Environmental Health Perspectives
Vol. 95, pp. 67-69, 1991

Severity of Health Effects Associated with Building-Related Illness

by Laura S. Welch*

Building-related illness ranges from mild rhinitis to potentially life-threatening hypersensitivity pneumonitis and legionellosis. Sick-building syndrome, consisting of headache, mucous membrane irritation, and fatigue, may be present in 30% of all office workers. Hypersensitivity pneumonitis, asthma, and legionellosis are less common, and it is difficult from existing studies to estimate the incidence of these more severe illnesses. There are even fewer data on an illness now being called multiple chemical sensitivity and its relationship to indoor environments. New studies are needed to estimate the frequency of all building-associated illnesses, and case definitions for these disorders must be delineated.

Introduction

Several investigators have recently reviewed the health effects of indoor air pollution (*1–6*) as have other speakers at this conference. In this paper, I discuss the extent and severity of health problems from indoor air quality in offices. I address issues of severity of these disorders and do not focus on the etiology. In addition, I do not focus on the long-term risks, including cancer risk, of environmental tobacco smoke, radon, or home combustion products; these have been reviewed in detail by Samet et al. (*1,2*).

First, how can we define severity? From a medical point of view, severity in an individual case is equated to either measured impairment of an organ system or to the degree of disability and not solely to the individual's perception of discomfort. I use this medical definition in discussing severity of health effects. In addition, severity in a public health sense also depends on the prevalence of a disease; a disorder that causes limited impairment in one person but is present in a high proportion of the general population can have a significant public health or population impact.

Impairment and Disability

In any discussion of disability it is important to distinguish between impairment and disability. Impairment is the loss of use or function of some part of the body. Disability is the degree to which that impairment interferes with the individual's ability to work. As an example, arthritis is an impairment of the joints of the body. For a professional singer, arthritis of the hands would not cause a great degree of disability, but for a professional pianist it would cause a total disability. Impairment of the lungs would interfere with the ability of a sheet metal worker to work because his work depends on his ability to be physically active, whereas a clerk-typist with the same degree of lung damage could continue working. Therefore, it is not only the amount of damage to an organ system that would determine how disabled a person is, but also how much he needs to use this organ system to perform his job.

This discussion of the medical effects of indoor air quality of offices is based on two areas: literature review and clinical experience. These two areas give different perspectives on the issue of severity of health effects from indoor air quality. The clinical data tell us what severity of disease presents itself to the physician, whereas from the epidemiological studies we get a perspective of the amount and degree of disease from large-scale surveys of buildings. Please note that these views are quite different. Epidemiologic surveys are usually cross-sectional and do not record data from those who are out of work due to illness. Clinical series have the opposite bias, for the population at risk is not clearly defined; a series of case reports may overstate the magnitude of severe illness secondary to indoor air quality.

Table 1 displays the medical conditions that have been linked to indoor air quality of offices. Table 2 describes the symptoms used to define a case of sick-building syndrome (*7*). It is useful to make a distinction between sick-building syndrome (SBS) and building-associated illness (BAI). BAI has a known etiology and pathological alterations; SBS is a clinical description of a constellation of symptoms in the setting of normal physical and laboratory findings. In the following section, I review briefly the clinical characteristics of the disorders in Table 1.

Table 1. Specific medical effects of poor indoor air quality of offices.

Rhinitis, allergic/nonallergic
Asthma
Hypersensitivity pneumonitis
Humidifier fever
Legionellosis, other infections
Sick-building syndrome
Headache, mucous membrane irritation, difficulty concentrating, fatigue

*George Washington University School of Medicine, Division of Occupational and Environmental Medicine, 2300 K Street, N.W., Washington, DC 20037.

Table 2. Classification of sick-building syndrome.

Sensory irritation of eyes, nose, and throat
Skin irritation
Neurotoxic symptoms
Fatigue
Reduced memory or concentration
Lethargy
Headache, dizziness
Nausea
Odor and taste complaints
Nonspecific reactions
Runny eyes or nose
Asthmalike symptoms in asthmatics

Specific Medical Effects of Poor Indoor Air Quality

Rhinitis. Rhinitis can be classified as allergic or nonallergic. Clinically, the patient has coryza (a runny nose), a sensation of nasal congestion, and a post-nasal drip. Allergic rhinitis is precipitated by exposure to identified allergens such as specific pollens, animal dander, and molds. Nonallergic rhinitis is often called vasomotor rhinitis. It has, by definition, a similar clinical picture but is precipitated by exposures other than allergens, such as perfumes or irritants, and mediated without involvement of the traditional hallmark of allergic rhinitis, IgE.

Hypersensitivity Pneumonitis. Hypersensitivity pneumonitis (HP) is classically an acute, recurrent, noninfectious pneumonia occurring within 4 to 8 hr of exposure to a specific antigen and subsiding in 24 hr. It can have chronic form, with a more complicated case definition. Hypersensitivity pneumonitis can be diagnosed with a combination of criteria: symptoms of fever, chills, cough, rales; restrictive lung disease on pulmonary function testing; the presence of precipitating antibodies in the serum; infiltrates on the chest X-ray; lymphocytes on bronchial lavage; and granulomas on pathological examination of lung tissue.

Humidifier Fever. Humidifier fever consists of a clinical picture similar to acute hypersensitivity pneumonitis, with fever, chills, myalgias, and malaise, but without chest symptoms. The traditional case definition specifies that the chest X-ray be normal.

Asthma. Asthma consists of reversible airway obstruction. There is no uniform definition of occupational asthma, but most experts would call it a new state of bronchial hyperreactivity secondary to some agent at work (*8*) or reversible obstruction of the airways caused by inhalation of a substance or material used by a worker or present at his work (*9*). Asthma can be a preexisting disease that is exacerbated by exposures at work rather than having these exposures as the primary cause; this is not defined as occupational asthma but rather as exacerbation of preexisting disease. Exacerbation of preexisting disease is work related, but I reserve the term occupational asthma for use as defined above.

Legionellosis. Legionellosis and other infections occur secondary to contamination of air supply in buildings. Legionellosis is discussed in detail in other sources (*3,4*).

Sick-Building Syndrome. Sick-building syndrome consists of some combination of the following symptoms: headache, mucous membrane irritation, difficulty concentrating, fatigue. To diagnose sick-building syndrome in a clinical setting, another clinical syndrome (such as influenza or other viral illnesses) should not be present, and patients with SBS usually have normal physical examination and laboratory testing.

Epidemiological Studies

Epidemiological studies have described the spectrum of symptoms in buildings without making specific clinical diagnoses (*10,11*). Large cross-sectional surveys include studies in Denmark and Great Britain. The Danish Town Hall studies surveyed 3757 workers in 14 buildings (*12*). The survey included new and old, mechanically and naturally ventilated buildings. Twenty-eight percent of the persons surveyed had some work-related mucosal irritation, and 36% had some headache, fatigue, or malaise. One British study looked at 4373 workers in 42 buildings and 47 ventilation conditions (*13*). Eighty percent had some work-related symptom, with 57% having some lethargy, 46% headache, 47% blocked nose, 9% chest tightness. In this survey there were more symptoms in clerical workers than in professional workers, who in turn had more symptoms than managerial workers.

These studies report prevalence of symptoms, not specific diagnoses. In essence, these studies provide data on sick-building syndrome but not other diseases, for the studies do not have clear case definitions for hypersensitivity pneumonitis or asthma, for example. For example, the British survey reported 9% had some chest tightness, but we do not know how many of these would meet a case definition for work-related asthma.

Some other sources of data are useful for estimating incidence of specific building-associated illnesses. Hogdson et al. (*14*) reviewed literature on hypersensitivity pneumonitis to determine the usefulness of certain diagnostic criteria. They included papers published from 1950 to 1980, which included at least three cases in which X-rays had been taken. They cited 31 references, and only 1 was reported from HVAC systems.

Kriess and Hogdson (*3*) summarized building outbreaks of hypersensitivity pneumonitis and humidifier fever. They reviewed 8 papers that reported 72 individual cases in buildings, and 15 papers that reported 115 individual cases occurring in homes. (The difference between Hogdson et al. and Kreiss and Hogdson is due to a stricter case definition for inclusion in Hogdson et al.'s review.) These reviews demonstrate that hypersensitivity pneumonitis and humidifier fever can occur in buildings but do not give us a measure of prevalence; all cases are not likely to be reported in the literature.

There are no data on building-associated asthma. Three percent of all Americans have asthma (*15*), and 5 to 15% of all asthma is estimated to be occupational (*16,17*). This latter estimate is not likely to include-building related asthma. This estimate is derived from surveys of workplaces thought to be at risk based on exposure information and standard industry codes (SIC).

There are 50 to 100,000 cases annually of legionella; this disease can be fatal but is usually treatable, and most patients recover without sequela. Again, there are no specific data on the amount of legionella due to buildings.

Ashford and Miller, in a recent review and book (*18,19*), suggested that a syndrome of multiple chemical sensitivity can develop after exposure to indoor air pollutants. There have been other detailed reviews of the diagnosis of multiple chemical sensitivity (*20*) and others have reviewed the field of clinical

ecology, which puts forth a pathophysiologic approach and a treatment approach to the disorder (*21,22*). There are no data to derive estimates of the rates or severity of multiple chemical sensitivity in the office setting; the absence of a case definition for the disorder makes it hard to collect incidence or prevalence data or to agree on the severity of the disease.

So far, this discussion has focussed on the incidence of new disease due to indoor air quality of offices. However, exacerbation of preexisting disease by buildings may be an important problem. Exacerbation of a preexisting disease is not occupational disease in a strict sense, in that the building is not the primary cause, yet exacerbation of preexisting disease can cause significant disability and can be prevented if recognized. My clinical experience says that this is an important problem in particular for allergic and nonallergic rhinitis and for asthma. Building conditions may cause someone with allergic rhinitis to become asthmatic because of low-level irritants and a high load of antigens.

Conclusions

To review, we know little about the severity of disease secondary to indoor air quality of offices. From epidemiological surveys, we can see that mucous membrane symptoms are common, and our clinical experience suggests that these particular symptoms are more common in those with preexisting allergic rhinitis. My clinical experience is that asthma is not infrequent in buildings. Cases that I have seen are often in individuals with an atopic history or in individuals with childhood history of mild asthma but none as an adult, with onset of disease with building renovation. We currently do not have the data to describe rates of the other building-associated illnesses; the case definitions are not uniform, and cases are not likely to be reported. Hypersensitivity pneumonitis is likely to be rare in comparison with SBS, but impairment will be significant if this disease occurs.

There are many unanswered questions on severity of health effects secondary to indoor air quality of offices. Some complete case studies of problem buildings would be useful. Such studies should go beyond symptoms surveys and include enough diagnostic testing to define all cases of building-associated illness. To do this, we need case definitions for reporting of hypersensitivity pneumonitis, multiple chemical sensitivity, and occupational asthma. Case definition and study of problem buildings should focus attention on the diseases of most concern; in my opinion, these are asthma and multiple chemical sensitivity. For asthma, we need data from a prospective study. Are the individuals who develop asthma in a building without a high exposure to an irritant all methacholine positive before the onset of disease? Is the natural history of those people who have a positive methacholine or other nonspecific challenge tests different if they work in tight buildings than if they do not? This type of question can only be answered in large prospective studies.

In addition, much research is needed on multiple chemical sensitivity. Initial work should include a case definition or a set of case definitions and then some descriptive epidemiology to tell us who is getting sick. After these preliminary steps we can look at rates of this disorder in sick buildings.

Certainly, headache and eye irritation are not to be ignored, and there are data to suggest that SBS interferes significantly with both the productivity of employees and the quality of their work life. However, this disorder is not life-threatening, and symptoms usually are reversible on leaving the building. The building-associated illnesses, on the other hand, can be quite disabling and cause permanent impairment. Research to determine incidence, prevalence, and severity of these more severe disorders is very important. Factors that cause SBS and BAI are likely to be different, so studies of the latter need to be defined clearly. I recommend that we should define and use clear case definitions and then study both the incidence and pathophysiology of these disorders.

REFERENCES

1. Samet, J. M., Marbury, M. C., and Spengler, J. D. Health effects and sources of indoor air pollution. Part II. Am. Rev. Respir. Dis. 137: 221–242 (1988).
2. Samet, J. M., Marbury, M. C., and Spengler, J. C., Health effects and sources of indoor air pollution. Part I. Am. Rev. Respir. Dis. 136: 1486–1508 (1987).
3. Kreiss, K., and Hogdson, M. J. Building-associated epidemics. In: Indoor Air Quality (P. J. Walsh, C. S. Dudney, and E. D. Copenhaver, Eds.), CRC Press, Inc., Boca Raton, FL, 1984, pp. 87–106.
4. Kreiss, K. The epidemiology of building-related complaints and illness. State Art Rev. Occup. Med. 14(4): 575–592 (1989).
5. Walsh, P. J., Dudney, C. S., and Copenhaver, E. D. Indoor Air Quality. CRC Press, Inc., Boca Raton, FL, 1984.
6. Hogdson, M. J. Clinical diagnosis and management of building-related illness and the sick building syndrome. State Art Rev. Occup. Med. 4: 593–606 (1989).
7. Molhave, L. The sick building—a subpopulation among the problem buildings. In: Indoor Air 1987. Proceedings of the IV International Conference on Indoor Air Quality and Climate (B. Seifert, H. Esdorn, and M. Fischer, Eds.), Institute for Water, Soil and Air Hygiene, Berlin, 1987, pp. 469–473.
8. Hendrick, D. J., and Fabbri, L. Compensating occupational asthma. Thorax 36: 881–884 (1981).
9. Brooks, S. M. Branchial asthma of occupational origin. Scand. J. Work Environ. Health 3: 53–72 (1977).
10. Melius, J., Wallingford, K., Keelyside, R., and Carpenter, J. Indoor air quality—the NIOSH experience. Ann. Am. Conf. Gov. Ind. Hyg. 10: 3–7 (1984).
11. Finnegan, M. J., Pickering, C. A. C., and Burge, P. S. The sick building syndrome: prevalence studies. Br. Med. J. 289: 1573–1575 (1984).
12. Skov, P., and Valbjorn, O. The Danish indoor climate study group. The "sick" building syndrome in the office environment: the Danish town hall study. Environ. Int. 13: 339–349 (1987).
13. Burge, P. S., Hedge, A., and Wilson, S. Sick building syndrome: a study of 4373 office workers. Appl. Ind. Hyg. 31: 493–504 (1987).
14. Hogdson, M. J., Parkinson, D. K., and Karpf, M. Chest x-rays in hypersensitivity pneumonitis: a metaanalysis of secular trend. Am. J. Ind. Med. 16: 45–54 (1989).
15. Asthma—United States, 1980–1987. Morbid. Mortal. Weekly Rep. 39: 493–497 (1990).
16. Chan-Yeung, M., and Lam, S. Occupational asthma. Am. Rev. Respir. Dis. 133: 686–703 (1986).
17. Blanc, P. D. Occupational asthma in a national disability survey. Chest 92: 613–617 (1987).
18. Ashford, N. A., and Miller, C. S. Chemical Sensitivity: A Report to the New Jersey Department of Health, New Jersey Department of Health, New Brunswick, NJ, 1989.
19. Ashford, N. A., and Miller, C. S. Chemical Exposures: Low Levels, High Stakes. Van Nostrand Reinhold, New York, 1991.
20. Cullen, M. R. Workers with multiple chemical sensitivities. State Art Rev. Occup. Med. 2(4) (1987).
21. American College of Physicians. Clinical ecology. Ann. Intern. Med. 111: 168–178 (1989).
22. American Academy of Allergy and Immunology, and Executive Committee Position Statements. Clinical ecology. J. Allergy Clin. Immunol. 78: 269–271 (1986).