

Early access to readily available, science-based information from an economical baseline assessment of the home environment can assist in advancing health related issues toward sustainable solutions.

The review of literature found a proliferation of recent research on this subject that indicates a broadening academic acceptance of a stronger association between mold and ill-health in indoor environments. This bodes well for the development of solutions to better diagnose indoor environment-based illness in a timely manner to benefit the health afflicted and society at large. A sustainable solution encompasses proper thorough professional assessment, prudent environmental cleanup methods, appropriate industry regulation, enhanced homeowner awareness and training, economic prudence,

and verification of effects. This sustainable solution by definition must include a strong business case to provide economic justification to support shifting the burden to a societal collective from the individual, to overcome an historic societal pattern of non-recognition and non-action. The details will be left to future research.

Solutions to reversing spiraling health care costs for reactive treatments are possible through an integrated systems-based approach between health care providers, the medical profession, IAQ professionals, and the product service industry. This paper offers some scenarios to assist this effort.

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US Environmental Protection Agency (US EPA): www.epa.com

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Health Canada: healthcanada.ca

Healthy Habitats: www.habitats.com

Healthy Home Partnership: www.healthyhomespartnership.net

Healthy Dwellings: http://healthydwellings.com

Healthy Homes IAQ: www.HealthyHomesIAQ.com

IAQ Resources Canada: www.iaqresourcescanada.com

IAQA: IAQA.org

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National Center for Healthy Housing: www.nchh.org

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CMHC The Clean Air Guide: How to Identify and Correct Indoor Air Problems in Your Home1997 cat # NH15-83/1998E

Gov't of Canada Hazardcheck – Hazards in your Environment 2010 ISBN: 978-1-100-14721-5

US HUD and US Dept of Agriculture Healthy Homes – Assessing Your Indoor Environment

US HUD Help Yourself to a healthy Home

IAQ Resources Canada Mold Resource Kit: Residential Assessment and Cleanup

John Hopkins Univ. Press 2001My Home is Killing Me

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