Multiple Chemical Sensitivity (MCS): The Controversy and Relation to Interior Design

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Abstract

Objectives

It is important for designers to become knowledgeable on multiple chemical sensitivity (MCS) as it relates to indoor air quality (IAQ). It is also important to design spaces and specify materials for the built environment that promotes good IAQ.

Theoretical/conceptual framework

MCS is a condition in which a person reports sensitivity or intolerance to a number of chemicals and other irritants at very low concentrations (EPA, 2003). Within the medical community, MCS has been controversial and still is today regarding its name, definition, diagnosis, and treatment. Some physicians consider MCS a psychological illness or phenomenon, while others physicians and clinical ecologists treat patients with MCS. However, research indicates that many individuals have become ill from chemicals emitted from materials within interior spaces.

Summary of Analysis

A consensus on MCS within the medical community is essential. The relevance of MCS for the design community is that many materials used in building construction, interior finishes and furnishings, and products for installations contain chemicals that may trigger MCS. Therefore, it is essential that designers specify safe, healthy materials.

Conclusions

Since many designers (architects and interior designs) are working to improve IAQ, they could take the initiative for change by working collaboratively on research with the medical community and individuals with MCS; by educating other designer about appropriate product specifications; and by becoming a legislative advocate.

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Introduction

In the 1940s, people were experiencing health problems and becoming ill; poor indoor air quality (IAQ) was recognized as the source. The illness has many names, but the most commonly used term is multiple chemical sensitivity (MCS). MCS is "a condition in which a person reports sensitivity or intolerance . . . to a number of chemicals and other irritants at very low concentrations" (EPA, 2003). Patients experience numerous symptoms caused by environmental factors. In the 1940s, Theron G. Randolph, M.D., developed the concepts underlying MCS. During his lifetime, he worked with patients to determine the cause of their symptoms and to aid them in their recovery (Barrett & Gots, 1998; Randolph, 1945; 1947; Randolph & Moss, 1982). His ideas were not without controversy; however, and even today, many physicians in the medical community are skeptical about MCS (Barrett & Gots, 1998).

Their skepticism stems from the lack of consensus on a name for the condition; an agreed-upon definition of the condition; and specific criteria for prevention, diagnosis, and treatment of MCS. The lack of research to develop diagnostic criteria and tests for MCS continues to stymie the medical community's response to MCS (Barret & Gots, 1998). However, in 1999 definitive criteria for identifying MCS were proposed by a group of medical professionals (Bartha, et al., 1999). Some research has been conducted to validate these criteria, the symptomatology of patients, the effects of interior materials (e.g., carpet), and other aspects of MCS (Caress, Steinemann, & Waddick, 2002). Some medical professionals express concern about the lack of progress in MCS research (Gist, 1999).

Within the medical community, a wide range of opinions exists regarding the treatment of MCS. Some physicians believe the condition is psychological (Kerns, 2001; Magill & Surda, 1998; Winterbauer, 1997), while others call it a phenomenon (Barrett & Gots, 1998). Some physicians and clinical ecologists will treat patients with MCS (Barrett & Gots, 1998; Kutsogiannis & Davidoff, 2001; Winterbauer, 1997), but often the condition is misdiagnosed or under diagnosed (Kutsogiannis & Davidoff, 2001). In the legal community, MCS is also controversial. Cases are being brought into the legal system that involve MCS related to IAQ (McDonald, 2002; Winterbauer, 1997). However, issues that make cases difficult to win are the lack of definitive criteria (McDonald, 2002; Winterbauer, 1997), and the lack of support by some doctors for patients' legal claims (Duff, 2001).

Within the design community, concern for designing a safe, healthy environment for clients is common. The terms, "green" or "sustainable" design are used to describe the creation of safe, healthy environment that meets today's needs without compromising the needs of

future generations (IDEC, 2003). One aspect of "green" or "sustainable" design is IAQ. Designing safe, healthy environments is part of the professional code of ethics (ASID, 2003), which leaves little doubt that designers need to design spaces for people with MCS. Though some designers specify products for people with MCS, others do not because of the lack of education (Haberle, n/d). It is important to realize that furnishings (e.g., carpet, synthetic textiles) chosen for interior environments may contain VOCs, which off-gas into the interior. These VOCs may greatly influence IAQ, and IAQ is the key factor that affects people with MCS (AIA, 1997; Anderson, 1997; Williams, 1997).Thus, it is important for designers to know the causes and symptoms of MCS to avoid triggers and decrease exposures to toxic chemicals. Since this is the case, designers (architects and interior designers) should take the lead by becoming educated on good IAQ; designing spaces and specifying materials that are safe for people with MCS; becoming involved in research to further promote good IAQ, and becoming an legislative advocate for people with MCS.

The purpose of this study is to review the existing literature on MCS as it relates to IAQ and the controversy regarding MCS. Based on the findings of this review, implications for and suggestions regarding the design community's possible role in research, education, and legislative advocacy are presented.

Review of Literature

Background

Multiple chemical sensitivity (MCS) is used to describe people who experience numerous symptoms related to environmental factors (Barrett & Gots, 1998). In the 1940s, Theron G. Randolph, M.D. believed that some of his patients became ill from exposure to an [unnamed] "substance at doses far below the levels normally considered safe" (Barrett & Gots, 1998, p. 5). Dr. Randolph stated that various environmental factors were attributed to allergies in children, resulting in symptoms that included fatigue, irritability, behavior problems, depression, confusion, and nervous tension (Barrett & Gots, 1998; Randolph, 1945; 1947). These children were allergic to food additives as well as other contaminants such as cleaning solvents, scented products, and tobacco smoke. In the 1950s, Dr. Randolph proposed that synthetic chemicals were causing a new form of sensitivity in humans (Randolph & Moss, 1982). He was concerned not only with foods but also with a variety of environmental chemicals. He found that exposure to formaldehyde caused a variety of symptoms. Formaldehyde resins are frequently used in building materials such as plywood, paneling, and particleboard as well as in textile manufacturing. Over time, Dr. Randolph and his followers gave the condition many names.

Names for and Definitions of MCS

The multiplicity of names for MCS reflects some of the confusion regarding this condition and has raised questions on its authenticity from skeptics such as Barrett and Gots (1998). Even the Environmental Protection Agency (EPA) is unsure of its position on MCS because of the diverse views found "among medical professionals about the existence, causes, diagnosis, and treatment of this condition" (EPA, 2003). A variety of names are

still used for the condition referred to as MCS; however, by the late 1980s, the term "multiple chemical sensitivity" had been coined by Mark Cullen, M.D., a Professor of Occupational Medicine at Yale University (Barrett & Gots, 1998) and is the term now most frequently applied to the condition today (EPA, 1994).

There are not only a variety of terms for the condition but also a variety of definitions (EPA, 1994). Various groups such as the EPA, authors of healthy environment books, and medical researchers have proposed a definition for MCS. The EPA describes MCS as "a condition in which a person reports sensitivity or intolerance . . . to a number of chemicals and other irritants at very low concentrations" (EPA, 2003). Bower (2000), a designer and builder, and the author of *The Healthy House,* defines MCS as an increased sensitivity to many chemicals—especially petro-chemicals and their derivatives—that may be encountered daily.

Likewise, medical professionals have used various definitions. Tarlo, et al. (2002) state, "Multiple chemical sensitivity (MCS) is a clinical description for a cluster of symptoms of unknown etiology [contributing causes of an illness] that have been attributed by patients to multiple environmental exposures when other medical explanations have been excluded" (p. 669). Thivierge (1999) provides the definition used in the *Gale Encyclopedia of Medicine*, which states that MCS is a "disorder in which a person develops symptoms from exposure to chemicals in the environment. With each incidence of exposure, lower levels of the chemical will trigger a reaction and the person becomes increasingly vulnerable to reactions triggered by other chemicals" (p. 1953). Kerns (2001), author and professor of medical ethics and philosophy, defines MCS as "an acquired condition characterized by more or less severe symptomatic reactions in a wide variety of organ systems, to low levels of common ambient toxicants" (p. 52).

Dr. Mark Cullen (1987) developed a definition for diagnosis—seven diagnostic criteria: (1) some documentable environmental exposures, insults, or illness at onset; (2) symptoms affect more than one organ system; (3) symptoms recur and subside in response to predictable stimuli; (4) symptoms occur when exposed to different chemicals and toxins; (5) symptoms are caused by proven exposures; (6) exposures that produce symptoms must be very low (far below average levels); and (7) no common test of organ-system function can explain symptoms (p. 657-658). According to Dr. Cullen (1987), the criteria should not be restrictive and describe a sizeable patient population, as there are many patients who meet "some but not all of [the criteria]" (p. 658).

In 1989, a consensus began emerging among 89 medical professionals (clinicians and researchers) experienced in the "study, evaluation, diagnosis, and/or care of adults and children with chemical sensitivity disorders" (Bartha, et al., 1999). Based on a 1989 multidisciplinary survey of these medical professionals, criteria defining MCS were identified. Ten years later, the top five consensus criteria were still unrefuted in published literature. The definitional criteria are as follows: MCS is "[1] a chronic condition [2] with symptoms that recur reproducibly [3] in response to low levels of exposure [4] to multiple unrelated chemicals and [5] improve or resolve when incitants are removed" (Bartha, et al., 1999). In 1999, a sixth criterion was proposed: "requiring that symptoms occur in multiple

organ systems. These criteria are all commonly encompassed by research definitions of MCS" (Bartha, et al., 1999). The groups' recommendation was "that MCS be formally diagnosed . . . in all cases in which the [six] . . . consensus criteria are met and no single other organic disorder . . . can account for all the signs and symptoms associated with chemical exposure" (Bartha, et al., 1999).

MCS seems to be emerging most consistently as the name for the condition, and research studies, similar to the McKeown-Eyssen, et al. study, are moving the medical community toward a definition. The definition that seems to be emerging is "a chronic condition with symptoms that recur reproducibly in response to low levels of exposure to multiple unrelated chemicals [and the conditions] improve[s] or resolve[s] when incitants are removed [and that] requiring… symptoms occur in multiple organ systems" (Bartha, et al., 1999).

Symptoms Triggered by Exposures and Synergistic Reactions

Exposure to a chemical or other substance may trigger MCS symptoms. Exposure may occur in one of two ways: either in one phase—exposure to high doses of a chemical in a short time may trigger symptoms—or in two phases—exposure to low doses of a chemical over a longer period of time, and then later, exposure to another chemical or other substance triggers symptoms (Gist, 1999; Thivierge, 1999). Miller (1994) suggests that the two-phase exposure includes an onset followed by spreading—additional exposures.

There are several theories on what takes place during exposure. One is that the initial exposure disrupts the immune system. Another theory is that exposure affects the central nervous system. Another theory is that both of these factors, as well as a psychological component, cause MCS to develop (Miller, 1994).

The chemicals that trigger symptoms also are separated into onset and spreading phases. In the onset phase, a person is exposed to chemicals such as adhesives, chlorine, disinfectants, formaldehyde, freon, landfill emissions, pesticides, and petroleum-based products. In the spreading phase, additional exposures seem to further sensitize the individual to low levels of a variety of chemicals or substances. During the spreading phase, the list of chemicals and products that can trigger symptoms is very broad and can include aftershave, air fresheners, carbonless paper, chlorinated water, cologne, copy machines, deodorant, dry cleaning solvents, car exhaust, fabric softener, fumes from roof tar and roads, glue, ink, laser printers, mothballs, nail polish and remover, newsprint, tobacco smoke, perfume, permanent press clothing, plastic, plastic containers, potpourri, shampoo and other scented hair and body products, soap, correction fluid, stain proofing products, synthetic textiles, veneered wood, and vinyl shower curtains. Even ingesting certain substances, including food additives and preservatives, alcohol, caffeine, food sweeteners, medicines that include aspirin, and synthetic vitamins may trigger symptoms (Meggs, 1999; Miller, 1994). It is important to note that designers specify products that include the use adhesives and stain proofing as well as synthetic textiles and veneered woods. Exposure to chemicals from such interior products as polyester (a synthetic textile) may trigger symptoms of MCS

One class of chemicals that trigger symptoms is volatile organic compounds (VOC), which are "compounds that vaporize (become a gas) at room temperature" (EPA, 2003). VOCs are natural and synthetic organic compounds (Godish, 2001) and include formaldehyde, pesticides, solvents, and cleaning agents (EPA, 1994; Wittenberg, 1996). Other types of chemicals that are suspected of triggering symptoms include petrochemical fuels (diesel, gasoline, and kerosene); household products (waxes, detergents, and cleaning products); latex; tobacco smoke; personal care products (perfumes and fragrances); and artificial colors, flavors, and preservatives (EPA 1994; Gist, 1999; Thivierge, 1999; Wittenberg, 1996). It is important for designers to note that formaldehyde, pesticides, and solvents are used in the production of many interior materials.

People who develop MCS may be exposed to these chemicals in various locations: in the workplace as an industrial worker, living or working in a poorly ventilated building, residing in communities with high air or water pollution, or being exposed in unique situations. Often the chemical exposure is the result of indoor air pollution within a tightly sealed building (Thivierge, 1999). Frequently, designers are specifying materials that emit chemicals and are installed in airtight buildings. For example, carpet may emit VOCs into the air and, with poor circulation, promotes poor indoor air quality.

Symptoms reported by patients vary greatly, but according to Gist (1999), they typically include "chest pain, depression, difficulty remembering, dizziness, fatigue, headache, inability to concentrate, nausea, and aches and pains in muscles and joints" (p. 4). Nash (2001) identified the following symptoms: "asthma, sinus and respiratory problems, digestive disturbances, skin rashes, blood diseases, neurological disorders and brain damage. These symptoms can occur after only brief exposures to almost any chemical" (p. 21).

A study by Caress, et al. (2002) documented patient symptomatology. A questionnaire was administered to 1,579 individuals reporting a hypersensitivity to common chemical products in the southeastern United States. A majority of the participants (52.2%) experienced severe or somewhat severe symptoms. Listed below in order of frequency are the symptoms reported after the exposure: headache (88.4%), burning eyes (76.8%), stomach distress/nausea (55.1%), dizziness (46.4%), loss of mental concentration (31.9%), muscle pain (30.4%), and loss of consciousness (7.2%). Along with these symptoms, more than half of the participants (59.4%) developed asthma or a similar breathing problem. Participants reported that a particular product or substance triggered symptoms. Triggering mechanisms that set off reactions included "cleaning agents (88.4%), second-hand tobacco smoke (82.6%), perfume (81.2%), pesticides (81.2%), car exhaust (72.5%), barbershops/beauty salons (60.9%), new carpets (53.6%), pesticides in public parks (52.2%), new furniture (39.1%), chlorine in household water (39.1%), and fresh ink or newsprint (26.1%)" (Caress, et al., 2002, p. 429). "The most common triggers . . . were cleaning products (88.4%), tobacco smoke (82.6%), perfume (81.2%), pesticides (81.2%), and car exhaust (72.5%)" (Caress, et al., 2002, p. 429). From this study, it is critical for the design field to realize that chemicals in new carpet and new furniture may trigger symptoms of MCS.

Caress, et al. found that sometimes the actions of others may trigger a symptomatic MCS reaction. Such behaviors include the following: someone burning a fire in a fireplace, woodstove, or barbeque (39.1%), someone's second-hand tobacco smoke (33.3%), someone using pesticides or herbicides on a lawn or garden (31.9%), and someone using laundry products (18.8%). Thus, various actions by others triggered symptomatic MCS reactions.

Another important aspect of this study was the implication of a possible linkage between MCS and other medical conditions. The majority of the participants (53.6%) stated that they had at least one other medical condition that may be related to their hypersensitivity, including gastrointestinal problems (26.1%), fibromyalgia (21.7%), chronic fatigue syndrome or other immunological troubles (18.8%), or some another medical condition (27.5%). Thus, MCS may be linked to other medical conditions.

From Caress, et al.'s study, MCS was linked to symptoms after exposure, products that triggered symptoms, and actions by others triggered symptomatology; and MCS was possibly linked to other medical conditions. Though the sample was large; the study involved one area of the United States. Future studies need to be conducted throughout the country to generalize to the population.

MCS is an environmentally triggered illness, creating a synergistic reaction within the body. Synergism refers to a phenomenon in which the combined action of two things is greater than the sum of the individual actions (Bower, 2000). Whether exposure takes place in one phase or two phases, individuals become sensitive not only to one chemical but to many chemicals. This multi-sensitivity becomes synergistic (Bower, 2000; Pilatowicz, 1994).

Individuals with MCS experience a synergistic reaction to chemicals. One chemical mixing with another chemical creates a volatile reaction within the body (Bower, 2000). This is similar to the dangerous mixing of alcohol and barbiturates. When the two are mixed, the result can be lethal. So, for instance, there are hundreds of indoor air pollutants that "probably act synergistically" (Bower, 2000, p. 39). For example, when tobacco smoke and radon gas are both present in a room, the combined effect is considerably greater than the sum of the individual effects (Bower, 2000). Unfortunately, since an astronomical number of possible chemical combinations exist, the effects of chemicals on humans are seldom studied in combination. For the designer, choosing materials that emit chemicals in combination with other environmental factors may trigger symptoms of MCS.

Diagnosis of MCS

Since there is no consistent or measurable set of symptoms, nor is there a single diagnostic test or marker, MCS is particularly difficult to diagnose (Kutsogiannis & Davidoff, 2001; Magill & Suruda, 1998; Thivierge, 1999).

While not insinuating previous problems, a physician should investigate the patient's psychiatric history as well as a history of previous medical evaluations and treatments. When the patient history is completed, the physical examination should begin by focusing on organ systems that reference symptoms. The laboratory evaluation should be "challenge testing," where patients inhale low concentrations of offending chemical (Magill & Suruda, 1998). Ultimately, the diagnosis of MCS may be "one of exclusion"—excluding one cause at a time (Tarlo, et al., 2002, p. 669).

Some members of the American Medical Association (AMA), the American College of Physicians, and the American Academy of Allergy (Winterbauer, 1997) believe that the condition is purely psychological (Kerns, 2001; Magill & Surda, 1998; Winterbauer, 1997) and many doctors will not treat patients with MCS for this reason (Duff, 2001). In one study, findings indicated that 65% of the subjects with MCS reported an incidence of current or past clinical depression, anxiety disorders, or other psychological disorders, in comparison to 28% in the control group. However, some physicians have suggested that since patients with MCS can no longer lead a normal life and/or because MCS affects the nervous system, MCS itself may be the cause of a patient's depression, anxiety, or other psychological disorders (Heuser, Wojdani, & Heuser, 1992). In the Caress, et al. (2002) study, only 1.4% of respondents had a prior history of emotional problems; however, 37.7% developed emotional problems after the hypersensitivity emerged.

Many doctors will no longer treat patients with MCS because of the government's and insurance companies' position—lack of definition and support by medical profession (Duff, 2001). Buchwald and Garrity (1994) found that patients with . . . MCS averaged 23 visits per year to their medical provider. Patients not only made frequent visits but also lost time at work. Bell (2003) found that "lost . . .worker productivity [was] associated with related conditions such as sick building syndrome [SBS] . . . has been estimated at $10 billion [per] year" (p. 20). Patients with MCS affected by SBS bring lawsuits in which doctors are expected to testify. Thus, few doctors are willing to support patients' legal claims in court.

Brown and Kelley (2000) examined "the role of physicians in the detection and treatment of environmentally induced illness [MCS]" (p. 46). Their results suggest that physicians lack adequate education in occupational and environmental medicine (OEM). Although Kutsogiannis and Davidoff (2001) found that both traditional medical specialists and clinical ecologists treated MCS patients, they also found that both groups had a tendency to overlook the condition.

Clinical ecologists (practice is in environmental health) have taken the most active lead in diagnosing and treating MCS (Barrett & Gots, 1998; Winterbauer, 1997), and yet, clinical ecology "is not advocated by standard medical textbooks and is not a component of medical school or specialty training programs. Environmental medicine is a component of the specialty of preventive medicine (public health), but the theories and practices of clinical ecology are not" (Barrett & Gots, 1998, p.7).

An organization of clinical ecologists has been formed within the American Academy of Environmental Medicine and has attracted not only allergists but also physicians from

other traditional medical specialties (EPA, 1994). This organization and its members are moving forward with research to prove that MCS is not a psychological illness but a very real physical illness.

Population Affected

Because of the lack of consensus on a definition and on diagnostic criteria, MCS has been difficult to diagnose and those affected difficult to identify. Studies that have been conducted, however, find certain demographic characteristics of patients with MCS. According to Thivierge (1999), most patients with MCS "are female, the median age . . . is 40 years old, and most experienced symptoms before they were 30 years old" (p. 1953). Caress, et al. (2002) also found a higher percentage of MCS among females as well as middle-aged and older individuals. An estimated "25 percent to 33 percent of the population has MCS, but those with chronic symptoms are a subset of this, with estimates varying between four percent and 15 percent" (Nash, 2001, p. 21). Other studies likewise estimate that MCS affects about 15 percent of the population (Ashford & Miller, 1998; CIIN, 2002). Three to four percent of the 15 percent with MCS are such severe cases that they require "lifestyle changes . . . mandatory for survival" (CIIN, 2002, p. 41). Some patients are totally disabled who suffer severe symptoms daily, while others are minimally disabled with mild symptoms that flare up only periodically (Bartha, et al., 1999).

Research supports that MCS affects the population generally, regardless of a person's racial, social, or economic background. Caress, et al. (2002) found that the racial, ethnic, and socioeconomic characteristics of those with MCS "virtually mirrored . . . the general population in [a given] geographic area" (p. 435), which suggests that one's racial, social, or economic background is not a determining factor in acquiring MCS. The demographic data on education and income indicated that MCS occurred across a wide distribution of education and income levels, with a slight tendency to occur more frequently among those with higher education and income levels. This was explained by the makeup of the sample that consisted of a higher upper-level bias (Caress, et al., 2002).

Patients with MCS include "Persian Gulf veterans, industrial workers, occupants of 'sick buildings,' and people living near contaminated sites" (Gist, 1999, p. 4). Government studies have found that two to four times as many cases of chemical sensitivity occur among Gulf War veterans as occur among average citizens (Bartha, et al., 1999). The term "Sick Building Syndrome" (SBS) refers to an array of symptoms that affect some of a building's occupants while they are in the building and that diminish or go away when they leave the building, yet "cannot be traced to specific pollutants or sources within the building" (EPA, 2003). Randolph (1982) cites patients whose symptoms worsened each time they passed through an industrial site and, particularly, when the wind blew from the industrial site toward their travel or location. Approximately 80 percent of patients developed chronic conditions from exposure at their place of employment (Nash, 2001). People living near contaminated sites have an increased risk of health problems. Ashford and Miller (1998) cite a study by David Ozonoff of Boston University in 1987 in which he "survey[ed] households surrounding an odorous chemical waste disposal site and found

that exposed individuals more often complained of respiratory symptoms . . . and constitutional symptoms . . . than did the control [group]" (p. 64).

Treatments, Prognosis, and Prevention

Magill and Suruda (1998) recommend that before treatment begins, an effective physician-patient relationship must be established. The overall goals of treatment are to maximize rehabilitation—a return to normal activities, to control symptoms (no cure is known), and to treat the emotional distress the patient experiences as a result of having MCS. According to Kerns (2001), the best treatment is to minimize any further exposure to chemicals, which will diminish the risk of the patient experiencing the (frequently disabling) symptoms. Thivierge (1999) states that doctors may prescribe antihistamines, analgesics, and other medications to lessen symptoms; however, avoiding those chemicals that trigger the symptoms is the most effective treatment. Doing so, however, is extremely difficult—for two reasons. First, the number of offending chemicals in our environment generally is increasing. [This increase in chemicals is of particular concern to the design profession.] Second, avoidance means isolation—remaining at home where patients can control the chemicals present in their environment. "This isolation limits their abilities to work and socialize, [and for this reason,] supportive counseling may also be appropriate" (p. 1953).

According to Magill and Suruda (1998), physicians should be compassionate as they evaluate and care for patients with MCS; however, physicians should avoid "the use of unproven [though none have been proven], expensive or potentially harmful tests and treatments" (p. 721). DeHart (1998) suggests that Magill and Suruda place too much emphasis on being compassionate and understanding. DeHart is concerned that this emphasis will cause the development of a psychosomatic illness and will reinforce not only avoidance of many chemicals but also avoidance of family, social contacts and work settings, which could result in continued isolation and focus on the illness. Kerns (2001) believes that whether a traditional treatment approach or an alternative treatment method is used, more research is needed into various treatment methods for those suffering from MCS.

Preventing MCS is difficult because each person reacts differently to high-dose exposures. One possible preventive measure may be to adequately ventilate any space that has potential for chemical exposure—either acute high-dose or chronic low-dose. Another preventive measure is for all individuals to wear proper protective equipment in industrial areas or buildings to minimize the risk of chemical exposure (Thivierge, 1999).

MCS and the Legal Community

MCS is also controversial in the legal community because neither diagnostic criteria nor diagnostic testing methods have been established for MCS. However, workers' compensation and reasonable accommodation claims for those with MCS have sometimes had successful outcomes (McDonald, 2002; Winterbauer, 1997). Some cases have used American Disabilities Act (ADA) law to sue employers, while others have used various

state laws. In ADA lawsuits, plaintiffs with MCS will not likely succeed because "SBS [sick building syndrome] and MCS typically only affect a person's ability to work in a certain building or around colleagues who wear certain scents" (McDonald, 2002, p. 102). According to McDonald (2002), there is a greater chance of success using state laws. For example, "California's Fair Employment and Housing Act requires a showing merely of a 'limitation' of a life activity, not of a substantial limitation," with no preclusion from working in various other jobs (p. 102).

MCS and the Design Community

Applying conservation principles, green or sustainable design has a minimal negative impact on humans and the global environment (NPS, 1997). For the design community, this "represents the holistic [approach to design with a] concern for a broad array of environmental topics . . . energy efficiency, resource conservation, and indoor-air quality" (Wasley, 2000, p. 207). Green design is concerned with the health, safety, and welfare of humans and the global community.

However, safe, healthy products and green products may not always be the same. According to Wasley (2000), "safe is not necessarily green and green is not necessarily safe" (p. 213). "Green products . . . [are] nontoxic, energy efficient, resource efficient, recyclable, durable, [and] contain recycled content. They also must be manufactured with minimum pollution and impact to the environment" (Haberle, n/d). Wasley (2002) asks, "Should the use of manufactured wood products . . . be ruled out unconditionally due to their reliance on formaldehyde-based glues? Can the world's forests support the technological simplicity of [a] . . . house, where stud construction is eliminated in favor of solid logs?" (p. 213). Wasley (2000) states that "an architect or builder [or interior designer] simply cannot offer a blanket solution to an extremely sensitized person" (p. 214). Rather, the designer needs to develop a method to decipher individual reactions to specific chemicals or other substances and then make choices about which products to use. Wasley continues, "[One] way to think of the relation of safe and green . . . is to see these MCS houses as uncompromising voices on the health side of a debate between the values of personal health and environmental sustainability" (p. 214).

Finishes and furnishings chosen for interiors may greatly impact the IAQ (AIA, 1997). A growing body of scientific evidence indicates that "the air within homes and other buildings can be more seriously polluted than the outdoor air in even the largest and most industrialized cities" (EPA, 1995, p. 2). Research also shows that people are indoors about 90% of the time. This places many people at more serious risk to their health because (1) there is greater risk of exposure to pollution indoors than outdoors, and (2) they are exposed to indoor air pollutants for longer periods of time and are often more susceptible to the effects of indoor air pollution (EPA, 1995; Pilatowicz, 1995).

Indoor air pollution is caused by the emission of VOC gases or particles released into the air (EPA, 2003; Godish, 2001). Other kinds of indoor air pollutants include biological contaminants such as molds, bacteria, fibers, and dusts (AIA, 1997; EPA, 1994) and

combustion contaminants such as oil, gas, kerosene, coal, wood, and tobacco (EPA, 1994).

Many common household products can cause indoor air pollution and may emit VOC gases (EPA, 2003). VOCs are found in building and furnishing materials such as adhesives, sealants, solvents, and lubricants that are used in the construction and installation process. VOCs are also found in cabinetry or furniture made of certain pressed wood products and in housekeeping and maintenance products (EPA, 1995; 2003; Wasley, 2000; Wittenberg, 1996). Pesticides are extremely toxic and are sometimes found in building construction materials (EPA, 1994; Wasley, 2000). Other building materials that contain pollutants include asbestos-containing insulation and wet or damp carpet harboring mold and mildew. Products used for personal care, crafts, and hobbies may also contain pollutants. Mechanical and electrical systems, including central heating and cooling systems and humidification appliances, may emit pollutants. Other pollution sources that may affect indoor air include radon and outdoor air pollution (EPA, 1995).

Formaldehyde, in particular, has been a great concern in IAQ, and the EPA (1995) has classified it as a probable human carcinogen. This chemical is found in many materials used in home construction. In the early 1980s, one source of formaldehyde used in building construction was urea formaldehyde foam insulation (UFFI); today, this type of insulation is seldom used. However, many formaldehyde-based resins are components of other materials (e.g., particleboard, fiberboard, paneling, plywood, and finishes). All these materials are used in home construction and in mobile homes. Formaldehyde can be found in building materials such as subflooring or paneling; the components of wood-based products such as furniture and cabinetry; and finishes on permanent press fabrics for a variety of applications such as clothing, draperies, and mattress ticking (EPA, 1994).

One material used in most homes is carpet. The fibers a carpet is made of may cause problems for IAQ (Tremblay, Peng, Kreul-Froseth, & Dunbar, 1999). Natural fibers such as wool, cotton, or jute are staple fiber—short fibers han synthetic carpets such as nylon (AIA, 1997; Yeager & Teter-Justice, 2000). Carpet also traps allergens and biological contaminants such as mold, mildew, and dust (EPA, 1994; Tremblay, et al., 1999). Carpet glues, carpet backing, finishing chemicals, and carpet padding often contain VOCs and may cause health problems for people with MCS (AIA, 1997) and, particularly, installers of carpet (Williams, 1997). Carpet backing made of styrene butadiene rubber (SBR) latex is not considered safe for a healthy environment (AIA, 1997). Fortunately, the carpet industry is concerned about IAQ, and so it tests products and provides information on VOC emissions (Tremblay, et al., 1999).

IAQ also affects office buildings. During a five-year period, researchers in California used a "cross-sectional survey of multiple office buildings to identify factors [causes of health complaints] that are statistically associated with health symptoms" (CBS, 1994). Using twelve office buildings, 880 occupants completed questionnaires. Indoor and outdoor air was measured for concentrations of carbon dioxide (CO_2), carbon monoxide (CO), VOCs, fungi, bacteria, and indoor temperatures and humidities. Some results were significant. First, "buildings that used mechanical ventilation without air conditioning and those using

mechanical ventilation with air conditioning had a higher prevalence of all symptoms except headaches compared to buildings with natural ventilation" (Fisk, et al., 1994). Thus, there is a higher frequency of symptoms associated with airtight buildings with no outside ventilation. Second, "the use of carbonless copy paper is associated with increased symptoms . . . organic chemicals in this type of paper may be the cause, and inhalation of vaporized compounds or physical contact with the paper may be the exposure route" (Fisk, et al., 1994). There was also an increase in symptoms associated with carpet. Carpets may be "a source of increased symptoms because they release VOCs or fibers or because microbiological material such as fungi and dust mites find them perfect habitats. Williams (2001) reports the results of a study conducted with carpet. In the early 1990s, the Anderson Lab in Massachusetts conducted an extensive study. "Individuals who suspected their illness was caused by their carpeting sent . . . samples to Dr. Anderson" (p. 172). Carpet samples were placed in a glass aquarium. A small heating pad was placed under the carpet and used to raise the carpet to body temperature. Then air was blown from this aquarium into another chamber that contained white mice. This took place for four hours (one hour at a time) over a two-day period. Results were that 17 of 50 mice died. With one carpet sample, one mouse suffered severe convulsions after the second hour of exposure. Another study at the "Anderson Lab showed that mice exposed to a carpet sample developed hypersensitivity pneumonitis—the same pathological changes to lung tissue biopsied from a patient exposed to the identical carpet" (p. 172).

Implications

It is clear that a consensus on MCS is needed within the medical community. Without a consensus, other communities, such as the legal and design communities, are adversely affected. This review of literature suggests several implications for the design community specifically..

For the Design Community

"The built environment has a powerful impact on public health" (HBN, 2002). A prodigious quantity of material is used in building construction. Many of these materials contain or release toxic chemicals into the air throughout their life cycle. Thus, "the materials and design of a building can greatly affect the indoor air quality and in turn the health of its occupants" (HBN, 2002). It is designers (architects and interior designers) who must specify that nontoxic materials be used in buildings.

However, since "green products are not necessarily safe" (Wasley, 2000, p. 213), each material or product needs to be evaluated according to the individual client's needs and health. The following are a few examples of materials and installation methods to use to create a healthy environment, as well as possible resources to aid in the selection process.

Because of the quantity typically installed, carpet is often a major source of triggers for people with MCS. When specifying new carpet, designers should ask manufacturers for information regarding lower emitting carpet, carpet pad, and adhesives that are "lower emitting"—emit a lower amount of chemical gases into the air. The carpet industry

provides information on carpet materials, IAQ, and the "green label" testing program at http://www.carpet-rug.com/index.cfm. The method of installing carpet is also important. Before new carpet is installed, the carpet should be unrolled and aired out in a clean, well-ventilated area. The individual with MCS should not occupy the space during and immediately after carpet installation. To increase the amount of fresh air indoors, doors and windows should be opened to reduce exposure to chemicals that are released from newly installed carpet. The use of window fans and room air conditioners to exhaust fumes to the outdoors is recommended during and after installation. "Ventilation systems should be in proper working order, and should be operated during installation, and for 48 to 72 hours after installation" (EPA, 1994, p. 21).

Hard floor coverings (e.g., stone, ceramic tile, or porcelain tile) are solid inert products, making them durable and safe (e.g. do not emit toxic gases) for interior environments (AIA, 1997). In specifying wood flooring, the material added to the wood should be determined. Often, formaldehyde is used in processed wood; this type of product should be avoided for good IAQ (AIA, 1997; Riggs, 2002). In specifying resilient floor covering, linoleum is a natural, biodegradable product that does not emit VOC gases. Vinyl tile and sheet vinyl are made from PVC; PVC emits VOC gases and is non-biodegradable. Thus, linoleum is more preferable than a vinyl product for good IAQ (AIA, 1997).

Other interior materials, such as fabrics, may pose a problem for individuals with MCS. Cotton, although a natural material, is produced using the world's largest quantity of pesticides, according to McDonough (Haberle, n/d). William McDonough designed a totally organic, environmentally safe upholstery fabric at a competitive price. EnviroTex is "the first and only completely sustainable upholstery product" (DesignTex, 1998). Information on EnviroTex® can be found at www.dtex.com (DesignTex, 2003). Other textile manufacturers are following his lead. Cliff Goldman, president of Carnegie Fabrics, has become an advocate for environmentally safe fabrics and has developed a line of environmentally safe upholstery fabrics (Bonda, 2002). Carnegie Fabrics offers the Climatex LifeguardFR™ line of upholstery fabrics, which is not only environmentally safe but is also fire retardant (Bonda, 2002). Carnegie Fabrics can be found at http://www.carnegiefabrics.com/ (Carnegie, n/d).

Many paints use VOCs to improve durability, to enhance the finish, and to decrease the drying time (AIA, 1997). Some paints with VOCs are still on the market (Riggs, 2002). However, some low odor, low VOC paints are available (Hirshfields, 2002; Diamond Vogel, 2002). The Microban® built-in protection found in some paint products is designed to resist the growth of bacteria and mold (Hirshfields, 2002).

Wall coverings are manufactured with paper, fiber, or polyvinyl chloride (PVC). PVC-based (vinyl) wall coverings are most commonly used; however, they emit VOC gases into the indoor air and, when manufactured, create a toxic by-product. Biodegradable paper with a recycled content (paper or fiber) is environmentally safe. Likewise, traditional wallpaper paste is preferred to self-stick wall covering because the self-stick adhesive has a higher VOC content (AIA, 1997; Riggs, 2002).

Acoustical ceiling tile and Gypsum board are the most common ceiling materials. Most acoustical ceiling tile is less expensive than gypsum board, does not require paint or another finish, and is sometimes made from recycled newspaper, mineral wool, perlite, or clay. Some ceiling tile and sprayed-on ceilings contain hazardous materials (e.g., asbestos, formaldehyde, or crystalline) and should be avoided (AIA, 1997; Riggs, 2002). However, there is a large selection mineral fiber ceiling tile, and some ceiling tile is produced with a resistance to mold (Armstrong, 2003).

Many resources are available to help designers specify appropriate materials for a safe environment. Green Seal is one resource and can be found at http://www.greenseal.org. Green Seal strives to achieve a healthier and cleaner environment by identifying and promoting products and services that cause less toxic pollution and waste, conserve resources and habitats, and minimize global warming and ozone depletion. Since it is an independent, non-profit organization that has no ties to a manufacturer or company, and since it does not recommend or certify specific products, it is a good resource for information (Green Seal, 2003).

Another organization that promotes green building is the U.S. Green Building Council (USGBC). The USGBC endeavors "to promote buildings that are environmentally responsible, profitable and healthy places to live and work" (USGBC, 2003). Its Leadership in Energy and Environmental Design (LEED), a Green Building Rating System™, provides a national standard for developing sustainable, high-performance buildings so that building performance can be assessed and sustainability goals met. LEED emphasizes sustainability in site development, energy efficiency, materials selection, water savings, and indoor environmental quality (USGBC, 2003).

Conclusions

Research is still lacking in several areas and should be conducted by designers working together with chemical engineers. Data are lacking on the identity of many chemicals, as well as their emission rate and frequency, being emitted from many building materials and consumer products. There are standard methods to quantify emission from certain products and materials (e.g., carpet, paints, office furniture). However, "new products and materials that emit significantly lower levels of indoor pollutants" need to be developed (EPA, 2001, p. 8).

Since much is still not known about how "a change in the building design, operation, and maintenance will influence the mixture of indoor pollutants . . . [or] how to measure the concentrations of biological contaminants present indoors" (EPA, 2001, p. 8), research on IAQ needs to be conducted by designers on remodeled buildings prior to and after completion of construction.

There is a lack of research on the environmental exposures in schools, homes, and non-occupational buildings. Research also is lacking on the IAQ of buildings in other countries and should be conducted. Likewise, research is lacking on where and to what extent MCS is occurring in other countries.

Research of architects' and interior designers' practices should also be conducted. Many designers use green products; others do not (Haberle, n/d). Designers who specify green products may or may not be using products that are safe and healthy for good IAQ as well as being safe for individuals with MCS. Research among interior designers could gather data on how many designers are using green products, safe products, or safe and green products.

Research also should be conducted among interior design educators. Many educators are teaching students about "green" or "sustainable" design. Research could determine what and how much is being taught on this topic, at what level of complexity, and at what grade levels.

Among designers, there is little controversy for designing safe, health environments, which is part of the professional code of ethics. Since this is the case, it should be the designers (architects and interior designers) who take the lead. First, designers need to become better educated on "green" or "sustainable" products and, then begin to consistently specify products that enhance good IAQ. Second, designers should be advocates for those individuals suffering from MCS; designers should lobby for legislation regarding IAQ, testify for clients with MCS, educate other designers through presentations at professional meetings, and educate the public through community education programs. Third, designers might conduct research among clients with MCS or assist with MCS research conducted by other designers, design educators, physicians, or medical researchers. Through these methods, designers will take the lead to improve the IAQ and quality of life for everyone.

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