CHAPTER 27

MULTIPLE CHEMICAL INTOLERANCE AND INDOOR AIR QUALITY

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27.1 INTRODUCTION

In the setting of a sick building, sometimes sporadically, there are some occupants who report extreme sensitivity to a host of exposures, ranging from new carpet and paint odors to cleaning agents and offgassing from office equipment. Because these persons are in the minority, their complaints tend to be ignored. They suffer from an enigmatic condition known as multiple chemical sensitivity, or multiple chemical intolerance.

These individuals report multiple symptoms, including severe headaches, fatigue, muscle pain, memory and concentration difficulties, various skin conditions, shortness of breath, and a variety of gastrointestinal problems, which they report being triggered by common, low-level chemical exposures and various foods and drugs. Some have been diagnosed with chronic fatigue syndrome or fibromyalgia. There is growing concern among scientists that indoor air contaminants may not only trigger their symptoms, but may cause the illness itself. These individuals are not to be ignored. They are often the key to understanding indoor air problems in a building.

Susceptibility to indoor air contaminants varies greatly from person to person, perhaps by several orders of magnitude. Building managers and indoor air quality (IAQ) specialists need to be on the lookout for these "canaries," individuals who may be more susceptible to low-level air pollutants, for a variety of reasons. First, their health concerns tend to drive the building investigation process. Until they feel better or until the building is ruled out as a cause for their symptoms, air quality concerns will fester, as other occupants tend to regard these individuals as barometers for the building's health. Second, these individuals

can often help locate problem sources that are not identifiable by air sampling or other testing methods. Third, addressing sensitive individuals' concerns openly and honestly makes good risk management sense and will help prevent compensation claims, disability disputes, and litigation.

These chemically intolerant individuals report disabling symptoms when exposed to myriad substances, e.g., fragrances, tobacco smoke, diesel exhaust, as well as particular foods, medications, alcoholic beverages, and caffeine—intolerances that sometimes, but not always, predate their difficulties in the building by years, even decades. The chemically intolerant are showing up in increasing numbers in the waiting rooms of occupational/environmental medicine doctors and allergists, yet little is currently known about the underlying disease that afflicts them.

One thing we do know is that chemically intolerant people appear in a variety of settings, ranging from manufacturing plants, offices, schools, and farms, to hospitals, courthouses, and casinos. Those affected report multisystem symptoms and new-onset chemical, food, and drug intolerances that never bothered them before their "initiating" exposure event. Scientists have described this breakdown in tolerance, referred to by some as *toxicant-induced loss of tolerance* (TILT), among different demographic groups in more than a dozen countries. Research in this area is in its infancy. Nevertheless, there remains the potential for liability if, in the future, indoor air exposures are shown to initiate TILT, resulting in long-term disability.

Investigators responding to IAQ complaints must consider all possible etiologies, weighing the relative contributions of contaminant sources, HVAC system deficiencies, occupant load, and physical factors (temperature, humidity, etc.), and, no less importantly, the susceptibility of the occupants themselves. Chemically intolerant individuals represent an estimated 2 to 6 percent of the population. They spend time in office buildings, schools, homes, and public buildings. To a great extent, their needs will dictate the design, construction, and operation of twenty-first century indoor environments. This has already begun. The Canada Mortgage and Housing Corporation (CMHC) has sponsored several prototype residential housing units for the chemically intolerant, educating and encouraging Canadian builders to adopt practical approaches to protect this subset of the population.

27.2 HISTORICAL BACKGROUND

In the 1950s, an allergist named Theron Randolph described a phenomenon he called *chemical susceptibility* in a cosmetic saleswoman suffering from asthma, fatigue, irritability, depression, and intermittent loss of consciousness. Her symptoms seemed to flare whenever she was exposed to "man-made combustion products and derivatives of gas, oil, and coal" (Randolph 1962, Randolph and Moss 1980). Other physicians, noting similar problems in their patients and even themselves, allied with Randolph. In 1965, Randolph and his adherents broke away from the allergists' organizations and founded the Society for Clinical Ecology (renamed the American Academy of Environmental Medicine in 1984). Many clinical ecologists adopted various unorthodox diagnostic and treatment approaches, going well beyond Randolph's original teachings. Most, however, continued to employ his central diagnostic/therapeutic approach, i.e., trial avoidance of potential chemical and food incitants followed by judicious reexposure to determine which ones trigger symptoms. Position papers by several influential medical societies (American Academy of Allergy and Immunology 1981, 1986; American College of Physicians 1989; American Medical Association 1992) challenged the ecologists' claims. Over the past decade, there has been an outpouring of technical reports, concept papers, and hypotheses about this illness. People on all sides of the issue seem to think its prevalence is on the rise. Some physicians

and researchers attribute this surge of patients and interest to (1) increased synthetic organic chemical production and use since World War II (including pesticides), coupled with (2) decreased fresh air exchange indoors due to energy conservation efforts following the oil embargo of the mid-1970s. Others attribute it to increased media attention and public awareness of environmental exposures.

Recently, there has been a softening of positions taken against the illness (Ashford and Miller 1998, ACOEM 1999). Although concerns about unproved diagnostic and treatment practices continue, affected individuals are turning to board-certified occupational and environmental medicine physicians and toxicologists in universities. In 1987, Mark Cullen of Yale edited a collection of papers entitled *Workers With Multiple Chemical Sensitivities: An Overview,* offering a spectrum of authors' opinions on the illness (Cullen 1987). He recommended the name *multiple chemical sensitivity* (MCS), and offered the first of several proposed case definitions for it: "Multiple chemical sensitivity (MCS) is an acquired disorder characterized by recurrent symptoms, referable to multiple organ systems, occurring in response to demonstrable exposure to many chemically unrelated compounds at doses far below those established in the general population to cause harmful effects. No single widely accepted test of physiologic function can be shown to correlate with symptoms." The terms *multiple chemical sensitivity* and *environmental illness* now appear on the National Library of Medicine's bibliographical database, MEDLINE. While there is general agreement that an illness exists, and that these patients suffer, medical opinion concerning the nature and origin of the phenomenon remains polarized. At the debate's core is the question, "Is MCS the result of chemical exposures, psychological factors or some mix of these?" The mix might also vary from person to person. If chemical exposures can cause MCS, the repercussions for environmental policy, product liability, compensation, and medical treatment, will be monumental.

Canada was the first nation to examine this problem through its 1985 Thomson Report (Thomson 1985) and subsequent sponsorship of clinical studies. In the United States, the issue has been examined by several states (New Jersey, Maryland, and California) (Ashford and Miller 1989, Bascom 1989, Kreutzer et al. 1999), federal environmental agencies (ATSDR 1994, Fiedler and Kipen 1997a), the National Academy of Sciences (NRC 1992), and various professional organizations (AOEC 1992, ACS 1999). Proposed research strategies have evolved from these meetings (summarized in Ashford and Miller 1998), but few comprehensive or illuminating studies have been funded. Amid the confusion of opinion swirling around the problem, affected individuals and those who wish to help them are in need of safe, rational, interim approaches that might help alleviate the condition. Of equal importance, there is a need for practical strategies (e.g., integrated pest management, reducing VOC levels in new construction) to prevent the illness from developing in other people.

27.3 DEFINING SENSITIVITY AND INTOLERANCE

The different meanings ascribed to the term *sensitivity* may have added to the confusion surrounding this illness. "Sensitivity" is used in three relatively distinct ways (Ashford et al. 1995):

1. The heightened responses of certain individuals to *known* toxicants or allergens, e.g., the responses of susceptible persons to toxic substances like mercury and carbon monoxide, or allergic reactions to antigens like housedust mites and animal dander.
2. The responses of certain individuals to identifiable exposures that at this time cannot be explained by generally accepted disease mechanisms. This category includes:

a. Sick building syndrome (SBS) involving individuals who respond to one or several air contaminants that may or may not be identifiable. The fact that affected individuals' symptoms resolve when they leave the building provides evidence for SBS.
b. Sensitivity, such as that induced by toluene di-isocyanate (TDI), that starts out as specific hypersensitivity to a single substance (or one chemical class), but evolves into nonspecific hyperresponsiveness (described further in category 3 below).

3. The heightened, extraordinary, or unusual responses of certain individuals to structurally diverse chemicals at exposure levels orders of magnitude below those producing symptoms in most people (cf. Cullen 1987).

Patients with MCS appear to exhibit this third type of sensitivity. Synonyms and related terms include environmental illness (EI), chemical intolerance, ecological illness, idiopathic environmental intolerance (IEI), universal allergy, and toxicant-induced loss of tolerance (TILT). Proposed underlying mechanisms range from entirely psychogenic to entirely toxigenic, and everything in between (Ashford and Miller 1998, ACS 1999, NRC 1992, AOEC 1992, ATSDR 1994). Odor conditioning is one example of a possible dual toxigenic-psychogenic mechanism (Doty et al. 1988). A bright line should be drawn between this third type of sensitivity and antibody-mediated sensitivities, or allergies. Allergists prefer the term *chemical intolerance* over *chemical sensitivity* in order to distinguish this condition from true allergies. We also prefer the term *chemical intolerance* because it describes these individuals' responses without presuming any specific mechanism, allowing time for the science to unfold. *Sensitivity,* on the other hand, implies an underlying sensitization process, when, in fact, the loss of tolerance these individuals describe may result from something entirely different, e.g., cell membrane disruption or gene activation. For the remainder of this chapter, we will therefore use the term *chemical intolerance* or *multiple chemical intolerance* in preference to *chemical sensitivity* or *multiple chemical sensitivity.* Tolerance is defined as the ability to withstand an insult. Affected individuals appear to lose their prior natural or innate tolerance for a wide spectrum of substances.

Researchers have observed multiple chemical intolerances occurring in a minority of sick building occupants (type 2a), with some people developing profound illness marked by multisystem symptoms and multiple intolerances. Many of these people ultimately adopt constricted lifestyles that transform their careers, families, social life, ability to travel, and recreational pursuits. Even their selection of home furnishings and clothing is dictated by their striving to avoid problem exposures.

27.4 PHENOMENOLOGY

Chemically intolerant individuals often say their illness began following specific exposure events, referred to as *initiating* events, e.g., a chemical spill, repeated exposure to solvents,

Case Study 1. Multiple Chemical Intolerance Following Pesticide Use

A "mystery illness" involving some 250 people broke out at a major casino resort hotel following repeated application of propoxur, a carbamate insecticide, used for cockroach control. Affected individuals reported dizziness, weakness, nausea, sore throat, fainting, sweating, headaches, racing heartbeat, shaking and trembling, lip and facial tingling, and red, splotchy rashes. While most recovered, 19 people experienced persistent symptoms. When these individuals were seen in an occupational medicine clinic 9 to 15 months after the initial episode, 12 of the 19 (63 percent) reported intolerances to perfume, gasoline, newsprint, cleaning materials, pesticides, and various other solvents that had not bothered them before the casino exposure (Cone and Sult 1992).

Case Study 2. Multiple Chemical Intolerance at the Environmental Protection Agency's Headquarters

EPA's Washington, D.C., headquarters building became a "sick building" during an extensive renovation, which included painting, moving walls, and the installation of 27,000 square yards of new carpeting. Even before the renovation, some occupants had reported symptoms suggestive of a potential indoor air quality problem in the building.

The EPA Waterside Mall headquarters building was originally a housing complex, consisting of two residential towers with a mall between. Residential space was converted to office space for the agency's use. During the remodeling, more than 100 individuals, including agency scientists, reported symptoms. Most who were affected improved when corrective measures were taken. Some office areas were found to have as little as 0.2 air changes per hour. About 2 dozen employees experienced persistent symptoms, long after the building had outgassed, including malaise, "spacey" feelings, difficulty thinking, respiratory problems, nausea, headaches, and dizziness. Symptoms were triggered by various common foods and chemicals, including perfumes, auto exhaust, and tobacco smoke (Welch and Sokas 1992, Ashford and Miller 1998, EPA 1989, Hirzy and Morison 1989). Even 10 years later, some of these individuals continue to experience disabling symptoms triggered by common exposures.

Case Study 3. Multiple Chemical Intolerance in a Manufacturing Facility

Some 50 to 75 aerospace manufacturing workers became acutely ill when a new composite plastic material was introduced into their workplace. Symptoms included headaches, fatigue, dizziness, nausea, breathing difficulties, and cognitive disturbances. Industrial hygienists identified phenol, formaldehyde, and methyl ethyl ketone as principal components, although airborne concentrations were within established safety limits. Thirty-seven workers filed compensation claims. A panel of medical specialists found no medical diagnosis or immunological abnormalities that could explain most workers' symptoms. More than a dozen of the claimants reported persistent, disabling symptoms triggered by common environmental exposures (Simon et al. 1990).

a pesticide application, indoor air contaminants associated with new construction, combustion products, etc. (Miller 1994) (see Case Studies 1 to 3). A subset of those exposed in these situations appear to evolve to a chronic condition that can persist many years, even decades, beyond the initial exposure. At first, individuals describe "flu-like" symptoms that will not go away, or feeling as though they are in a "perpetual fog." Next to develop are multisystem symptoms that seem to wax and wane unpredictably and a dawning awareness of a few new intolerances or adverse reactions, e.g., to alcohol or medications. Over time, these intolerances spread to a wide variety of everyday exposures—chemicals, foods, drugs, caffeine, alcoholic beverages, and skin contactants. The intolerances may appear within weeks of an acute, high-level exposure, or, in the case of lower-level, chronic exposures as in a sick office building, develop insidiously over months or years. Food intolerances may not be recognized as such initially; instead, every sort of digestive difficulty, feeling ill after meals, or extreme irritability if a meal is missed or delayed may be noted. Symptoms may occur following inhalation, ingestion, mucosal contact, or injection (e.g., drugs). Different exposures (Table 27.1)—fragrances, chemicals outgassing from new furnishings or carpeting, traffic exhaust, cleaning agents, etc.—may trigger different constellations of symptoms in different individuals. Even the same individual may experience different symptom patterns with different exposures. There is consistency, however: A *particular* exposure, e.g., diesel exhaust or a certain fragrance, in a *particular* person, reportedly elicits a characteristic constellation of symptoms—a signature response for that person having that exposure. Responses may occur at below-olfactory-threshold concentrations. Symptoms develop seconds to hours following a triggering exposure, and may persist minutes to days. Responses

are diverse and highly individual, ranging in intensity from mild (nasal congestion, nausea, or slight headache) to severe (mental confusion, depression or seizures) (Table 27.2). Hyperresponsiveness to physical stimuli, including light, noise and touch, is commonly reported (Miller and Prihoda 1999a, 1999b). People with no sense of smell (anosmic) still may report chemical intolerances.

The chemically intolerant appear to constitute a distinct subset of the population. The fact that normal people do not experience these same symptoms, even when exposed to much higher concentrations of the same chemicals, has led some doctors to conclude the problem must be psychogenic. These intolerances to structurally unrelated substances violate fundamental tenets of toxicology and allergy, and the symptoms can be almost anything. The condition simply cannot be explained by existing disease paradigms. What *is* compelling about the condition is the fact that researchers have described identical patterns of multisystem symptoms and new-onset intolerances developing in demographically diverse *groups* in more than a dozen countries following well-documented chemical exposures. This, more than anything else, has fueled scientists' search for a new disease paradigm that would explain these observations. Recently proposed animal models for the condition (Sorg 1999, Overstreet et al. 1996, Rogers et al. 1999) may offer a new window into the underlying mechanism. Building managers and IAQ professionals need to bear in mind that medicine may be in the early observational stages of uncovering a new disease process.

People with multiple chemical intolerances report that avoiding triggering exposures provides some relief (Lax 1995). Comprehensive avoidance is challenging, as well as socially isolating; low VOC exposure levels (parts per billion or trillion) are near-ubiquitous. Symptom-exposure relationships may be difficult to discern for several reasons (Ashford and Miller 1998): *habituation* with chronic exposures, e.g., VOCs in a sick office building, and *apposition,* i.e., overlapping symptoms resulting from common exposures (chemicals, foods, drugs), both can hide or "mask" the effects of particular exposures. Many individuals quit their jobs in order to minimize exposures to fragrances, carbonless copy paper, cleaning agents, etc., while others switch employers, occupations, and residences, searching for a safer environment.

TABLE 27.1 Triggering Exposures

Reported by at least 80 percent of 112 people who developed multiple chemical intolerance following an exposure to pesticides (n = 37) or indoor air contaminants (n = 75)

New carpeting	Enclosed mall
New automobile interior	Oil-based paint
Poorly ventilated meeting rooms	Particle board
Perfume	Gas engine exhaust
Detergent aisle in grocery	Hotel rooms
Newspaper/printed materials	Phenolic disinfectants
Fresh asphalt/tar	Dry-cleaned clothes
Diesel exhaust	Insecticides
Felt-tip markers	Gasoline
Nail polish/remover	Potpourri
Restroom deodorizers	New tires
Fabric stores	Cigar smoke
Heavy traffic	Cigarette smoke
New plastic shower curtain	Incense
Hairspray	Insect repellent

Source: Miller and Mitzel (1995).

TABLE 27.2 Symptoms Commonly Reported by Chemically Intolerant Individuals

Major categories were derived via factor analysis of symptoms reported by 112 self-identified chemically intolerant people who reported becoming ill following exposure to indoor air contaminants (n = 75) or cholinesterase-inhibiting pesticides (n = 37).

Neuromuscular	Weak arms	Trembling hands
Loss of consciousness	General stiffness	Insomnia
Stumbling/dragging foot	Cramps in toes/legs	Airway
Seizures	Painful trigger points	Cough
Print moving/vibrating on page	Gastrointestinal	Bronchitis
Feeling off balance	Abdominal gas	Asthma or wheezing
Tingling in fingers/toes	Foul gas	Postnasal drainage
Double vision	Problems digesting food	Excessive mucus production
Muscle jerking	Abdominal swelling/ bloating	Shortness of breath
Fainting	Foul burping	Eye burning/irritation
Numbness in fingers/toes	Diarrhea	Susceptible to infections
Clumsiness	Abdominal pain/cramping	Dry eyes
Problems focusing eyes	Constipation	Enlarged/tender lymph nodes
Cold or blue nails/fingers	Cardiac	Hoarseness
Uncontrollable sleepiness	Heart pounding	Cognitive
Head-related	Rapid heart rate	Memory difficulties
Head fullness/pressure	Irregular heart rate	Problems with spelling
Tender face/sinuses	Chest discomfort	Slowed responses
Sinus infections	Affective	Problems with arithmetic
Tightness in face/scalp	Feeling tense/nervous	Problems with handwriting
Brain feels swollen	Uncontrollable crying	Difficult concentration
Ringing in ears	Feeling irritable/edgy	Difficulty making decisions
Headache	Depressed feelings	Speech difficulty
Feeling groggy	Thoughts of suicide	Feelings of unreality/spacey
Musculoskeletal	Nerves feel like vibrating	Other
Joint pain	Sudden rage	Feeling tired/lethargic
Muscle aches	Loss of motivation	Dizziness/lightheadedness
Weak legs		

Source: From Miller and Mitzel (1995).

27.5 PREVALENCE AND DEMOGRAPHICS

Between 15 and 30 percent of the U.S. population report being "especially" or "unusually" sensitive to certain chemicals (Table 27.3). Population-based surveys show that approximately 2 to 6 percent of the general population report physician-diagnosed "multiple chemical sensitivity," "environmental illness," or significant daily impairment from chemical exposures (Kreutzer et al. 1999, Meggs et al. 1996, Voorhees 1998). Questions used in these surveys varied, but their findings are strikingly similar.

The largest and best designed of these studies was a 1995 California Department of Health Services state-wide, randomized telephone interview survey involving more than 4000 people (Kreutzer et al. 1999). The researchers found that 15.9 percent of participants reported being "allergic or unusually sensitive to everyday chemicals"; 11.9 percent described sensitivities to more than one type of chemical; and 6.3 percent reported doctor-diagnosed "environmental illness" or "multiple chemical sensitivity." Female gender and Hispanic ethnicity were associated with increased self-reporting of sensitivity (adjusted odds ratios of 1.63 and 1.82, respectively). In contrast with most published clinical studies,

employment and education were not associated with chemical sensitivity or doctor-diagnosed MCS, nor were there any associations with marital status, geographic location, and income. The California study concludes: "Surprising numbers of people believed they were sensitive to chemicals and made sick by common chemical exposures. The homogeneity of responses across race-ethnicity, geography, education, and marital status is compatible with physiologic response or with widespread societal apprehensions in regard to chemical exposure."

Results of several state surveys (California, New Mexico, North Carolina) suggest that multiple chemical intolerance could be one of the most prevalent, *if not the most* prevalent, chemically related illnesses in the United States (Kreutzer et al. 1999, Voorhees 1998, Meggs et al. 1996). A U.S. EPA survey found that nearly one-third of federal office workers in mechanically ventilated federal office buildings considered themselves "especially sensitive" to one or more common chemical exposures (Table 27.3) (Wallace et al. 1993). Notably, rates were similar for complaint and non-complaint buildings.

On average, 80 percent of self-identified MCS patients enrolled in clinical studies have been women with an average age in the fourth decade and an average educational level of at least 2 years of college (Fiedler and Kipen 1997b). In contrast, among military and industrial populations, the vast majority of those reporting chemical intolerances are males, likely reflecting underlying gender ratios (Simon et al. 1990; Miller and Prihoda 1999a, 1999b). In office building situations, the condition is more commonly reported by college-educated white females of middle to upper-middle socioeconomic status who are in the midage range (30 to 50 years) (Ashford and Miller 1998). It is not known why more chemically intolerant patients report working in office buildings and service industries, rather than in heavy industry where exposures to chemicals are more common, nor why more women than men appear to be sick (Lax and Henneberger 1995, Miller and Mitzel 1995, Black et al. 1990). The skewed gender ratios may stem from male/female differences in willingness to report symptoms; something unique about the mixture of indoor air pollutants in a sick building, a setting in which women may be relatively more confined, e.g., as secretaries; or gender-based biological response differences. The apparent paradox that fewer multiple chemical intolerance cases arise in heavy industries versus service industries may be due to: "The healthy worker" selection effect, i.e., workers bothered by chemical exposures tend to migrate to nonchemical jobs; the fact that women, who may be biologically more vulnerable, are less apt to work in heavy industry, mining, construction, etc.; or some unknown, but unusually insidious effect of indoor air chemical mixtures.

TABLE 27.3 Frequency of Self-Reported Chemical Intolerance from Several Large Surveys

Population	Number of people studied	Those considering themselves especially or unusually sensitive to certain chemicals, %	Those reporting physician-diagnosed multiple chemical intolerance or daily symptoms triggered by chemicals, %
EPA office workers (Wallace et al. 1993)	3948	31	Not evaluated
Rural North Carolinians* (Meggs et al. 1996)	1027	33	3.9
California residents* (Kreutzer et al. 1999)	4046	15.9	6.3
New Mexico residents* (Voorhees 1998)	1814	17	1.9

*Randomly sampled.

27.6 SYMPTONS

The vast majority of chemically intolerant individuals report multisystem symptoms (Table 27.2). Fatigue is the most prevalent complaint. Their symptoms greatly overlap those of chronic fatigue syndrome and fibromyalgia (Ashford and Miller 1998, Miller and Mitzel 1995, Chester and Levine 1994, Buchwald and Garrity 1994). Mood changes (irritability, anxiety, depression) are commonly reported. Exposure-related memory and concentration difficulties have led teachers, attorneys, executives, nurses, and other professionals to abandon their cognitively demanding careers.

Different groups with different "initiating" exposures describe strikingly similar symptoms: Among 75 chemically intolerant individuals who became ill following building remodeling and 37 who became ill following exposure to a cholinesterase-inhibiting pesticide, symptoms, ranked in order by severity, were nearly identical (Table 27.2). Central nervous system symptoms led the list. The most common gastrointestinal complaint was "problems digesting food." The most frequent respiratory complaint was "shortness of breath or being unable to get enough air."

Individuals' symptoms are often exposure-specific, e.g., "spaciness" or an upset stomach around diesel exhaust, irritability in the detergent aisle of a grocery store, or confusion with a particular fragrance. Some patients say the nature of their symptoms helps them identify a particular trigger (e.g., a pesticide), even when no odor is evident. Individuals who shared the same initial exposure event (e.g., remodeling of the EPA's headquarters building—see Case Study 2) may report very different symptoms.

Illness often begins with "flu-like" symptoms, resembling "chronic fatigue syndrome," a diagnosis many eventually acquire (Buchwald and Garrity 1994). Awareness of chemical or food intolerances develops gradually, sometimes accidentally, e.g., following a work holiday or vacation trip (especially to a relatively clean environment such as the mountains or seashore). In these situations, the chemically intolerant may become "unmasked." Then when they return to their workplace or home, their symptoms flare up. After this happens several times, they begin to suspect environmental causes.

27.7 THE INTERNATIONAL EXPERIENCE WITH MULTIPLE CHEMICAL INTOLERANCE

Researchers have described this phenomenon—groups of individuals developing multisystem symptoms and new-onset intolerances following an initial chemical exposure event—in more than a dozen countries, including the United States, Canada, Australia, New Zealand, and nine European nations. These groups include: radiology workers from New Zealand and other nations exposed to x-ray developer solution containing glutaraldehyde and other solvents (Genton 1998); federal employees in the EPA headquarters building in Washington, D.C., exposed to volatile organic chemicals outgassing from new carpet and construction materials (Hirzy and Morison 1989, EPA 1989); homeowners in Germany exposed to pentachlorophenol wood preservative used in log homes (Ashford et al. 1995); sheep dippers in Great Britain exposed to organophosphate pesticides (Ashford and Miller 1998, Monk 1996, Stephens et al. 1995); hospital workers in Nova Scotia exposed to building air contaminants (Ashford and Miller 1998); casino card dealers in Lake Tahoe, California, exposed to solvents and pesticides (Cone and Sult 1992); and Gulf War veterans exposed to various chemicals and drugs during military service (Miller and Prihoda 1999a, 1999b; Ashford and Miller 1998; Fiedler et al. 1996b; Miller 1996).

A study comparing European and U.S. experiences with the condition revealed that "initiating" exposures involving pesticides and solvents were commonly reported on both

continents (Ashford et al. 1995, Ashford and Miller 1998). There were notable differences between countries that may inform future studies. For example, pesticides were not implicated in Sweden, Finland, and the Netherlands, where cooler temperatures help control insects. Organophosphate and carbamate pesticides are frequently cited initiators in the United States. Those who first become sick after organophosphate or carbamate pesticide exposures tend to report more severe symptoms, on average, than those exposed to building air contaminants, suggesting that pesticides in these classes might be especially potent initiators (Miller and Mitzel 1995).

Organic solvent initiating exposures were reported in all nine European countries surveyed and in North America. Most of these exposures were chronic, involving repeated solvent use, rather than a one-time chemical spill or release. A so-called wood preservative syndrome, attributed to pentachlorophenol used to preserve logs for homes, appeared only in Germany (Schimmelpfennig 1994). Notably, sick building syndrome, which is widely recognized in Scandinavia, has not been associated with cases of multiple chemical intolerance there. Perhaps the fact that Scandinavians tend not to use pentachlorophenol or pesticides indoors might explain this. Onset with new carpeting installation has been noted there, however.

Environmental activism may influence prevalence rates in some countries; however, similar illnesses appeared in every European country studied (Ashford et al. 1995). The practice of clinical ecology (Sections 27.2 and 27.11), which began in the United States and spread to Canada and the United Kingdom, may explain the apparent higher prevalence in those countries, but it fails to explain the illness' presence in Germany and Holland. Differences in cultural practices may play a role. In Europe, people tend to spend more time out of doors, walking to work and shopping, and windows in homes and offices are frequently left open, while in the United States, 90 percent of people spend their day indoors, often in tightly sealed schools, homes, and office buildings.

Building construction materials and furnishings vary greatly between countries, e.g., wall-to-wall carpeting versus washable throw rugs, or no floor covering at all; solid hardwood furnishings versus particle board, veneered or pressed wood; varying use of paint, wallpaper, and adhesive constituents; and office equipment, including photocopiers, computers, and laser printers. Ventilation practices also differ between countries and cultures. In North America, tightly constructed office buildings and schools with little or no provision for fresh outside air have become increasingly common over the past 2 decades. Chemical use indoors, e.g., pesticides, cleaners, personal care products, fragrances, etc., also varies greatly between nations.

27.8 RELATIONSHIP BETWEEN MULTIPLE CHEMICAL INTOLERANCE AND INDOOR AIR POLLUTANTS

Indoor air pollutants are among the most frequently cited initiators *and* triggers for multiple chemical intolerance. Over the past 2 decades, the condition has become widely known among indoor air professionals. Proposed explanations for the condition's apparent increase include:

1. The exponential rise since World War II in synthetic organic chemical production and use (including pesticides), indoors and out, resulting in widespread exposure to novel chemical species never encountered during human evolution
2. The construction of tighter, more energy-efficient housing, offices, and commercial buildings, together with decreased fresh outside air supply resulting from energy conservation measures during the oil embargo of the mid-1970s

3. The fact that today more people spend the majority of their day indoors, in buildings or vehicles, inhaling myriad, low-level volatile organic chemicals

Indoor air pollutants not only appear to set off symptoms in the chemically intolerant, but several studies suggest that some pollutants or pollutant mixtures may also initiate the condition (Miller and Mitzel 1995; Cone and Sult 1992; Miller and Prihoda 1999a, 1999b). Indoor air VOC levels tend to be much higher during or soon after remodeling or new construction, by as much as several orders of magnitude, than those later said to trigger symptoms. Differentiating between exposures that initiate the process and those that trigger the first robust symptoms is not always possible. For example, a person might become ill following a pesticide application at home (initiation), but notice the most pronounced symptoms with workplace exposures to fragrances, new carpet, paint, particle board, furnishings, etc., at work (triggering). The former may cause subtle and gradual loss of tolerance; the latter, robust and immediate symptoms. About 40 percent of chemically intolerant individuals are unable to recall any initiating events (Fiedler et al. 1996a); others describe a series of exposures they feel caused stepwise deterioration in their health; and still others report lifelong health problems and intolerances that are exacerbated by indoor air contaminants.

27.9 CASE DEFINITIONS

By definition, a syndrome is "a *group* of symptoms or signs typical of a disease" (Webster's 1986). Technically, therefore, MCS is not a syndrome: The symptoms patients report are too heterogeneous. Different organ systems are affected in different individuals. This feature, more than any other, has encumbered the development of a case definition for the condition. Nevertheless, several consensus case definitions have been proposed that may have utility for research or medical evaluation purposes, e.g., for compensation (Bartha et al. 1999, NRC 1992, AOEC 1992, Nethercott et al. 1993). Some researchers fear that restricting the illness' definition to a limited number of symptoms, as has been done for chronic fatigue syndrome and "Gulf War syndrome," could prematurely constrict the field of view, thereby excluding from study cases that do not fit preordained criteria. For example, some proposed MCS case definitions exclude asthma or depression on the grounds that these are "diagnosable" conditions (Cullen 1987), even though low-level chemical exposures might cause asthma and depression. There is a consensus that scientifically conducted human exposure challenge studies (double-blinded, placebo-controlled) are needed to determine whether chemically intolerant individuals do in fact respond adversely to very low level environmental exposures, at concentrations well below those affecting most people (NRC 1992, AOEC 1992, Miller et al. 1997).

It appears that other medical conditions may share the same two-step mechanism (initiation and triggering) involved in multiple chemical intolerance (see Sec. 27.10). For example, reactive airways dysfunction syndrome (RADS), an asthma-like condition, begins after a specific, acute chemical exposure; subsequently, bronchoconstriction is triggered by diverse chemical inhalant exposures. Some researchers think RADS may be multiple chemical intolerance manifesting in single organ systems, e.g., the lungs (Meggs 1994). Conceivably, some cases of depression (Rosenthal and Cameron 1991, Bell 1994, Bell et al. 1992), migraine headaches, attention deficit disorder, panic attacks, seizures, etc., might be initiated by acute or chronic chemical exposure and thereafter perpetuated by everyday, low-level exposures (Ashford and Miller 1998).

Most case definitions proposed for MCS (summarized in Ashford and Miller 1998) echo the same central observations: chronic, multisystem symptoms triggered by diverse, low-level chemical exposures, with symptoms resolving when those exposures are avoided.

A recent paper (Bartha et al. 1999) proposed six "consensus criteria" for MCS, based primarily on an earlier survey of 89 clinicians and researchers familiar with, but having divergent views of, the illness (Nethercott et al. 1993). The consensus paper defines MCS as (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 (6) with symptoms that occur in multiple organ systems. These same criteria are encompassed by most proposed research case definitions for MCS. The authors recommend that MCS be formally diagnosed *in addition to* any other diagnosable disorders (e.g., migraine, asthma, depression) in all patients in whom the above six criteria are met and "*no single other organic disorder...can account for all the signs and symptoms associated with chemical exposure.*"

Miller and Mitzel (1995) compared symptoms reported by 112 self-identified MCS patients, 37 who traced their illness to a cholinesterase-inhibiting pesticide exposure and 75 to remodeling of a building. *Individual symptom patterns* varied, yet, overall, the two exposure *groups* exhibited statistically similar ordering of symptoms, ranked by intensity. These findings suggest a shared underlying mechanism or final common pathway for the illness despite different initiating exposures. A second comparative study of persons with MCS, Gulf War veterans, and individuals with implants (mostly breast implants) again showed similar distributions of multisystem symptoms and new chemical, food, and drug intolerances, despite differences in reported initiating exposures (Miller and Prihoda 1999a, 1999b). These studies imply that a wide variety of chemical exposures, whether exogenous (e.g., chemical spill, pesticide application, indoor air contaminants) or endogenous (e.g., implants), might initiate multiple chemical intolerance.

27.10 PROPOSED MECHANISMS

The underlying dynamic remains a mystery. Some physicians and researchers view multiple chemical intolerance as a psychogenic phenomenon resembling depression, somatoform disorder, or posttraumatic stress disorder. Others see it as a chemically caused medical illness and propose various physiological explanations (Table 27.4) (for details see Ashford and Miller 1998, Bell et al. 1992, Bascom 1989, Meggs 1994). To date, surprisingly little research has been done looking into possible immunological, neurological, inflammatory, or psychological underpinnings for the condition. Funding for such studies has been scant.

TABLE 27.4 Theories/Mechanisms Proposed to Explain Multiple Chemical Intolerance

Immune dysfunction or sensitization
Neurological damage or sensitization
Impaired detoxification pathways
Inflammation
Vasoconstriction/vasculitis
Psychiatric or psychological disorders:
An erroneous belief that chemicals are causing illness
Posttraumatic stress disorder
Conditioned behavior (odor conditioning)
Somatoform disorder
Depression
Combinations of the above mechanisms

As discussed above, researchers have surveyed more than a dozen countries and in each one have found people who report developing multisystem symptoms and new-onset chemical, food, drug, alcohol, and caffeine intolerances following well-documented exposures, e.g., to pesticides, indoor air contaminants, or solvents. *The fact that these groups, who share little in common save some initial chemical exposure, all report the same new-onset chemical, food, and drug intolerances, is a compelling anomaly.* Compelling anomalies in science expose the limitations of old paradigms and drive the search for new ones. Although the symptoms associated with multiple chemical intolerance are too diverse for it to be a *single* syndrome, it is possible that what we are dealing with is an entirely new *class* of diseases. The germ theory and the immune theory of disease also arose out of a need to explain certain anomalous observations. These theories took seemingly unrelated illnesses involving different organ systems, myriad causal agents, and different *specific* mechanisms and collapsed them into a single general mechanism that fit the observations of reliable observers and just made sense. Fever, the hallmark symptom for infectious diseases, may have its parallel in the new-onset chemical intolerances that mark these illnesses, all of which appear to share the same general mechanism, here referred to as toxicant-induced loss of tolerance (TILT) (Miller 1997, Ashford and Miller 1998, Newlin 1997). Exposures causing TILT, e.g., pesticides, solvents, or combustion products, may be acting via different *specific* mechanisms and affecting different target organs (Fig. 27.1), as is the case for different infectious diseases, e.g., cholera, AIDS, and shingles.

TILT appears to involve two steps (Fig. 27.2) (Ashford and Miller 1998, Miller 1997): (1) First, a single high-level exposure or repeated lower-level exposures to pesticides, solvents, indoor air contaminants, etc. cause loss of tolerance in a subset of those exposed (initiation); (2) thereafter, low levels of common substances—chemicals, foods, medications, alcoholic beverages, and caffeine—set off multisystem symptoms, thus perpetuating illness (triggering).

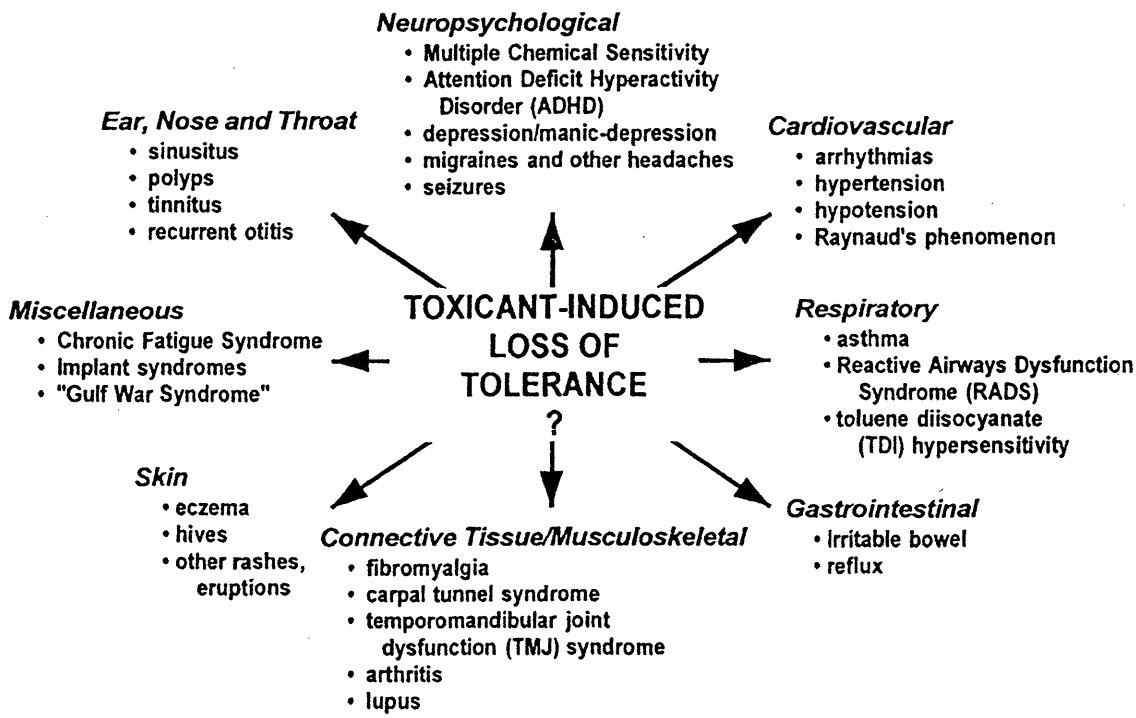

FIGURE 27.1 Conditions that may result from toxicant-induced loss of tolerance. Illnesses like depression, migraine, arthritis, and chronic fatigue may have various underlying mechanisms, one of which might be TILT.

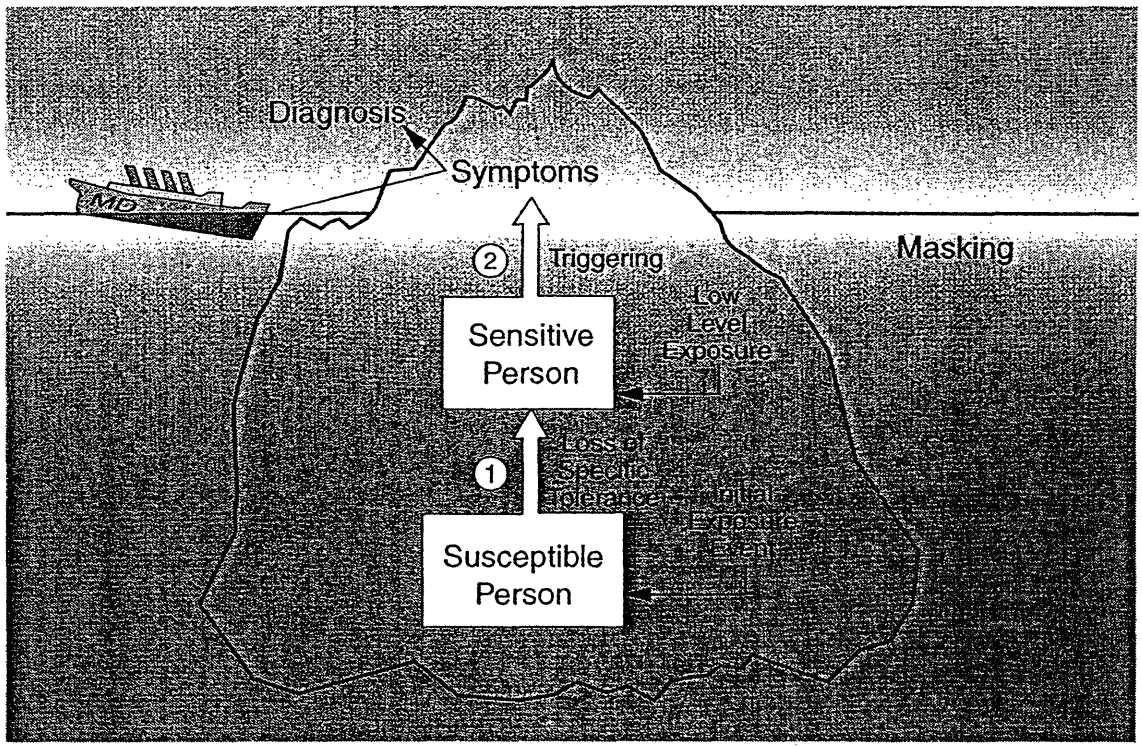

FIGURE 27.2 Phenomenology of toxicant-induced loss of tolerance (TILT). Illness appears to develop in two stages: (1) initiation, i.e., loss of prior, natural tolerance resulting from an acute or chronic exposure (pesticides, solvents, indoor air contaminants, etc.), followed by (2) triggering of symptoms by small quantities of previously tolerated chemicals (traffic exhaust, fragrances), foods, drugs, and food/drug combinations (alcohol, caffeine). The physician sees only the tip of the iceberg—the patient's symptoms—and formulates a diagnosis based on them (e.g., asthma, chronic fatigue, migraine headaches). Masking hides the relationship between symptoms and triggers. The initial exposure event causing breakdown in tolerance also may go unnoticed. (*©UTHSCSA 1996.*)

Which inhalants, foods and drugs trigger symptoms varies from case to case. Many affected individuals say that continued exposure expands their circle of intolerances, a phenomenon referred to as "spreading." Symptoms are exposure-specific and highly individual. For example, one person might experience headaches with diesel exhaust, mental confusion with a certain fragrance, or nausea with cashews. The effects of a single exposure may last for hours. Thus, a person who uses hairspray or fragrances in the morning, cooks breakfast on a gas stove, and then drives through heavy traffic to work in a sick building may experience near-continuous symptoms that overlap in time, creating a kind of background symptom noise that hides or "masks" the effects of single exposures (Miller 1996, 1997). Repeated daily exposure to the *same* trigger, whether office air contaminants or caffeine, appears to result in *habituation,* with symptoms becoming chronic in nature. Masking and habituation tend to blur the symptom-exposure relationship so that physicians, and even the patients themselves, may fail to recognize triggers. "Withdrawal-like" symptoms may occur when exposures are interrupted (e.g., over a weekend) with symptoms becoming robust with reexposure following a period of avoidance, e.g., Monday morning on return to work. Masking may explain the day-to-day variations in symptom intensity most affected individuals initially report.

Converging lines of evidence support TILT as a general mechanism underlying this illness:

1. Similar multisystem symptoms and new-onset intolerances reported by researchers among different demographic groups from more than a dozen countries following well-defined exposures to pesticides, solvents, indoor air contaminants, etc.

2. The fact that these new-onset intolerances are not limited to chemical inhalants but also involve foods, caffeine, alcohol, medications, and skin contactants.
3. The striking parallels between this condition and addiction (see below) suggesting related neural mechanisms (Randolph and Moss 1980, Miller 1997).
4. The identification of an anatomical substrate—the nervous system—whose malfunction could explain these problems,
5. Recent animal models replicating features of TILT (Overstreet et al. 1996, Sorg 1996, Rogers et al. 1999).

Randolph was first to describe the striking resemblance between chemical intolerance and drug addiction. Both are characterized by stimulatory and withdrawal symptoms, cravings, and cross-addiction/intolerances to structurally diverse substances. One theory is that both addiction and chemical intolerance (or "abdiction") might result from loss of tolerance due to repeated exposure to drugs or pollutants, leading to an amplification of stimulatory and withdrawal symptoms. Addicts become addicted, in part, in order to avoid unpleasant withdrawal symptoms. In contrast, chemically intolerant individuals who recognize specific triggers tend to avoid those triggers, but for the same reason addicts remain addicted—in order to avoid unpleasant withdrawal symptoms. Initially, many chemically intolerant individuals consume caffeine and have no idea that it bothers them. In fact, they may experience a brief lift from it, while overlooking the caffeine withdrawal headaches they develop several days later. These apparent polar opposites—addiction and abdiction—thus could be mirror-image strategies for avoiding withdrawal symptoms resulting from TILT (Newlin 1997, Miller 1996, 1999).

Specific physiological mechanisms that might explain TILT and multiple chemical intolerance include olfactory-limbic kindling (sensitization of the nerve pathways that lead from nose to brain) (Bell et al. 1992), other neural sensitization processes (Sorg 1999), neurogenic inflammation (Bascom 1991, Meggs and Cleveland 1993), genetically based or chemically induced cholinergic supersensitivity (Overstreet et al. 1996), and metabolic differences, e.g., decreased sulfation capacity (McFadden 1996), abnormal porphyrin metabolism (Morton 1995), or paraoxonase deficiency (organophosphate detoxifying enzyme) (Costa et al. 1999, Haley et al. 1999).

Proposed psychological mechanisms include odor conditioning, physician-induced (iatrogenic) beliefs, panic disorder, toxic agoraphobia, posttraumatic stress disorder (e.g., illness resulting from a traumatic chemical spill or childhood sexual abuse), somatoform disorder, and depression (Binkley and Kutcher 1997; Göthe et al. 1995; Gots 1995; Guglielmi et al. 1994; Kurt 1995; Pennebaker 1994; Simon 1994; Sparks et al. 1994a, 1994b; Spyker 1995; Staudenmayer et al. 1993; Staudenmayer and Selner 1987; Staudenmayer 1999). Carefully conducted studies are needed to untangle this confusion of competing hypotheses.

Persons who develop chemical intolerances following an "initiating" exposure sometimes suffer from health problems that preceded the "initial" exposure event. Aerospace workers whose chemical intolerances began after a new composite plastic was introduced in a workplace process averaged 6.2 unexplained physical symptoms which *preceded* the change in process, versus 2.9 unexplained symptoms in unaffected coworker controls (Simon et al. 1990) (see Case Study 3). Fifty-four percent of the chemically intolerant workers had a history of anxiety or depression that preceded their exposure, versus 4 percent of controls. Other researchers find that past psychiatric illness does not explain the illness (Fiedler et al. 1992). Even for chemically intolerant individuals who have a history of depression predating their "initiating" exposure, the question remains whether their intolerances are due to depression, whether they may be more vulnerable to developing intolerances because of preexisting depression (altered brain neurochemistry), or whether their

preexposure depression was itself due to prior, unidentified intolerances (Davidoff and Fogarty 1994).

Some researchers have concluded the condition must be psychogenic because it runs counter to accepted disease mechanisms. Davidoff and Fogarty (1994) examined 10 published studies that explored possible psychogenic theories for chemical intolerance. All were found wanting: In these studies, scientifically unsupportable conclusions concerning cause-and-effect were drawn, and psychological symptoms were erroneously assumed to be psychogenic when chemical exposures might also explain them. The study designs failed to exclude physiological mechanisms. Future studies need to be designed to distinguish between competing hypotheses.

27.11 MEDICAL EVALUATION AND TREATMENT

"Clinical ecologists," who today call themselves "environmental physicians," are the physician group historically most sympathetic to this illness. Some worked earlier as allergists, otolaryngologists, etc. before joining the ecologists. Various professional medical societies, especially the allergists, have been critical of the ecologists' claims, and have published position papers critical of their theories and practices, citing the anecdotal nature of their studies, an overreliance on self-reported symptoms, and their "unproven" diagnostic and treatment practices, such as sauna therapy, vitamin and mineral supplements, and provocation/neutralization (subcutaneous injection or under-the-tongue administration of dilute foods and chemicals for testing and treatment). Clinical ecology has been labeled "junk science," and a "medical subculture," the patients as "true believers," and the whole phenomenon as "An unnecessary burden perpetrated on society...tantamount to organized crime" (Staudenmayer 1999, Brodsky 1987, Staudenmayer and Selner 1987, Huber et al. 1992). Some see these attacks on the ecologists as "killing the messenger," using the lack of evidence of theraputic effectiveness not only to reject their unorthodox approaches, but also to reject the legitimacy of the condition.

There is no established or even widely accepted *medical* treatment for multiple chemical intolerance at this time. A multifaceted approach, components of which include the identification and avoidance of chemicals and foods that trigger symptoms, low- or no-cost alterations of patients' physical environments, and psychological support, as appropriate, has the potential to alleviate suffering and prevent worsening of the condition.

In the United States, affected individuals must chart their own course to recovery. Obtaining balanced information and medical help from informed and receptive physicians is difficult. Patients' memory and concentration problems interfere with care seeking, making lifestyle changes, obtaining social support services, etc. difficult, especially in the absence of good family support. Many individuals seek assistance from federal agencies. However, the Environmental Protection Agency (EPA), the Agency for Toxic Substances and Disease Registry (ATSDR), the National Institute of Environmental Health Sciences (NIEHS), the National Institute for Occupational Safety and Health (NIOSH), and various state agencies provide no clear path for obtaining answers or assistance. Canada alone has two government-sponsored clinics devoted to chemical intolerance research and patient evaluation. Comparable facilities are not available in the United States or elsewhere (Ashford and Miller 1998).

Chemically intolerant patients often deplete their financial resources and energies consulting dozens of specialists and trying a host of unproved treatments. In one study, 40 percent had consulted at least 10 medical practitioners (Miller and Mitzel 1995). The average patient makes 23 health care provider visits per year (Buchwald and Garrity 1994). The practitioners they see often have never heard of the condition and little train-

ing is available through medical schools or professional conferences. Various national patient support groups offer counsel free to patients, referring them to sympathetic physicians, attorneys, etc.

Busy doctors seldom take occupational or environmental histories, even when circumstances warrant (IOM 1995). These histories are time-consuming and physicians may be unable to interpret the information they do receive. Potentially important exposures may be missed or dismissed, e.g., recent remodeling, pesticide use. Specialists who focus on single organ systems tend to underestimate the illness' full impact. As a result, chemically intolerant patients migrate from physician to physician accumulating personalized sets of diagnostic labels—organic brain syndrome, chronic fatigue syndrome, psychosomatic disease, migraines, fibromyalgia—unaware of the underlying dynamic. Patients often become angry with and try to avoid doctors they find skeptical or ill-informed, especially since physicians render professional opinions that bear heavily on insurors' determinations, compensation boards, and disability reviewers, as well as the views of employers, friends, and family.

Physicians need to ask about and document chemical, food, drug, alcohol, and caffeine intolerances these individuals may have experienced, both before and since the putative initiating exposure. Self-administered questionnaires, e.g., the 50-item Quick Environmental Exposure and Sensitivity Inventory (QEESI) (see appendix at the end of the chapter), can speed this process (Miller and Prihoda 1999a, 1999b). The QEESI contains five scales that allow patients to self-rate their symptoms, chemical intolerances, other intolerances (foods, drugs, alcohol, caffeine, skin contactants, pollens, dust, molds), life impact, and masking (i.e., ongoing exposures that may hide the symptom-exposure relationship). These scales have been shown to exhibit good reliability, validity (i.e., they correlate well with standard health status and life function measures), sensitivity (92 percent) and specificity (95 percent) (Miller and Prihoda 1999a, 1999b). This screening questionnaire takes only 10 to 15 minutes to complete and can be administered at intervals to monitor progress. The QEESI might also help indoor air consultants identify more vulnerable building occupants and tailor indoor air interventions accordingly. A workplace physician, nurse, or industrial hygienist could also provide the QEESI to individuals who report building-related health problems.

Physicians may be hesitant to diagnose multiple chemical intolerance even when they feel this label best fits the patient's situation. They tend to use "piecemeal," but widely accepted, diagnoses with compensable diagnostic codes, e.g., asthma, toxic encephalopathy, or migraine headache. Workers' compensation boards and insurance companies often challenge a multiple chemical sensitivity diagnosis, undermining physicians' willingness to use it. In contrast, toxicant-induced loss of tolerance, which describes the underlying mechanism—the breakdown in tolerance resulting from exposure that has been reported by reputable scientists in numerous, peer-reviewed medical articles, has not yet been scrutinized or challenged in this manner.

It is the responsibility of health care providers to discuss TILT with their patients *when symptoms and circumstances warrant.* Which symptoms? Fatigue, memory and concentration difficulties, mood changes, and multisystem health problems. The more organ systems are affected, the more practitioners should entertain this possibility (recalling that when the illness begins, only a single organ system may be involved). What circumstances? If symptoms develop in the aftermath of an exposure to solvents, pesticides, a sick building, remodeling, or new construction; if a sudden, major change in an individual's health has occurred; if clinical laboratory abnormalities (e.g., pulmonary function tests) appear after the exposure and/or improve with avoidance and/or worsen with reexposure; if others who share the same initial exposure became ill at about the same time, particularly if they manifest multiple symptoms and intolerances; and if formerly well-tolerated exposures—chemicals, foods (or feeling ill after meals or if a meal is missed), medications, alcohol, or

caffeine—now set off symptoms. New-onset depression, asthma, severe headaches, etc., *in the absence of other clear causes,* should invite inquiry as to whether chemical intolerance might be involved. None of the above factors alone "proves" anything, but the more that fit, the more the practitioner should suspect TILT.

Under circumstances like these, a practitioner needs to help patients understand the divergent opinions about this illness in the medical community, explore available treatment options, including psychological therapies, social support interventions, and avoidance strategies, being mindful that the efficacy of any treatment for this condition remains unproved, and help patients understand that the underlying mechanism remains a mystery and that no test is diagnostic of the problem.

The value of a careful exposure history cannot be overemphasized. Patients can be instructed to draw their own symptom/exposure timelines: Symptoms and medical problems are recorded across the top of the line, and lifetime events (e.g., changes in jobs, residences, military service, surgeries, pregnancies, remodeling, pesticide use, etc.) along the bottom. A clear, concise chronology, preferably in this format, can bring into clearer focus potential contributory exposures.

A comprehensive physical examination is essential, even though findings are frequently negative or not diagnostic. Routine baseline laboratory tests may be helpful, e.g., a complete blood count and chemistry profile, as well as specific tests suggested by symptoms or physical findings, e.g., thyroid function tests, pulmonary function testing, autoimmune markers, neuropsychological testing, etc. (Weaver 1996). Blood tests for environmental chemicals should be ordered only when specific exposures are suspected *and* the substance is not rapidly metabolized or excreted. Biological specimens can confirm exposure to chlorinated pesticides or *recent* exposure to cholinesterase-inhibiting (organophosphate or carbamate) pesticides, but generally are not helpful for exposures to most solvents, indoor air VOCs, or cholinesterase-inhibiting pesticides months after an acute pesticide exposure. To date, no single, consistently abnormal immunological parameter has been demonstrated in these patients.

Various atypical laboratory findings have been reported in these individuals, including abnormal T and B lymphocyte counts; helper/suppressor T cell ratios; immunoglobulin levels; autoimmune antibodies (e.g., antinuclear, antismooth muscle, antithyroid, antiparietal cell); activated T lymphocytes (TA1 or CD26); quantitative EEGs; evoked potentials; SPECT and other brain scans (Heuser and Mena 1998, Hu 1999, Mayberg 1994, Ross et al. 1999); vitamin, mineral, amino acid, and detoxification enzyme levels; and blood or tissue levels of pesticides, solvents, and other chemicals. Study flaws vary, but include the failure to define the study population (no case definition used); to compare cases with age- and sex-matched controls; to blind specimens so that those performing the analyses are unaware of whether samples came from patients or controls; and to document the test method's accuracy and reproducibility. Some proponents for the illness claim that different immunological abnormalities occur in different patients. However, if enough tests are done, statistically a certain number will be abnormal (e.g., 1 in 20), a fact frequently forgotten.

There is an emerging consensus that "in cases of claimed or suspected MCS, complaints should not be dismissed as psychogenic and a thorough work-up is essential" (EPA 1994). Recognition of chemical intolerance as a disability under the Americans with Disabilities Act (ADA) likewise is growing (see below). Employers who dismiss the condition out-of-hand because of the medical uncertainties surrounding it, or on the basis of their own hunch that it does not exist, leave themselves open to litigation (Winterbauer 1997).

Among treatments patients have tried, the one they most consistently report as helpful is identifying and avoiding their chemical and food triggers (Johnson 1996, LeRoy et al. 1996, Miller 1995). In one study, 97 percent of 112 chemically intolerant individuals reported major food intolerances (Miller and Mitzel 1995). The occupational medicine doc-

tors these patients see are unlikely to attempt food elimination diets. It simply is not part of their training. On the other hand, allergists, who may use elimination diets, often feel ill-prepared to evaluate the patients' chemical exposure concerns. As a result, these patients tend to "fall in the crack" between these two specialties. Inadequate reimbursement for the physicians who see them, the complexities of medical management, and frequent involvement in compensation and litigation have not helped their popularity as patients.

Compounding these difficulties, chemically intolerant patients frequently report adverse reactions to drugs (prescription and over-the-counter) (Miller and Prihoda 1999a). Many either avoid drugs altogether or use reduced doses if possible. Drug side effects, even with standard dosing, and frequent unusual or idiosyncratic reactions frustrate physicians and patients alike (McLellan 1987).

The condition disrupts careers, families, and social lives. Psychological support (to be distinguished from traditional psychotherapy) can be an important therapeutic adjunct irrespective of whether the condition is psychogenic or physical in origin, and may be provided by psychologists, psychiatrists, social workers, or primary care doctors. Some patients have found psychological support "very helpful," although most report that psychological interventions do little to alleviate their responses to chemicals (Miller 1995). Claims that certain psychological and psychiatric interventions are effective are strictly anecdotal (Amundsen et al. 1996, Bolla-Wilson et al. 1988, Guglielmi et al. 1994, Schottenfeld and Cullen 1985, Spyker 1995). No studies comparing the efficacy of exposure avoidance versus psychological/behavioral interventions have been conducted. Some authors have touted psychological interventions as the preferred or only acceptable treatment modality (Sparks et al. 1994b). Given the uncertainties concerning the origins of this condition, these recommendations are at best premature and, at worst, potentially harmful (Miller 1995).

Multiple chemical intolerance is increasingly being recognized as a disability (Winterbauer 1997). Internal memoranda of the Social Security Administration and Department of Housing and Urban Development recognize the illness for purposes of compensation and housing accommodation, respectively. The most recent available statistics from the Equal Employment Opportunity Commission (EEOC) indicate that from November 1, 1993, through September 30, 1998, 465 MCS discrimination-related complaints were filed, 60 percent of which alleged failure of the employer to provide reasonable accommodation and 47 percent of which alleged wrongful discharge (EEOC 2000). MCS complaints have a lower resolution rate (39.9 percent) than other discrimination complaints (81.2 percent) (EEOC 2000).

The courts have struggled over whether the illness should be viewed as a disability, issuing conflicting opinions. Current law would make it difficult for an employer to claim that a condition that so greatly restricts daily activity is not a disability (Winterbauer 1997). The Americans with Disabilities Act obligates employers to seek inexpensive, practical solutions that will reduce troublesome exposures (for a detailed discussion of the ADA and its applicability to MCS, see Winterbauer 1997). It does not require that a chemical-free workplace be provided.

Few affected by this illness report full recoveries, even decades after it develops. There are those rare individuals whose illness was recognized at an early stage, who avoided additional exposure, and who appear to have recovered (see Case Study 4) (Hileman 1991). Early recognition and exposure avoidance thus may have the potential to prevent permanent, disabling illness. Treating the illness once it is entrenched is difficult, underscoring the importance of prompt intervention and exposure avoidance. Physicians and indoor air specialists need to watch for individuals manifesting multiple symptoms and intolerances who may have ongoing exposures to pesticides, remodeling, solvents, etc., and who may be in the initiation phase of the illness. Removal from suspect exposures for 7 to 10 days on a trial basis may be diagnostic, as well as therapeutic. If improvement occurs, and symptoms not so severe as to preclude it, judicious reexposure under a physician's watchful eye may be illuminating.

Case Study 4. Improvement in Chemical Intolerance After Early Intervention

A 50-year old pharmacology professor developed facial itching and eye irritation, which bothered him whenever he worked in his small, windowless university office that was stacked floor-to-ceiling with books, papers, and files. Reading new journals and certain books made his eyes water. He felt better when he worked in the adjoining laboratory, despite its chemicals and solvents, so he moved in there. At home, he took all of his papers and books down to the basement. Despite these measures, his symptoms persisted. He started to notice that the Sunday paper had a pronounced odor and made his eyes water.

Weeks later, he became aware of burning and stinging of his face and inner eyelids when he tried to assemble cardboard file folders or examine freshly developed photographs. A physician suggested to him that he might be suffering from multiple chemical intolerance, and advised him not to touch paper and to air out newly printed materials before reading them. Still, the odor of newspapers became so objectionable that he could not be in the same room with one. Simply walking past a bookshelf full of books set off his symptoms. He resorted to wearing goggles, a face shield, gloves, and a respirator with formaldehyde and VOC absorbent cartridges, and used a desk fan whenever he worked with papers.

His intolerances spread further to include scented soaps, aftershaves, cosmetics, and lotions worn by others. These irritated his upper airway, and caused coughing, chest pain, and difficulty breathing. Carbonless copypaper, new permanent-press pants, automobile interiors, the subway, gasoline, enclosed malls, clothing aisles, his gas stove, felt-tip pens, carpeted areas, and his computer's exhaust also triggered symptoms. He went to see a second physician who recommended that he avoid unnecessary irritant exposures, which he did. Within a month, his symptoms began to improve. Subsequently, he learned that the exhaust vent to his office had been shut off during some repairs and never reopened. Nearly a year after he had first become ill, he was able to return to his laboratory, use solvents, and read new journals with only minor difficulty (Hileman 1991).

Some patients have been able to continue to work, provided they avoid exposures that bother them. Successful workplace accommodations (see Sec. 27.12) have included: increasing fresh air supply and air circulation, removing business machines (fax machines, copiers, laser printers) from the immediate work environment, providing an alternate work space, removing carpeting, selecting odorless and less toxic cleaning agents, adopting integrated pest management, and allowing employees to work from home (Table 27.5).

27.12 ENVIRONMENTAL EVALUATION AND INTERVENTION

Indoor air quality consultants experienced in dealing with multiple chemical intolerance can be helpful in identifying sources and low-cost solutions during an initial walk-through survey. These individuals need to be nonsmokers with an excellent sense of smell, enabling them to track down potential contributory sources, e.g., building materials, furnishings, office equipment, and cleaners. Molds also release VOCs that may trigger symptoms and, conceivably, even initiate the illness. Water leaks, water damage, musty odors or visible mold call for immediate corrective action in any building, no matter how hardy its occupants.

The chemical concentrations that trigger symptoms in these individuals appear to be orders of magnitude below OSHA standards. Unless OSHA limits are exceeded, which will rarely be the case, such standards have no relevance in these situations and should not be invoked nor used as a benchmark for safety. Not infrequently, building owners hire consultants who conduct extensive, expensive air sampling, hoping to assure occupants the

TABLE 27.5 Strategies for Accommodating Chemically Intolerant Individuals

- Adopt a fragrance-free workplace policy, asking that no scented products be worn during work hours. Some organizations have adopted dress codes that discourage fragrance use. Others post signs. Under no circumstances should affected individuals be named in memos or signage. Many people do not realize that shaving lotions, aftershaves, fabric softeners, deodorants, hairspray, and handcreams commonly contain fragrances; they need to know that even the fragrances they most enjoy wearing contain VOCs that may be noxious to others. Fragrances are readily transferable from hands to papers, posing a potential problem for highly susceptible individuals. Hospitals, especially, should be fragrance-free. Patients suffering from asthma, migraine headaches, nausea (e.g., individuals undergoing chemotherapy), not just multiple chemical intolerance, often are bothered by odors. The Mayo Clinic in Scottsdale, Arizona, discourages fragrance use by staff with a statement in its dress and decorum policy and quarterly newsletter reminders to employees: "Perfume Usage—for the consideration of patients and co-workers, please do not use heavily scented perfumes and colognes. Patients as well as employees may be allergic to certain scents, and heavy perfume/cologne usage can cause them discomfort or make them ill."

  Fragrance sprays and dispensers in restrooms, and scents or "air fresheners" dispensed automatically into the air or ventilation system, need to be eliminated. Unscented, nonodorous cleaning agents are preferred for restrooms, floors, and other surfaces. If restrooms are properly cleaned and ventilated, air fresheners should not be needed to mask odors. *Note:* The University of Minnesota's School of Social Work has a fragrance-free policy for offices and classrooms. Signs alert visitors: "Some persons employed or studying in the School of Social Work report sensitivities to various chemical-based or scented products. We ask for everyone's cooperation in our efforts to accommodate their health concerns." Several California cities have adopted fragrance-free resolutions or policies, in order to improve access to public events and facilities for the chemically intolerant.
- Modify or relocate the affected individual's work space so as to increase fresh air ventilation and reduce troublesome exposures. Other potentially helpful strategies include: Openable windows, fresh air exchangers, and/or adequately sized air filtration units with filter media for particulates and vapors; eliminating odorous furnishings, e.g., carpet, particle board furniture, or odorous veneers, laser printers, copiers, carbonless copypaper (some brands may be better tolerated); and placing personal computers and printers in ventilated enclosures with glass fronts. Metal desks and shelving may be preferable to veneers or particle board. Some employers have assigned an assistant to chemically intolerant employees to help with photocopying, entering problem areas, etc. In a few cases, state disability funds have paid for assistants.
- Provide personal protective equipment, e.g., face masks with appropriate filters, for meetings or other short-term exposures.
- Notify susceptible individuals in advance about maintenance activities that may pose a problem for them. Provide schedules for cleaning, extermination, floor waxing, repair and construction work, landscape chemical applications, or mowing. Alternatively, schedule these activities while affected employees are away from the building. Offer temporary, alternative work arrangements, e.g., during carpet cleaning, painting, or pesticide application, until employees can reenter the space without experiencing symptoms.
- Select the least toxic, most odor-free construction and maintenance supplies. Affected individuals' advice should be sought when choosing paint brands, cleaning products, whiteboard markers, new furnishings, etc.
- Eliminate, or at least minimize, pesticide use indoors and out. Lawn treatment chemicals, herbicides, etc., can migrate indoors via air intakes, cracks, and crevices (consider how a skunk's odor seeps indoors even when windows are closed). Use integrated pest management (IPM), applying pesticides only when non- or less-toxic approaches fail. IPM emphasizes improved sanitation, mowing, insect traps, baits, and sealing crevices and openings (for one university's experience with a pest control policy to protect the chemically intolerant, see Brown 1999). If pesticides are needed, then select the least toxic, least volatile, and least persistent formulation that will still work.

TABLE 27.5 Strategies for Accommodating Chemically Intolerant Individuals (*Continued*)

- Allow affected individuals to adopt flexible schedules and even work from home. Certain jobs permit flexible work hours, enabling chemically intolerant individuals to avoid traffic and traffic exhaust, or customers or coworkers wearing fragrances. Telemarketing, writing, or computer assignments may lend themselves to work-at-home arrangements. Employers need to ensure that such off-site employees know their assignments, function as full partners in the workforce, and are eligible for awards and other perquisites.
- Educate the entire workforce. All coworkers, custodial staff, maintenance personnel, etc. must receive instruction concerning the nature of the disability. This is essential for enlisting coworkers' support (e.g., for fragrance-free policies), and avoiding stigmatization or harassment of those affected. Coworkers need to understand that chemically intolerant individuals may *appear* well and occasionally be seen in restaurants, movie theaters, or hair salons, or working on their car without obvious difficulties, but that their health may be jeopardized by certain exposures. Managers need to show that they take the illness seriously and explain the protective actions being taken. A positive, proactive approach will prevent grumbling or unkind remarks or actions by coworkers. An appropriately phrased memo may preempt inconsiderate behavior by others, e.g., deliberate perfume use or spraying of fragrances on the affected individual's chair or telephone, actions that potentially could expose the employer to a harassment suit.

building is safe. The obliging consultant's report finds that exposures in the building are well below OSHA limits—an uninformative and potentially disastrous conclusion. Affected occupants are apt to see this as management's discounting their symptoms or questioning their veracity. Compensation claims and litigation can be the unfortunate result.

Environmental interventions for the chemically intolerant target three building occupant groups: (1) those who are healthy, but if exposed, may be at increased risk for developing the illness; (2) individuals who show early signs of TILT, e.g., those whose symptoms persist hours or days after they leave the building and/or who are beginning to develop new intolerances; and (3) those with the full-blown condition. Protective measures directed at these groups involve: (1) prevention; (2) early intervention; and (3) accommodation, respectively.

Achieving good indoor air quality draws on the entire compendium of strategies in this handbook—the use of nonoutgassing construction materials and furnishings, sufficient fresh makeup air, moisture control, proper HVAC maintenance, etc. Protecting the most vulnerable occupants should provide a margin of safety for others. Intervention during the illness' initiation phase has the potential to halt or even reverse its course (see Case Study 4). Like the proverbial canary in a coal mine, these individuals may be sentinels for building exposures that could be affecting others to varying degrees, e.g., causing eye irritation or lowering productivity. Illness recognition may occur in the workplace or a doctor's office. An employer's industrial hygienists and physicians are best positioned to recognize symptoms associated with workplace exposures. The QEESI (Sec. 27.11 and appendix to the chapter) can help affected individuals understand their condition better, enabling them to recognize triggers at work and at home, e.g., household extermination, hobby exposures, or home remodeling. At the present time, early recognition and prompt removal from exposure offer the most promise for reversing the condition.

Once the illness progresses beyond a certain point, no current medical treatment reliably reverses it. For this reason, it is crucial to respond to complaints immediately and to act quickly to resolve the problems. Frequently, an individual can be moved to another area or allowed to work at home temporarily to prevent worsening illness and disability, while management determines, preferably with the help of the affected individual and perhaps the physician, what actions are needed to remediate the problem. Accommodating chemically

intolerant individuals in the workplace is challenging. There are some low-cost interventions. An ongoing partnership between the affected person(s), management, personal physicians, the company's health professionals, industrial hygienists, building engineers, and maintenance staff should be established. Single interventions rarely are curative. More often, a trial-and-error process over an extended period, e.g., weeks or months, is required. Not every intervention will work. Installing an openable window might bring in exhaust from idling vehicles or buses. Moving the workstation away from copier machines and coworkers' fragrances will not be helpful if the new workstation is next to a restroom or janitor's closet.

People who are chemically intolerant fear being singled out or considered workplace troublemakers. Many simply suffer silently. If they appear well, coworkers may assume incorrectly that things are fine. Continued exposure, however, may jeopardize their health, as well as the health of others. Individuals who have had the condition for years are often the best source of information concerning what corrective measures may be beneficial.

Some patient support and advocacy groups work willingly with employers and employees to help identify cost-effective interventions. The director of one group, the National Center for Environmental Health Strategies, has served on federal advisory committees for housing and employment accommodations under the Fair Housing Act and the Americans with Disabilities Act (Lamielle 1999). Employers tend to steer clear of these groups for fear they may demand chemical-free workspaces. Reportedly, this is not the case. Neither is it incumbent on an employer to adopt these groups' recommendations. Rather, "to some degree, the employer's choice is between learning what these sources have to say at the outset of the accommodation process or in the middle of a trial" (Winterbauer 1997). Seeking advice from support groups demonstrates both a good faith effort and that the employer considers the employee inherently reasonable. Many employers have successfully accommodated chemically intolerant individuals, thereby retaining productive, loyal, and grateful employees (Miller et al. 1999, Brown 1999) (see Case Study 5).

Case Study Number 5. Workplace Accommodation for Multiple Chemical Intolerance

Three women with multiple chemical intolerances learned that the government agency they worked for was about to move to a new office building. In response to their concerns, an industrial hygienist conducted baseline air sampling just prior to move-in. Total VOC concentrations of 200 $\mu g/m^3$ (toluene equivalent units with chemical constituents) were found (Miller et al. 1999). Soon after the move, all three women reported worsening of their symptoms, including severe asthma, seizure-like activity, headaches, irregular heart beat, feelings of drunkenness, unsteadiness, light-headedness, cognitive difficulties, irritability, fatigue, and skin burning and redness, and worsening and/or spreading of their intolerances to chemicals associated with new construction, vapors from copier machines and fax machines, perfumes, and insecticides.

One woman who experienced balance problems and light-headedness in the new office building, ended up transferring to an older building and finally had to work from home. Another who became ill also left the building, but was able to return when an air cleaner equipped with charcoal/high-efficiency particulate filters was installed in her office. The third woman was able to work normally in the building, but only after it had outgassed for a year. One year postconstruction, a fourth chemically intolerant woman came to work in the same building. She experienced no major difficulties in the building, however, outside of work she noticed having reactions to perfumes, vehicle exhaust, petroleum and paint vapors, tire stores, carpeting, pet supplies, and insecticides.

One of the women reported having been chemically intolerant all her life. The others said they became sick after staying in a new motel room, working with laboratory solvents, or during new home construction. Workplace accommodations included scheduling maintenance activities while the women were away and providing respirators as needed (Miller et al. 1999). None of the other building occupants reported developing chemical intolerances, suggesting that VOC levels in the building were below those that might initiate TILT.

APPENDIX: THE QEESI©[1]

The Quick Environmental Exposure and Sensitivity Inventory (QEESI©) was developed as a screening questionnaire for multiple chemical intolerances (MCI). (See Miller and Prihoda 1999a, 1999b.) The instrument has four scales: symptom severity, chemical intolerances, other intolerances, and life impact. Each scale contains 10 items, scored from 0 = "not a problem" to 10 = "severe or disabling problem." A 10-item masking index gauges ongoing exposures that may affect individuals' awareness of their intolerances as well as the intensity of their responses to environmental exposures. Potential uses for the QEESI include:

1. *Research*—to characterize and compare study populations, and to select subjects and controls.
2. *Clinical evaluations*—to obtain a profile of patients' self-reported symptoms and intolerances. The QEESI can be administered at intervals to follow symptoms over time or to document responses to treatment or exposure avoidance.
3. *Workplace or community investigations*—to identify and assist those who may be more chemically susceptible or who report new intolerances. Affected individuals should have the option of discussing results with investigators or their personal physicians.

Individuals whose symptoms began or intensified following a particular exposure event can fill out the QEESI using two different ink colors, one showing how they were before the event, and the second how they have been since the event. On the cover of the QEESI is a "symptom star" (Figure 27.3), which provides a graphical representation of patients' responses on the symptom severity scale.

Interpreting the QEESI©

In a study of 421 individuals, including four exposure groups and a control group, the QEESI provided sensitivity of 92 percent and specificity of 95 percent in differentiating between persons with multiple chemical intolerances and the general population (Miller and Prihoda 1999a, 1999b).

Cronbach's alpha reliability coefficients for the QEESI's four scales—symptom severity, chemical intolerances, other intolerances, and life impact—were high (0.76 to 0.97) for each of the groups, as well as over all subjects, indicating that the questions on the QEESI form scales showing good internal consistency. Pearson correlations for each of the four scales with validity items of interest, i.e., life quality, health status, energy level, body pain, ability to work, and employment status, were all significant and in the expected direction, thus supporting good construct validity.

Information on the development of this instrument, its interpretation, and results for several populations have been published (Miller and Prihoda 1999a, 1999b). Proposed ranges for the QEESI's scales and guidelines for their interpretation appear in Tables 27.6 and 27.7.

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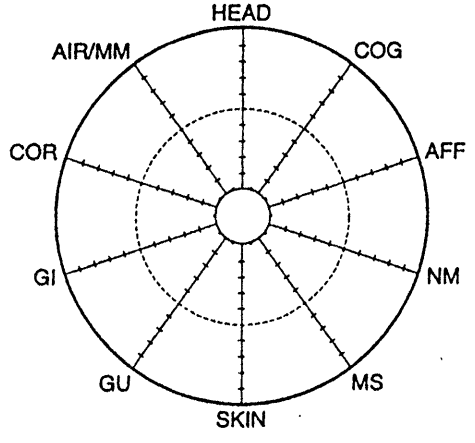
[1]For additional copies of the QEESI©, contact Claudia S. Miller, M.D., M.S., University of Texas Health Science Center at San Antonio, Department of Family and Community Medicine, 7703 Floyd Curl Drive, San Antonio, TX 78229-3900. Phone: (210) 567-7760; fax: (210) 567-7764; email: millercs@uthscsa.edu. For further information see *Chemical Exposures: Low Levels and High Stakes* by Nicholas A. Ashford and Claudia S. Miller, John Wiley & Sons, 1998 (1-800-225-5945).

Quick Environmental Exposure and Sensitivity Inventory V-1

(QEESI)©

The purpose of this questionnaire is to help identify health problems you may be having and to understand your responses to various exposures. If your health problems began suddenly or became much worse after a particular exposure event, such as a pesticide exposure or moving to a new home or office building, complete pages 1-3 describing how you are now, then go back through these same questions a second time, and identify how you were before the exposure event. After you have completed all of the items on pages 1-5, fill in the "target" diagram below.

Symptom Star



Instructions: After completing pages 1 through 5, unfold page 3 so that it lies just to the right of this page. Place a small dot on the corresponding spoke for each symptom item on page 3. Connect these points, For "before and after " scores (described above), use two different colors.

CHEMICAL EXPOSURES

The following items ask about your responses to various odors or chemical exposures. Please indicate whether or not these odors or exposures would make you feel sick, for example, you would get a headache, have difficulty thinking, feel weak, have trouble breathing, get an upset stomach, feel dizzy, or something like that. For any exposure that makes you feel sick, on a 0-10 scale rate the severity of your symptoms with that exposure. For exposures that do not bother you, answer "0." Do not leave any items blank.

0 = not at all a problem
5 = moderate symptoms
10 = disabling symptoms

For each item, circle one number only:

1.	Diesel or gas engine exhaust	0 1 2 3 4 5 6 7 8 9 10
2.	Tobacco smoke	0 1 2 3 4 5 6 7 8 9 10
3.	Insecticide	0 1 2 3 4 5 6 7 8 9 10
4.	Gasoline, for example at a service station while filling the gas tank	0 1 2 3 4 5 6 7 8 9 10
5.	Paint or paint thinner	0 1 2 3 4 5 6 7 8 9 10
6.	Cleaning products such as disinfectants, bleach, bathroom cleansers or floor cleaners	0 1 2 3 4 5 6 7 8 9 10
7.	Certain perfumes, air fresheners or other fragrances	0 1 2 3 4 5 6 7 8 9 10
8.	Fresh tar or asphalt	0 1 2 3 4 5 6 7 8 9 10
9.	Nailpolish, nailpolish remover, or hairspray	0 1 2 3 4 5 6 7 8 9 10
10.	New furnishings such as new carpeting, a new soft plastic shower curtain or the interior of a new car	0 1 2 3 4 5 6 7 8 9 10

Total Chemical Intolerance Score (0-100): ____

Name any additional chemical exposures that make you feel ill and score them from 0 to 10:_____

_____

_____

_____

_____

OTHER EXPOSURES

The following items ask about your responses to a variety of other exposures. As before, please indicate whether these exposures would make you feel sick. Rate the severity of your symptoms on a 0-10 scale. Do not leave any items blank.

0 = not at all a problem
5 = moderate symptoms
10 = disabling symptoms

For each item, circle one number only:

1.	Chlorinated tap water	0 1 2 3 4 5 6 7 8 9 10
2.	Particular foods, such as candy, pizza, milk, fatty foods, meats, barbecue, onions, garlic, spicy foods, or food additives such as MSG	0 1 2 3 4 5 6 7 8 9 10
3.	Unusual cravings, or eating any foods as though you were addicted to them; or feeling ill if you miss a meal	0 1 2 3 4 5 6 7 8 9 10
4.	Feeling ill after meals	0 1 2 3 4 5 6 7 8 9 10
5.	Caffeine, such as coffee, tea, Snapple, cola drinks, Big Red, Dr. Pepper or Mountain Dew, or chocolate	0 1 2 3 4 5 6 7 8 9 10
6.	Feeling ill if you drink or eat less than your usual amount of coffee, tea, caffeinated soda or chocolate, or miss it altogether	0 1 2 3 4 5 6 7 8 9 10
7.	Alcoholic beverages in small amounts such as one beer or a glass of wine	0 1 2 3 4 5 6 7 8 9 10
8.	Fabrics, metal jewelry, creams, cosmetics, or other items that touch your skin	0 1 2 3 4 5 6 7 8 9 10
9.	Being unable to tolerate or having adverse or allergic reactions to any drugs or medications (such as antibiotics, anesthetics, pain relievers, x-ray contrast dye, vaccines or birth control pills), or to an implant, prosthesis, contraceptive chemical or device, or other medical, surgical or dental material or procedure	0 1 2 3 4 5 6 7 8 9 10
10.	Problems with any classical allergic reactions (asthma, nasal symptoms, hives, anaphylaxis or eczema) when exposed to allergens such as: tree, grass or weed pollen, dust, mold, animal dander, insect stings or particular foods	0 1 2 3 4 5 6 7 8 9 10

Total Other Intolerance Score (0-100): ____

SYMPTOMS

The following questions ask about symptoms you may have experienced commonly. Rate the severity of your symptoms on a 0-10 scale. Do not leave any items blank.

0 = not at all a problem
5 = moderate symptoms
10 = disabling symptoms

For each item, circle one number only:

1	Problems with your muscles or joints, such as pain, aching, cramping, stiffness or weakness?	MS 0 1 2 3 4 5 6 7 8 9 10
2	Problems with burning or irritation of your eyes, or problems with your airway or breathing, such as feeling short of breath, coughing, or having a lot of mucus, post-nasal drainage, or respiratory infections?	AIR/MM 0 1 2 3 4 5 6 7 8 9 10
3	Problems with your heart or chest, such as a fast or irregular heart rate, skipped beats, your heart pounding, or chest discomfort?	COR 0 1 2 3 4 5 6 7 8 9 10
4	Problems with your stomach or digestive tract, such as abdominal pain or cramping, abdominal swelling or bloating, nausea, diarrhea, or constipation?	GI 0 1 2 3 4 5 6 7 8 9 10
5	Problems with your ability to think, such as difficulty concentrating or remembering things, feeling spacey, or having trouble making decisions?	COG 0 1 2 3 4 5 6 7 8 9 10
6.	Problems with your mood, such as feeling tense or nervous, irritable, depressed, having spells of crying or rage, or loss of motivation to do things that used to interest you?	AFF 0 1 2 3 4 5 6 7 8 9 10
7.	Problems with balance or coordination, with numbness or tingling in your extremities, or with focusing your eyes?	NM 0 1 2 3 4 5 6 7 8 9 10
8.	Problems with your head, such as headaches or a feeling of pressure or fullness in your face or head?	HEAD 0 1 2 3 4 5 6 7 8 9 10
9.	Problems with your skin, such as a rash, hives or dry skin?	SKIN 0 1 2 3 4 5 6 7 8 9 10
10.	Problems with your urinary tract or genitals, such as pelvic pain or frequent or urgent urination? (For women: or discomfort or other problems with your menstrual period?)	GU 0 1 2 3 4 5 6 7 8 9 10

Total Symptom Score (0-100): ____

MASKING INDEX

The following items refer to ongoing exposures you may be having. Circle "0" if the answer is NO, or if you don't know whether you have the exposure. Circle "1" if the answer is YES, you do have the exposure. Do not leave any items blank.

Circle "0" or "1" only:

1.	Do you smoke or dip tobacco once a week or more often?	NO=0 YES=1
2.	Do you drink any alcoholic beverages, beer, or wine once a week or more often?	NO=0 YES=1
3.	Do you consume any caffeinated beverages once a week or more often?	NO=0 YES=1
4.	Do you routinely (once a week or more) use perfume, hairspray, or other scented personal care products?	NO=0 YES=1
5.	Has either your home or your workplace been sprayed for insects or fumigated in the past year?	NO=0 YES=1
6.	In your current job or hobby, are you routinely (once a week or more) exposed to any chemicals, smoke or fumes?	NO=0 YES=1
7.	Other than yourself, does anyone routinely smoke inside your home?	NO=0 YES=1
8.	Is either a gas or propane stove used for cooking in your home?	NO=0 YES=1
9.	Is a scented fabric softener (liquid or dryer sheet) routinely used in laundering your clothes or bedding?	NO=0 YES=1
10.	Do you routinely (once a week or more) take any of the following: steroid pills, such as prednisone; pain medications requiring a prescription; medications for depression, anxiety, or mood disorders; medications for sleep; or recreational or street drugs?	NO=0 YES=1

Masking Index (0-10):
(Total number of YES answers) ____

IMPACT OF SENSITIVITIES

If you are sensitive to certain chemicals or foods, on a scale of 0-10 rate the degree to which your sensitivities have affected various aspects of your life. If you are not sensitive or if your sensitivities do not affect these aspects of your life, answer "0." Do not leave any items blank.

0 = not at all
5 = moderately
10 = severely

How much have your sensitivities affected:

1. Your diet	0 1 2 3 4 5 6 7 8 9 10
2. Your ability to work or go to school	0 1 2 3 4 5 6 7 8 9 10
3. How you furnish your home	0 1 2 3 4 5 6 7 8 9 10
4. Your choice of clothing	0 1 2 3 4 5 6 7 8 9 10
5. Your ability to travel to other cities or drive a car	0 1 2 3 4 5 6 7 8 9 10
6. Your choice of personal care products, such as deodorants or makeup	0 1 2 3 4 5 6 7 8 9 10
7. Your ability to be around others and enjoy social activities, for example, going to meetings, church, restaurants, etc.	0 1 2 3 4 5 6 7 8 9 10
8. Your choice of hobbies or recreation	0 1 2 3 4 5 6 7 8 9 10
9. Your relationship with your spouse or family	0 1 2 3 4 5 6 7 8 9 10
10. Your ability to clean your home, iron, mow the lawn, or perform other routine chores	0 1 2 3 4 5 6 7 8 9 10

Total Life Impact Score (0-100): ____

For additional copies of the QEESI, call 210-567-7760. For more information about this questionnaire, refer to Chemical Exposures: Low Levels and High Stakes (2nd Edition) by Nicholas A. Ashford and Claudia S. Miller, John Wiley & Sons, Inc., 1998. To order, call toll-free 1-800-225-5945.

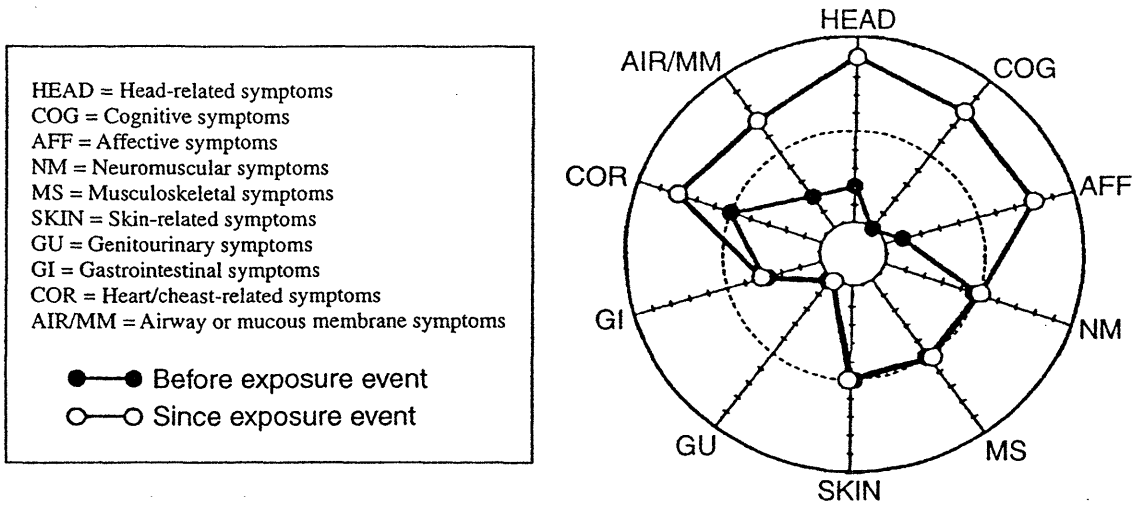


FIGURE 27.3 QEESI symptom star illustrating symptom severity in an individual before and after an exposure event (e.g., pesticide application, indoor air contaminants, chemical spill).

TABLE 27.6 Criteria for Low, Medium, and High Scale Scores

	Score		
Scale/index	Low	Medium	High
Symptom severity	0–19	20–39	40–100
Chemical intolerance	0–19	20–39	40–100
Other intolerance	0–11	12–24	25–100
Life impact	0–11	12–23	24–100
Masking index	0–3	4–5	6–10

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TABLE 27.7 Distribution of Subjects by Group

Uses "high" cutoff points for symptom severity (≥40) and chemical intolerances (≥40), with masking low or not low (<4 or ≥4)

Degree to which MCI is suggested†	Risk criteria*			Percentage of each group meeting risk criteria				
	Symptom severity score	Chemical intolerance score	Masking score	Controls $n = 76$	MCS — no event $n = 90$	MCS — event $n = 96$	Implant $n = 87$	Gulf War veterans $n = 72$
Very suggestive	≥40	≥40	≥4	7	16	23	39	45
Very suggestive	≥40	≥40	<4	0	65	66	36	4
Somewhat suggestive	≥40	<40	≥4	3	1	2	16	26
Not suggestive	≥40	<40	<4	0	0	2	3	6
Problematic	<40	≥40	≥4	7	3	1	1	0
Problematic	<40	≥40	<4	3	13	4	2	0
Not suggestive	<40	<40	≥4	68	1	0	2	18
Not suggestive	<40	<40	<4	12	1	2	1	1
				100	100	100	100	100

*Subjects must meet all three criteria, i.e., symptom severity, chemical intolerance, and masking scores, as indicated in each row of this table.

†"Very suggestive" = high symptom and chemical intolerance scores.

"Somewhat suggestive" = high symptom score but possibly masked chemical intolerance.

"Not suggestive" = either (1) high symptom score but low chemical intolerance score with low masking, or (2) low symptom and chemical intolerance scores.

"Problematic" = low symptom score but high chemical intolerance score. Persons in this category with low masking (<4) may be sensitive individuals who have been avoiding chemical exposures for an extended period (months or years).

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