Building Related Illness:

New Insight Into Causes And Effective Control

By

[1]W. Curtis White and [2]Richard A. Kemper

Building Related Illness (BRI), often referred to as “Sick Building Syndrome” or “Tight Building Syndrome,” continues to stimulate national attention as the scientific and lay communities have honed in on the causative factors and scope of effects. Many deleterious symptoms affecting the health and productivity of workers have been noted. Efforts to determine the sources of the problem and to find effective solutions have proven to be more formidable.

BRI is caused by excessive levels of organic vapors, physical irritants, or microbiological allergens within closed, tightly sealed buildings.

Newly emerging data implicate high levels of airborne fungi as the proximate cause of numerous outbreaks. The clinical manifestations we have observed are consistently those which result from hypersensitivity to fungi, their spores, and other microbial antigens.

By design, energy-efficient buildings concentrate the level of airborne microorganisms and their byproducts as sourced from environmental surfaces, people, dust, and furnishings, causing them to rise above the threshold at which many occupants will develop an allergic response.

In a paper[3] presented to the American Academy of Allergy and Immunology in Anaheim, CA, University of Michigan microbiologist Dr. Harriet A. Burge and her research team presented evidence that fungi within tightly sealed buildings can cause hypersensitivity pneumonitis, a condition that may produce permanent lung damage and death.

Researchers at the Walter Reed Army Institute of Research in Washington, DC conducted a four-year study[4] of barracks housing using more than 400,000 recruits to examine the incidence of influenza and other respiratory illnesses. The researchers, led by Dr. John F. Brundage, found that trainees housed in modern barracks were about 50% more likely to contract a respiratory infection during the seven-week training period than those housed in older, more drafty buildings.

To untangle the complexities of BRI, we must integrate multiple disciplines. Designing effective solutions requires a fundamental understanding of architectural, HVAC, and microbiological relationships as they impact indoor air quality and health.

I. Background

BRI is defined as the excessive reporting by a building’s occupants of one or more of the following symptoms:

*Headaches *Lethargy
*Dizziness *Burning Eyes
*Fatigue *Tight Chest
*Flu-like Symptoms
*Upper Respiratory Complaints

The onset of these symptoms is insidious and often attributed to factors other than BRI. After repeated attacks, however, workers recognize a typical pattern: symptoms appear 1-2 hours after arriving at work and disappear 3-4 hours after leaving. These symptoms are classic manifestations of BRI.

Workers also notice that the severity of the attacks usually increases with subsequent exposures. What may have been a slight cold persists for weeks, even months. The actual problem is often the continuous exposure to excessive levels of airborne fungi or bacteria.

As is typical of allergic reactions, the workers’ initial exposure produces a mild response. However, as the body’s immune system produces antibodies to these foreign invaders, subsequent exposures increase the severity of the symptoms.

IA . Architectural Contributions

As the energy crisis of the '70s approached, architects and planners recognized the need for energy conservation. Buildings were designed to produce an internal biosphere that required minimal energy to sustain. Improved HVAC technologies permitted more efficient filtration and recirculation of indoor air, reducing the need for large quantities of outdoor air.

During this time, interior designers began to utilize carpeting and other interior textiles with much greater frequency.

This juncture of efficiency and aesthetics provided the two most significant factors for increasing the microbial levels of indoor air:

* **Environs For Optimal Microbial Growth**
* **Recirculation Rather Than Replenishment of Indoor Air**

Carpeting and other textiles provide ideal conditions for microbial growth, combining both nutrients and moisture. In addition, they provide a "PROTECTED" environment that is not cleaned or disinfected as frequently or efficiently as hard surfaces.

Since air is recirculated and slowly replaced, the concentration of microorganisms increases with time until the threshold of occupant tolerance is exceeded.

IB. Microbiological Contributions

Bacteria, fungi, viruses, and algae are all associated with the indoor environment of buildings, and many produce BRI. Of these, bacteria and fungi are most frequently identified as being responsible for causing hypersensitive (allergic) reactions.

Although a building may be infested during construction (particularly with fungi), more typically the organisms are routinely brought into the building by its occupants.

For example, bacteria play an important role as part of the body's microflora and, along with the skin, are shed continuously. Given acceptable growth conditions, they can multiply from one organism to more than one billion organisms in just 18 hours. Fungi - typically outdoor organisms known as mold, mildew, and yeasts - enter the building on clothing, are wafted in through open doors, or are pulled in as "make up air" by the HVAC system.

Lofted into the air by normal activities in the building, these microorganisms may be transported throughout the building by occupants and the HVAC system. Thus, even the most remote areas of a building become vulnerable to infestation. Under favorable conditions, these microorganisms proliferate and colonize interior surfaces.

Inhalation of these microorganisms, their body parts, and/or their by-products, produces an immunologic response that triggers the release of specific antibodies. Repeated exposures magnify the antigen-antibody reactions, lowering tolerance levels, and exacerbating clinical symptoms.

Thus, these organisms often produce the symptoms we associate with BRI and are responsible for increased absenteeism, reduced productivity, and decreased morale. Reports to OSHA, NIOSH, or local health agencies and potential legal complications present additional concerns.

Besides health-related problems, these microorganisms are also responsible for odors, discoloration, deterioration, and defacement of interior surfaces.

These influences of microorganisms were highlighted at the spring A.S.H.R.A.E. Conference (IAQ-88) in Atlanta, Georgia, and The American Industrial Hygiene Conference in San Francisco, California, and are receiving increasing public and professional exposure.

II. Present Understanding

Previous investigations of BRI found high populations of microorganisms within components of HVAC systems. It was therefore assumed that these systems were uniquely responsible for elevated microbial levels within the ambient air. HVAC systems were proven to aerosolize microorganisms into the office environment, thus firmly establishing the belief that the source of microbial contamination was, indeed, the HVAC system.

During the past three years, Dow Corning researchers independently and in association with Kemper Research Foundation have attempted to piece together a myriad of data available from previous studies to correlate this information with data obtained from field investigations.

In 15 consecutive investigations of buildings with excessive fungal prevalence and classic BRI symptoms reported by occupants, only one building provided substantive data that implicated HVAC systems or its components.

Microbiological analyses of ambient air, however, revealed the presence of excessive levels of fungal organisms throughout each of the buildings.

Obviously, another source of the microorganisms was responsible for the excessive fungal levels that were observed.

In each of these 15 investigations, experiments were conducted utilizing a unique approach to microbial control. HVAC systems and components were not modified; instead, a surface-bonded antimicrobial treatment was applied to textiles and surfaces determined and/or predicted to harbor microorganisms.

The results of these experiments consistently contradicted traditional beliefs but hold significant promise for the introduction of a safe, effective, low-cost solution to excessive microbial levels in buildings.

Thus, a new understanding of this complex problem is emerging to permit better control of a primary cause of BRI. Recognizing the importance of microbial levels in the development or persistance of BRI symptoms can permit the effective control of the large percentage of problem buildings that previously evaded diagnosis.

Of course, recognizing the relative contribution and primary source of organisms does not solve BRI problems. Treatment strategies and tools must be safe and effective. Conventional biocides that merely kill or inhibit microorganisms provide little assistance. These agents lack the spectrum of activity and durability necessary to prevent high microbial populations on surfaces for an acceptable period of time.

Conventional biocides also must leach into the environment to be effective, thus creating additional problems or worker exposure to toxic substances. Perhaps the greatest concern, however, is the long-range consequence of repeated use of these conventional biocides.

Bioflora that are continuously

exposed to sub-lethal dosages of these toxic agents become resistant, making them more difficult to control and potentially more dangerous.

III. New Directions

New technical developments enable continuous control of microorganisms on most surfaces. This provides greater efficacy for extended lengths of time while minimizing toxicologic and adaptational effects.

The most significant development is a reactive silane-modified quaternized nitrogen compound developed by Dow Corning Corporation.

This unique agent, ÆGIS Microbe Shield™ (formerly marketed as SYLGARD®), reacts with surfaces to impart microbiocidal activity to surface molecules, creating a new surface that inhibits microbial growth.

These surfaces provide continuous control of microorganisms for an extended period of time, usually more than one year. Because the treatment is now a part of the surface, it does not create toxicologic or hyperresponsive concerns for building occupants. The treatment is not consumed by microorgansims and does not cause or promote adaptational changes typical of conventional antimicrobials. This reduces the risk of inductive or mutational responses that influence microbial resistance and pathogenicity.

Thus, we are now able to significantly reduce the number of microorganisms residing on specific surfaces, prevent reinfestation, and utilize the intrinsic antimicrobial activity of treated surfaces to kill transient microbes that settle upon them.

The integration of these distinct antimicrobial capabilities provides the first opportunity to effectively control the concentration of airborne microorganisms in buildings. Heavily infested surfaces can be disinfected and, with the application of this unique technology, provide the only effective means to control the level of airborne microorganisms.

Although a solution to all BRI problems remains beyond our capabilities, control of one major component is now possible. More importantly, this insight and improved technology provide the vehicle by which effective control of microbially-related problems may now be incorporated into building design, providing a healthier environment for all.

IV. Conclusion

This paper presents a brief overview of a serious problem confronting us today. It is our hope that we have provided information and insights that will permit a better understanding of BRI and encourage efforts to alleviate its deleterious effects.

Sickness as a human condition is too familiar to be a mystery. It is a part of our existence. Even as our knowledge and experience have taken us to more sophisticated understandings and improved our quality of life, nature still extracts its toll.

People are healthy when they are in harmony with their environments; they are sick when discord prevails. So it is with the structures of modern society. Sick buildings are out of harmony with the needs of their inhabitants. A tight, closed environment, while great for comfort and energy efficiency, confines and magnifies problems attributable to microorganisms. Within our civilization we have decided that technical progress and human comforts are worth the price. We accept the stresses of industrialization, the hazards of noxious chemicals, and the problems of our newly raised buildings. But with this acceptance, we pay a price. The price is one of new problems and specters of even greater problems. The artificial reordering of ourselves and our environment must be balanced with our abilities to cope with the changes.

As architects, designers, builders, owners, managers, lenders, engineers, and microbiologists, we must integrate our skills and apply them toward real improvement in the quality of life.

This philosophical view does not overly stretch our minds, but does challenge our technologies. Modern building practices have expanded our lifestyles and increased our standard of living, but nature is taking the second round in this fight and presenting us with an array of microbiological challenges. Round three has begun and our identification of the problems and safe, effective solutions are within our means. Implementation and continued achievements in the identification and solution of indoor microbial pollution must be diligently and intelligently pursued. One inevitable reality is that nature will declare round four.

[1]W. Curtis White is the CEO of ÆGIS Environmental Management, Inc. of Midland, Michigan and was formerly Manager of the Biotechnology Expertise Center at Dow Corning Corporation, Midland, Michigan.

[2]Richard A. Kemper is director of Biotechnology Research at Kemper Research Foundation, Cincinnati, Ohio.

[3] Burge, Harriet A. A paper presented at the annual meeting of the Academy of Allergy and Immunology, Anaheim, California, March 16, 1988.

[4]Brundage, J.F. "Building Associated Risk of Febrile Acute Respiratory Diseases and Army Trainees, JAMA, April 8, 1986, Vol. 259, #14.

ÆGIS Environmental Management, Inc.

2205 Ridgewood Drive
Midland, MI 48642
Phone: 989-832-8180 Fax: 989-832-7572

Form #5B6 Last Revision 8/2004