23 Indoor Air Quality and Associated Disorders

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The focus of occupational medicine has been transformed in many ways by the increasing proportion of the workforce employed in offices and other kinds of public facilities. Once considered safe by crude comparison with industrial settings such as construction, mining, and agriculture, experience has proven that these indoor environments are not free of significant health hazards. Moreover, the workers engaged in these sectors are neither experienced with environmental risks, nor well prepared in general to think about hazards of work, as their industrial counterparts were even long before the modern regulatory era. Finally, because almost all previous attention has focused on the kinds of conditions and hazards that arise in more traditionally dangerous settings, the regulatory framework has not evolved forms of controls that ensure, at least in law, that work will be safe.

This chapter is divided into two sections. The first deals with the spectrum of problems that occur indoors in nonindustrial buildings, focusing on the common features that implicated facilities have. The reader is also referred to Chapter 43 on the health care setting, a specialized and uniquely hazardous nonindustrial setting.

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The second section of this chapter deals with the spectrum of clinical complaints related to low-dose (relative to doses that occur in industry) chemical exposures, which have received increasing attention. Although these problems of chemical sensitivity most often occur in association with indoor nonindustrial environments, they may also be seen in a range of other work settings as well as in the nonwork environment. Their distinguishing feature is the occurrence of symptoms or other clinical problems at levels that are far below those at which knowledge of toxicology would predict effects, and typically far below accepted standards in industry for human exposures (see Chapter 15). These somewhat vexing problems have challenged many of the cherished paradigms of occupational health about what is safe and what is not, and form a special challenge for the occupational specialist, as well as primary care providers whose patients may complain about chemicals at levels deemed "safe."

BUILDING-RELATED CONDITIONS

Sick Building Syndrome

Since the 1970s, office workers worldwide have frequently complained of mucous membrane irritation, fatigue, and headache when working in specific buildings, with improvement within minutes to an hour of leaving the building. This constellation of symptoms, with tight temporal association to building occupancy, is called *sick building syndrome.* It is the most frequent of the building-associ-

ated health complaints in industrialized countries, which also include diseases caused by infection, hypersensitivity, and specific toxins. Researchers have estimated that as many as 30% of office workers report symptoms attributed to poor air quality, and workers in buildings not known to have indoor air-quality problems have many complaints attributed to the indoor work environment.

Despite the impacts on productivity and employee morale when many of a building's workers have sick building syndrome, little progress has been made in understanding the causes of this syndrome. Early investigations of this phenomenon sometimes concluded that symptoms were caused by mass psychogenic illness because no specific contaminants were measured in concentrations that could account for symptoms. However, the endemic nature of complaints in specific buildings and the consistency of complaints from workers in sealed buildings across the world did not satisfy diagnostic criteria for mass psychogenic illness. Fortunately, such attribution to psychological cause is no longer common or acceptable, although work stress is associated with reporting of symptoms among occupants of specific buildings. Occupants of buildings with high levels of complaints are often angry and fearful because they may have encountered resistance of managers to investigation, inconclusive results, or ineffectual remediation for a syndrome whose scientific causes remain elusive.

The recognition of building-related complaints by public health authorities in the United States followed an energy crisis in which ventilation standards were lowered to 5 cubic feet of outdoor air per person per minute. This observation led to the hypothesis that the new building-related symptoms were attributable to lower rates of ventilation in relation to indoor contaminant sources. Some evidence exists, both in cross-sectional and experimental studies, that ventilation rates are related to sick building syndrome prevalence, particularly for ventilation rates below 30 cubic feet per person per minute. Indoor air-quality consultants commonly measure carbon dioxide levels in buildings with high complaint rates. However, human occupants, who are the source of increased concentrations of carbon dioxide in indoor air as opposed to outdoor air, are not the likely source of contaminants that would explain sick building syndrome. Carbon dioxide measurements simply reflect ventilation effectiveness in relation to human occupancy, and are not predictive of sick building syndrome.

The most interesting work on causes of sick building syndrome comes from epidemiologic studies of occupants of buildings selected without regard to known indoor air-quality complaints. These cross-sectional studies suggest that certain building features and occupant characteristics are related to sick building syndrome prevalence. The variation in prevalence of building-related complaints among buildings suggests remediable causes. Occupants of buildings with air conditioning have been shown to have higher rates of building-related symptoms than occupants of naturally ventilated buildings or buildings with mechanical ventilation that does not alter air temperature or humidity. This observation and other work suggest that the ventilation system itself may be the source of poor air quality in some buildings. However, measurable parameters of bioaerosols do not yet exist that consistently correlate with symptom rates, although this is a rapidly developing field of investigation. Other environmental correlates of sick building syndrome include carpeting, high occupancy load, and video display terminal use. Personal factors associated with building-related symptoms in many cross-sectional studies include female sex, job stress or dissatisfaction, and allergies.

The health care provider with the challenge of responding to indoor air-quality complaints must proceed without the benefit of complete scientific understanding of what may be a multifactorial syndrome. No single measurement establishes whether air quality is adequate or inadequate, and the accept-

ability of indoor air quality rests with the occupants, and not a laboratory. In the difficult situation of indoor air-quality complaints, a multidisciplinary approach allows attention to design and maintenance of air-conditioning systems, exclusion of obvious contaminant sources in the occupied space, and reassurance of occupants that sick building syndrome is a self-limited condition. Indoor air-quality investigations customarily assess the ventilation in relation to occupant load by measuring carbon dioxide, suggest remediation of ventilation system maintenance and cleanliness deficiencies, and examine smoking policies. On the multidisciplinary team alongside industrial hygienists and ventilation engineers, health care providers have an important role to exclude the possibility of less common, but more medically serious, building-related diseases that nearly always occur with a background of sick building syndrome complaints among other workers, such as asthma and hypersensitivity pneumonitis.

Building-Related Allergic Disease

A 48-year-old social services eligibility technician began working in the implicated office building in October. She had a history of sinus symptoms and 15 pack-years of cigarette smoking, having been an ex-smoker for 10 years. In January, she began to have insidious onset of dry cough, which in March was diagnosed as asthma. Skin prick tests were negative to aeroallergens, and she was referred to an occupational medicine clinic in August because she noted deterioration during the workday, when she needed to use inhaled bronchodilators, and recovery in the evenings and on weekends, when she did not. Her asthma became much worse when she manipulated dusty records while her desk was being moved. She performed peak-flow measurements with a peak-flow meter, which showed reproducible, striking air-flow limitation shortly after entering the building, with partial recovery during lunch breaks outside the building and full recovery on weekends (Fig. 23-1). Methacholine challenge testing in September and November, before and after a 16-day vacation, found provocative concentrations (PC20) for a 20% decrement in forced expiratory volume in 1 second (FEV_1) of 0.29 and 0.47 mg/mL, respectively (normal PC20 > 15 mg/mL). These results confirmed a diagnosis of asthma and suggested slight improvement in airway hyperreactivity with a short work absence. Although she had notified her employer, her relocation to another building was delayed until late February, after her third course of prednisone treatment. After this relocation, her work-related airflow limitation (documented by peak-flow measurements), her symptoms, and her need for asthma medications all resolved. Her PC20 normalized to above 25 mg/mL 3 months after her relocation.

Nine months later, she was moved back to the original building into a set of offices that shared no ventilation system with the offices that she had previously occupied. Over the next 6 weeks, she experienced increasing symptoms and airflow limitation, once again requiring daily medication, and her PC20 fell to 0.22 mg/mL. She was medically restricted from the implicated building, with resolution of her work-related decrements in peak flows, decrease of her medication requirements, and increase in her PC20 to 5.19 mg/mL over the following 6 weeks. She has had no further difficulty with clinical asthma.

This building was built into an earthen bank, and workers reported musty odors and visible mold growth on the interior wall that abutted the bank. *Aspergillus* species of fungi were detected in the interior air but not in simultaneous measurements of outdoor air, suggesting amplification and dissemination of this bioaerosol indoors. The presumed source of the woman's asthma was fungal bioaerosols associated with moisture coming in from the earthen bank.

Building-related asthma is infrequently recognized by physicians, although it can lead to chronic irreversible illness, unlike sick building syndrome. Early recognition and removal from the building, as in this woman's case, can result in cure of asthma. Permanent asthma can result when recognition of occupational etiology is delayed and asthma becomes severe before the patient leaves the implicated exposure. Such sentinel cases of asthma imply risk for other workers. In this case, public health investigation after

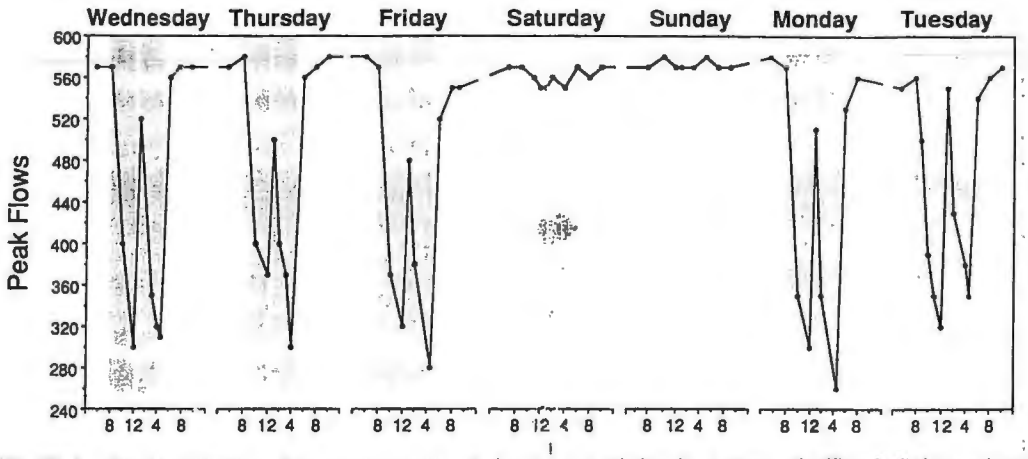

FIG. 23-1. Peak-expiratory flow measurements by hour and day in a case of office building-related asthma. Stippled columns indicate time at work.

two sentinel cases showed that coworkers had nearly five times the prevalence of physician-diagnosed asthma with onset or exacerbation since building occupancy compared with workers in another social service agency (1).

Building-related asthma occurs in water-damaged buildings and in relation to microbially contaminated humidifiers or biocides used in them. The biologic aerosols containing mold spores and perhaps bacteria are thought to be the sensitizing agents. Characterization of bioaerosols is difficult because few laboratories have expertise in identifying saprophytic fungi, in contrast to fungi that cause human infection. Despite the difficulty in characterizing the exposure, the history and peak-flow measurements can be valuable in documenting the occupational nature of building-related asthma. Cases of building-related asthma may occur along with cases of hypersensitivity pneumonitis in water-damaged buildings.

A 46-year-old pediatrician had been followed by an allergist for 10 years for upper respiratory and chest complaints after moving into an office suite. At first, he complained of sinus drainage and a sore feeling in his nose and throat. Over the years, he had acquired achiness in his chest associated with fever, productive cough, chest tightness, wheezing, fatigue to exhaustion, and shortness of breath on exertion. His forced vital capacity (FVC) fell within 3 years of building occupancy, consistent with a restrictive pattern. He had been treated with nasal cromolyn, inhaled steroids, bronchodilators, theophylline, antibiotics, and intermittent oral corticosteroids, without receiving a diagnosis. A year before his referral to an occupational medicine specialist, he had noted exacerbation in his chest symptoms and wheezing when he returned to his office suite after a week away from work. He then began to suspect an office-related cause to his symptoms, with increased cough, chest tightness, and achiness when he entered his suite, and resolution over hours after leaving and improvement on weekends. He noted a musty smell and fungal discoloration of wall board in the suite bathroom, which resulted from leaking pipes.

On referral, he was found to have basilar rales, bronchial hyperreactivity on histamine challenge test, and reduced exercise tolerance with excessive respiratory rate at rest and excessive minute ventilation for oxygen consumption. The chest radiograph was normal, but a high-resolution computed axial tomography scan showed fine centrilobular nodules. Bronchoalveolar lavage showed a lymphocytic alveolitis compatible with hypersensitivity pneumonitis, and a transbronchial lung biopsy showed a mild, patchy lymphocytic interstitial pneumonitis. His symptoms resolved with prednisone and removal from the office suite.

However, 2 months later, chest aching,

exertional shortness of breath, profound fatigue, and chilly feelings recurred within 45 minutes of using a musty restaurant bathroom that had been recurrently water damaged from roof leaks. He had a prolonged recovery time, requiring systemic steroids for 7 months. A year after this acute exacerbation, he again had a recurrence of chest symptoms, within hours of handling medical records from his previous office suite that had become wet when a hot water heater broke in his basement. He again required months of prednisone use and did not fully recover his health until a year later.

This case of building-related hypersensitivity pneumonitis illustrates the typical medical delay in suspecting and diagnosing a building-related etiology for symptoms. Few physicians are aware that office settings can be associated with diseases related to organic antigens. In contrast to building-related asthma, however, there are many published case reports and epidemic investigations of hypersensitivity pneumonitis and humidifier fever (2). Typically, people with hypersensitivity lung diseases may not be able to reoccupy a building in which they were sensitized to biologic aerosols from contaminated humidifiers, ventilation systems, or water-damaged materials on which fungal growth occurred. Even after remediation of the conditions that led to sensitization and disease, low levels of exposure can trigger recurrent symptoms. Because hypersensitivity pneumonitis can lead to irreversible lung fibrosis after recurrent acute episodes or prolonged exposure, early recognition and restricting affected people from the implicated building is the best means of preventing progression. Remediation can prevent cases in coworkers who are not yet sensitized. Occupational health practitioners can encourage specialists to proceed with diagnostic tests before development of classic late-stage abnormalities, such as those shown on chest radiographs. The history of this pediatrician suggests that he was sensitized to an antigen that was not unique to his water-damaged office setting.

Cases of hypersensitivity pneumonitis are often accompanied by systemic symptoms of myalgias, fever, and profound fatigue. These symptoms are not usually present in asthma, although both diseases commonly share chest symptoms, such as cough, chest tightness, and wheezing. In contrast to asthma and hypersensitivity pneumonitis, sick building syndrome alone is not accompanied by chest symptoms. When indoor air-quality complaints exist, health care providers should ensure that building-related asthma and hypersensitivity pneumonitis are not occurring, in addition to the more common complaints of mucous membrane irritation, headache, and fatigue. The occurrence of building-related chest disease dictates evaluation for sources of fungal and bacterial growth and means of dissemination from areas of water damage or from the ventilation system. Chest disease also requires more aggressive medical restriction from the building to prevent chronic disease.

Many patients report that they have building-related nose and sinus symptoms. It is likely that allergic rhinosinusitis can occur, in a way analogous to the response of airways and lung tissue to building-related antigen exposure. Little research has been done on this common clinical complaint to document its occurrence epidemiologically, to distinguish it from mucous membrane complaints in sick building syndrome, or to link it to exposures in implicated buildings.

Building-Related Infection

In 1976, 182 cases of a mysterious pneumonia occurred among members of the American Legion attending a convention in Philadelphia. After months of laboratory investigation, a newly discovered bacterial organism, *Legionella pneumophila*, was found responsible. We now know that this common environmental organism frequently grows in warm waters of building cooling towers in the absence of vigorous attempts to eradicate it. When contaminated cooling tower mists are entrained in air intakes of large buildings, cases of infection with the organism (legionellosis) can occur. Outbreaks have also been

recognized as a result of contaminated industrial water sprays, hospital shower heads, and hot tubs.

In addition to pneumonia, *Legionella* organisms have been associated with another building-related disease called Pontiac fever, which is characterized by fever, chills, headache, and myalgia. This disease was first described in 1968, in a building-related epidemic of 144 cases in a county health department in Michigan. The attack rate was nearly 100%, with an average incubation period of 36 hours.

In addition to infections that cannot be spread to other people, such as *Legionella* pneumonia, building ventilation characteristics are important to the spread of infections that can be passed on to other people, such as viral respiratory infection. Military studies have shown that types of housing with different ventilation characteristics, such as air-conditioned buildings compared with tents or naturally ventilated barracks, are associated with incidence of respiratory symptoms and signs of communicable disease in troops. Other airborne infections, such as tuberculosis, pneumococcal disease, varicella, and measles, may be affected by ventilation rates. A major concern in hospitals, prisons, and shelters is control of tuberculosis, for which ventilation and air disinfection techniques are critical. (See also Chapter 20).

Building-Related Complaints Due to Specific Toxins

Health professionals responding to building-related complaints must also consider specific exposures or toxins as a possible explanation. This is particularly important when complaints differ from those of sick building syndrome or occur in epidemic, rather than endemic, fashion. For example, complaints of headache and nausea dictate consideration of carbon monoxide poisoning, which can occur when air intakes entrain fumes from loading docks, parking garages, or boiler stack emissions. Building-related itching without rash can occur with fibrous glass exposure, which can result when air-duct lining is entrained in the airstream entering the occupied space. Epidemic coughing, dry throat, and eye irritation can result from detergent residues after the misapplication of carpet cleaning products. In instances of building-related complaints associated with specific exposures, a careful evaluation of types of symptoms, their prevalence, and their temporal onset may point investigators to the cause and to remediation resources.

Environmental tobacco smoke may contribute to the irritant symptoms of sick building syndrome. In many buildings, environmental tobacco smoke is circulated throughout the building as air is recirculated, with modest dilution from outdoor air ventilation. In buildings with indoor air-quality complaints, restriction of smoking to areas with separate exhaust ventilation may result in improved air quality for the remainder of the building.

Asymptomatic Problems

Sometimes building-related exposures do not lead to occupant symptoms, but nonetheless pose a health risk. For example, radon gas emitted from building materials, water, and soil surrounding foundations poses increased risk of cancer. Similarly, asbestos in insulation and some building materials in older buildings poses risks of cancer of the lung and other sites as well as nonmalignant lung disease if it is disturbed during occupant activities or renovation. Occupational health specialists and other health professionals are often called to help communicate risks of such exposures to building occupants or the public during removal of asbestos from older buildings.

MULTIPLE CHEMICAL SENSITIVITIES

Since the 1980s, a new clinical syndrome has been recognized in occupational and environmental health practice characterized by occurrence of multisystem symptoms after

exposure to low levels of synthetic chemicals. Unlike any other building-related illness, this disorder recurs in affected people in a diverse array of environmental situations and cannot be readily reversed by attention to any single exposure situation. The following is a representative example of what is now most widely referred to as multiple chemical sensitivities (MCS).

A 46-year-old library worker enjoyed good health until the onset of eye, nose, and throat irritation and recurrent headache associated with a renovation of the library where she worked. She and many coworkers complained primarily of dust and paint fume exposures, which were initially poorly controlled. After several weeks of effort, the employer succeeded in establishing temporary ventilation for the work area and conducting most of the construction activities at night. Almost all of the patient's coworkers improved dramatically after these changes were instituted. She, however, felt no better and began experiencing similar symptoms in her car, at various stores, and whenever she was around anything "scented," especially experiencing these symptoms in the office. She believed she was "reacting" to the small residual levels of construction-related exposures, but temporary transfer to another part of the library brought no relief. New symptoms, including difficulty breathing, muscle and joint aches, and confusion occurred both at work and at home, triggered by an increasing list of offensive odors, irritants and products. Efforts to clean her house of such materials, as well as a trial leave of absence from work (without the benefit of workers' compensation), resulted in only minimal improvement.

On clinical evaluation, the patient appeared well and had no physical findings. Laboratory tests, including workup for respiratory and central nervous system abnormalities, were unrevealing. Consultants in pulmonary medicine, rheumatology, and neurology were unhelpful, as were the various inhalers, nonsteroidal antiinflammatory agents, and migraine therapies. Because of the disparity between complaints and findings, the patient was referred to a psychiatrist who confirmed some depressive features, but could not explain the patient's complaints. A trial of selective serotonin reuptake inhibitor antidepressants was not tolerated by the patient, who discontinued the drug after 3 days.

Finally, frustrated by unsympathetic physicians and her employer, the patient took advice she obtained from the internet and sought an "environmental" physician, who advised total avoidance of all chemical exposures (including her job) and a variety of nontraditional remedies based on results of blood and hair tests, which purported to demonstrate organic chemicals and heavy metal "poisons," as well as immunologic "reactions" to a range of widely found chemicals such as formaldehyde. She remains highly symptomatic.

Although this case occurred in the setting of building-related illness, MCS may develop in any occupational setting and in people who have experienced a single episode or recurring episodes of a chemical injury, such as solvent or pesticide poisoning. Once the problem begins, however, many types of environmental contaminants in air, food, or water may elicit the symptoms at doses well below those that clinically affect others. Although there may not be measurable impairment of specific organs, the complaints are associated with dysfunction and disability. Although MCS is not common, it is prevalent enough to have generated substantial controversy. However, research has not yet elucidated its cause and pathogenesis, nor ways to treat or prevent it.

Multiple Chemical Sensitivities: Definition and Diagnosis

There is no general consensus on a definition for MCS, but certain features are sufficiently characteristic to raise suspicion and differentiate it from other occupational and nonoccupational health problems. Its major features are as follows:

- Symptoms usually occur after an occupational or environmental inhalation or toxic exposure. This precipitating event may be a single episode, such as an exposure to a pesticide spray, or recurrent, as in the case presented previously. Often the initial event or reaction is mild and may merge

without clear demarcation into the syndrome that follows.

- Symptoms resembling those associated with the preceding exposure begin to occur after exposures to surprisingly lower levels of various materials, including chemicals, perfumes, and other common work and household products, especially materials that have a pungent odor or are irritating.
- Symptoms appear referable to many organ systems. Central nervous system problems, such as fatigue, confusion, and headache, occur in almost every case.
- Complaints of chronic symptoms, such as fatigue, cognitive difficulties, and gastrointestinal and musculoskeletal disturbances, frequently complicate the temporal relationship between specific exposures and effects. These more persistent symptoms may even predominate over acute reactions to chemicals in some cases.
- Objective impairment of the organs that would explain the pattern or intensity of complaints is typically absent.
- No other diagnosis easily explains the range of responses or symptoms. Although the patient may, in fact, have other physical or emotional ailments, such as allergy or anxiety, MCS should be considered if it better explains the overall clinical picture.

Of course, not every patient meets these criteria precisely. But because the diagnosis of MCS is, in the end, based on subjective information, each point should be carefully considered. Each serves to rule out other clinical disorders that MCS may resemble, such as generalized anxiety disorder, classic sensitization to environmental antigens (e.g., occupational asthma), late sequelae of organ system damage (e.g., reactive airways dysfunction syndrome after a toxic inhalation), or systemic disease (e.g., systemic lupus erythematosus). On the other hand, MCS is not typically diagnosed by exclusion of all other possibilities, and exhaustive testing is not required in most cases.

In practice, diagnostic problems are seen in two clinical situations. Early in the course of the disorder, it is often difficult to distinguish MCS from occupational or environmental health problems that may have preceded it. For example, patients who have experienced symptomatic reactions to pesticide spraying indoors may find that their reactions are persisting even when they avoid direct contact with these chemicals. In this situation, a clinician might assume that significant exposures could still be occurring and may focus entirely on altering the environment further, which usually does not relieve the recurrent symptoms. This is especially troublesome in an office setting, where MCS may develop as a complication of sick building syndrome (see earlier). Although most coworkers improve after steps are taken to improve air quality, the patient who has acquired MCS continues to experience symptoms despite the lower exposures involved.

Later in the course of MCS, diagnostic dilemmas arise because of the chronic aspects that may obscure the patient's intolerance to common odors and chemicals. After many months, the patient with MCS is often depressed, anxious, and frustrated about his or her health. Physical inactivity, often with weight gain, sleep disturbances, and significant social dysfunction, are common. These phenomena demand considerable attention therapeutically and may also make it hard to focus on the patient's perceived strong intolerance to chemicals and odors.

Pathogenesis

The sequence of pathologic events that leads from apparently self-limited episodes of an environmental exposure to the development of MCS in certain people is not known. There are several current theories.

A group of "environmental" physicians, initially called "clinical ecologists," have promulgated the view that MCS is a form of immune dysfunction caused by insidious accumulation of exogenous chemicals over a lifetime. Susceptibility factors in this view may include nutritional deficiencies (e.g., vi-

tamins and antioxidants), the presence of subclinical infections (e.g., candidiasis), or other host factors. In this theory, the precipitating exposure or exposures are important because of their contribution to lifelong "chemical overload."

Another biologically oriented theory is that MCS represents an atypical biologic sequela of chemical injury, such as a new form of neurotoxicity due to solvents or pesticides, or injury to the respiratory tract after an acute inhalational episode. In this theory, MCS is seen as a final common pathway of different primary disease mechanisms.

A more recent concept has focused on the relationship between the mucosa of the upper respiratory tract and the limbic system, especially the close anatomic proximity of the two in the nose. Under this view, relatively small stimulants to the nasal epithelium could result in amplified limbic responses (as occurs, for example, in addicted people to the substances to which they are addicted), explaining the dramatic and sometimes stereotypic responses to low-dose exposures. This theory also may explain the prominent role of stimuli with strong odors, such as perfumes, in triggering responses in many patients.

Many investigators and clinicians with experience have invoked primarily psychological mechanisms to explain MCS, linking it to other anxiety or affective disorders. Some believe that MCS is a variant of posttraumatic stress disorder or a conditioned response to a toxic experience. One group has suggested MCS is a late-life response to early childhood traumas, such as sexual abuse. In these theories, the precipitating illness plays a more symbolic than biologic role in the pathogenesis of MCS. Host susceptibility is obviously very important in these theories, particularly the predisposition to somaticize psychological distress.

Although there is much published literature, few clinical or experimental studies have been presented or published to support strongly any of these views as the single best explanation for MCS. Research has been hampered by variously defined study populations, inappropriately matched control groups, and lack of "blinding" of subjects and investigators. As a result, most available data are descriptive. Perhaps most difficult of all, debate over the etiology of MCS has been heavily dominated by strong dogmas. Because major financial decisions, such as patient benefit entitlements and physician reimbursement, may depend on how MCS is viewed, many physicians have very strong opinions that make the scientific validity of their observations questionable. Treating MCS patients also requires awareness of the possibility that these theories may be well known to patients as well in the internet era, and they may also have very strong views.

Epidemiology

Detailed information about the epidemiology of MCS is not available. Estimates of prevalence in the U.S. population range as high as several percent, but the scientific basis for these estimates is questionable. Best evidence suggests that although many people find chemicals and other odors objectionable, and may even report discomfort when around them, MCS in clinically overt form is uncommon. Although most available data come from case series by various practitioners who treat patients with MCS, some general observations appear recurrently in the reports:

- Multiple chemical sensitivities occurs most commonly in midlife, although patients of virtually all ages have been described.
- Workers in higher socioeconomic status jobs seem more often affected, whereas economically disadvantaged workers seem underrepresented; this may be an artifact of differential access to occupational and environmental health services, or a diagnostic bias.
- Women are more frequently affected than men.
- Some host factor or susceptibility is important because mass outbreaks have been

uncommon, and only a small fraction of victims of chemical overexposures acquire MCS or anything like it. Although most host factors have not been adequately studied, common atopic allergic disorders do not appear to be an important risk factor for MCS.

Several classes of chemicals have been commonly implicated in the initial presentation of MCS, specifically organic solvents, pesticides, and respiratory irritants. This may be a function of the widespread exposure to these materials. The other commonplace setting in which many cases occur is in the "sick building" situation, with some patients evolving from sick building syndrome into MCS, as in the patient described in the previous case. Although the two illnesses have much in common, their epidemiologic features serve to distinguish them: sick building syndrome usually affects a high proportion of people sharing a common environment, whereas MCS occurs sporadically and without tight temporal association with one environment.

Finally, there is great interest in whether MCS is a new disorder or a new presentation of an old one. Views on this are divided, much as is opinion on the pathogenesis of MCS. Those favoring a biologic role for chemicals argue that MCS is a 20th-century disease with rising incidence related to widespread chemical usage. Those who support psychologic mechanisms see MCS as an old somatoform disorder with a new societal metaphor—the social perception of chemicals as agents of harm.

Natural History

Multiple chemical sensitivities has not yet been studied enough to delineate its clinical course completely, although reports of large series of patients have provided some clues. The general pattern is early progression as the process evolves, followed by less predictable periods of small improvements and exacerbations. These modest changes are often perceived by the patient in relation to environmental factors or treatments, but no scientific basis for such relationships has been established.

Two important observations have been made. First, there is little evidence that MCS is a progressive disorder. Patients do not get worse from year to year in any demonstrable physical way, or have resultant complications, such as organ system failure, unless there is intercurrent illness. MCS is not lethal—perceptions of patients notwithstanding, a basis for a hopeful prognosis and reassurance. Unfortunately, it has been equally clear from clinical series that complete remissions are unlikely, given current treatment (or lack thereof). Although significant improvement may occur, this is usually related to better patient function and sense of well-being. The underlying tendency to react to chemical exposures persists, although symptoms may become tolerable enough to allow a normal lifestyle.

Clinical Management

There remains no specific treatment for MCS. Many traditional and nontraditional strategies have been tried, although few have been subjected to the usual scientific standards to document success or failure, such as a blinded clinical trial. Approaches to treatment of the disorder have followed theories of pathogenesis. Those who believe that MCS is caused by biologic consequences of large burdens of exogenous chemicals have focused attention on avoidance of further exposures through the use of "natural" products and the radical alteration of lifestyle. Diagnostic tests of unproved significance, including body fluid assays for trace organic chemicals and antibodies to common chemicals, have been developed as a basis to attempt to "desensitize" patients. Dietary supplements, such as vitamins and antioxidants, have been recommended to improve host resistance to chemical effects, again without evidence of efficacy. A more radical treatment involves elimination of toxins

from the body by chelation or accelerated turnover of fat, where lipid-soluble pesticides, solvents, and other organic chemicals may be concentrated.

Those who take to a psychological view of MCS have tried approaches consistent with these theories. Supportive individual or group therapies and behavioral modification techniques have been described, although the efficacy of these therapies remains unproved. These patients tend to be intolerant to pharmacologic agents used to treat affective and anxiety disorders, making treatment plans much more difficult.

Despite limitations of current knowledge, certain treatment principles can be synthesized:

To the extent possible, the search to "get to the bottom" of MCS in an individual patient should be minimized—it is counterproductive to starting support and treatment. Many patients have already had considerable medical evaluation by the time MCS is first recognized, and further evaluation, unless necessary to exclude treatable diseases, is often a distraction.

Whatever the particular beliefs of the clinician, the existing knowledge and uncertainty about MCS should be explained to the patient, including the fact that its cause is unknown.

The patient must be reassured that consideration of psychological complications that commonly arise does not mean that the illness is not real, serious, and worthy of treatment.

The patient may also be reassured that MCS is neither progressive nor fatal, but that complete cures are not likely with current modalities.

Uncertainty about pathogenesis aside, it is most often necessary to modify the patients' work environments to remove them from triggers of symptoms. Although radical avoidance is counterproductive to the goal of enhancing function, regular and severe symptomatic reactions must be limited to allow the patient to begin the supportive care he or she needs in a trusting doctor–patient relationship. Often this requires a job change. Workers' compensation may be appropriate in the perspective of MCS as a complication of a work exposure, which often appears to be the case.

The goal of all therapy must be improvement of function because the underlying problem cannot be changed given current knowledge. Psychological problems, such as adjustment difficulties, anxiety, and depression, must be treated, as should coexistent clinical disorders, such as atopic allergies. Because patients with MCS do not tolerate chemicals in general, nonpharmacologic approaches may be necessary. Most patients need direction, counseling, and reassurance to adjust to life with an illness such as MCS. Whenever possible, patients should be encouraged to increase activities to their premorbid level. Passivity and dependence, common responses to the disorder, should not be reinforced.

Prevention and Control

Primary prevention strategies cannot be developed without knowledge of the pathogenesis of the disorder or the host risk factors that predispose some people to become affected. However, reduction of opportunities in the workplace for the overexposures that seem to lead to MCS in some people, including especially respiratory irritants, solvents, and pesticides, may reduce the occurrence of MCS. Certainly better ventilation in offices and other nonindustrial workplaces would also help, and there are more than enough reasons to recommend such an approach.

Secondary prevention would appear to offer some greater control opportunities, although no specific interventions have been studied. Because psychological factors may play a role in victims of occupational overexposures, careful and early management of people who get exposed is advisable even when the prognosis from the exposure itself

is good. Patients seen in clinics or emergency departments immediately after acute exposures should be assessed for their reactions to the events and should probably receive very close follow-up when undue concerns of long-term effects or persistent symptoms are noted. Obviously, efforts should be made for such patients to ensure that preventable recurrences do not occur because this may be an important risk factor for MCS by whatever mechanism is causal.

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Occupational Health

Recognizing and Preventing Work-Related Disease and Injury

Fourth Edition

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