A THEORETICAL OVERVIEW OF SICK BUILDING SYNDROME IN THE BUILT ENVIRONMENT

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Abstract

The phrase 'Sick building syndrome' is very hazy and means many things to many people and thus the users and facility managers of the built environment attach less importance to the cause and upshot of this symptoms and illnesses due to shallow knowledge and understanding of the health challenge experienced in the building. The paper examines the notion explicitly. It identifies various symptoms of sick building syndrome, how a building gets to be sick and highlights the causes of sick building syndrome. The paper concludes that most building related illness is due to poor awareness of building users on the consequence of unhealthy activities, furniture and electrical gadget in the building that slowly release toxic vapours, gases and pollutants into the air at room temperature. The paper will be of great use to researchers, construction professionals, building users, built environment policy makers as well as students in the environmental studies.

Keywords: *built environment, sick building syndrome, Symptom, air conditioning, ventilation.*

Introduction

We spend around 90% of our time inside buildings breathing, living and working. Most modern day materials used in interior design and architecture contain toxic additives. These materials are harmful to human and animal health as they slowly release toxic vapours, gases and pollutants into the air at room temperature (off gassing). This creates indoor air pollution and low air quality levels. Interior air also becomes polluted through tobacco smoke, the use of space heaters, electrical equipment, appliances and chemical cleaning supplies. Interior air pollution is more damaging to human health than exterior air pollution as it is condensed and contained within small areas. Over time we may develop symptoms and illnesses such as sick building syndrome, asthma or allergies from indoor air pollution. (Holistic Interior Designs, 2011).

The Meaning of Sick building syndrome (SBS)

"Sick building syndrome" (SBS) is used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified. The complaints may be localized in a particular room or zone, or may be widespread throughout the building. In contrast, the term "building related illness" (BRI) is used when symptoms of diagnosable illness are identified and can be attributed directly to airborne building contaminants.

Table 1 shows two types of syndrome; one is a more allergic response in sensitive individuals. In addition, the World Health Organization (1983) lists the following symptoms of malaise: eye, nose and throat irritation sensation of dry mucous membranes and skin erythematic mental fatigue headache high frequency of airway infection and cough hoarseness, wheezing, itching and unspecific hypersensitivity nausea, dizziness.

Natural and Artificial Ventilation: Air-conditioning systems

People working in air-conditioned buildings consistently show higher rates of sickness than those working in buildings that are naturally ventilated or that have mechanical systems of ventilation supplying ducted air but not cooling or humidifying it, although it may be pre-heated (Finnegan et al 1984; Robertson et al 1985; Burge et al 1987; Wilson and

Hedge 1987; Wilson et al 1987). For all ventilation categories, workers in public sector buildings have consistently higher rates of building-related sickness than those in the private sector (Wilson and Hedge, 1987).

A 1984 World Health Organization Committee report suggested that up to 30 percent of new and remodelled buildings worldwide may be the subject of excessive complaints related to indoor air quality. Often this condition is temporary, but some buildings have long-term problems. Frequently, problems result when a building is operated or maintained in a manner that is inconsistent with its original design or prescribed operating procedures. Sometimes indoor air problems are a result of poor building design or occupant activities.

Many buildings are now designed to reduce the intake of 'fresh' outside air because it is cheaper to re-circulate air that has already been warmed up in winter, or cooled in the summer, than to take in outside air and heat or cool it. Doors, window frames and other seals in the building are made as air-tight as possible, windows cannot be opened, and the amount of outside air brought into the ventilation system may be reduced - perhaps to zero, so that only re-circulated air is being breathed. Such buildings are known as 'sealed' or 'tight' buildings. Sometimes air inlets have been found to be bricked up. And the power of fans that distribute air from the air handling unit into the distribution ductwork may be reduced, or some fans may be turned off altogether for periods of time to save on energy costs. (EPA, 1991).

Air-conditioning systems themselves can harbour pollutants and micro-organisms and so add to the contamination of the workplace. For example, dirt enters with the air supply and builds up in the ductwork over time, or may have been lying in the system since it was installed. Often there is no-one in an organisation who really understands how the systems work. In addition, maintenance and cleaning of systems seem to be the exception rather than the rule, through negligence or because the various parts of the system are inaccessible (Wilson et al 1987).

Syndrome and Symptoms

A syndrome is a group of symptoms that characterises a particular medical condition. Every person suffering from the condition may not have all the symptoms. Table 1 shows four syndromes that have been identified as being related to buildings. The symptoms that make up these syndromes are fairly common in any group of people, so it is their association with a particular building, and the fact that they improve after the person has left the building, that show the symptoms to be building related. It is often useful to keep a diary of symptoms, perhaps recording their severity on a scale of 0-7 every two hours for a week at work and throughout a weekend away from work.

Some of the symptoms are found in more than one syndrome, for instance lethargy and chest tightness, and the symptoms can be divided into four categories: Dryness of the skin, eyes, nose and/or throat allergic symptoms, such as watery eyes or runny nose asthmatic symptoms, such as chest tightness general feelings, such as lethargy, headache or malaise. Also it could be further observed from Table 1 that there exist two types of sick building syndrome; one is a probable allergic response. Not everyone would agree with this classification into allergic and non-allergic responses. sick building syndrome may consist of sub-syndromes based on reactions to chemicals or microbes. The symptoms particularly associated with the proposed chemical sub-syndrome include fatigue, headache, and dry and irritated eyes, nose and throat sometimes with nausea or dizziness. The most common to the proposed microbial sub-syndrome include itchy, congested or runny nose, itchy watering eyes, sometimes with wheezing, tight chest or flu-like symptoms. These symptoms fit with a presumed terminal nerve irritation mechanism in the case of chemicals, and an infective or allergic mechanism in the case of microbes.

Humidifier fever and occupational asthma are illnesses related to buildings but they are considered to be separate from sick building syndrome because their causes can more usually be identified. These syndromes are not as common as sick building syndrome, and it is not yet known whether some of the underlying causes might be common to all four syndromes.

Similarly, Legionnaires disease, is a building-related illness with a clearly identifiable cause (the bacterium *Legionella pneumophila*), unlike sick building syndrome which usually has non-specific causes. (Health & Safety Executive Booklet, MISC 150).

Table 1: Medical syndromes associated with buildings

SYNDROME	SYMPTOMS
Sick building syndrome **(Type 1)**	Lethargy and tiredness Headache Dry blocked nose Sore dry eyes Sore throat Dry skin and/or skin rashes
Sick building syndrome **(Type 2)**	Watering/itchy eyes and runny nose i.e. symptoms of an allergy such as hay fever
Humidifier fever	
(1) Flu-like symptoms	Generalised malaise Aches and pains Cough Lethargy Headache
(2) Allergic reaction in sensitive individuals	Chest tightness Difficulty in breathing Fever Headache
Occupational asthma	Wheeze Chest tightness Difficulty in breathing

Sources: World Health Organization 1983; Morris 1987; Wilson and Hedge 1987

Symptoms of Sick Building Syndrome

Since the symptoms of sick building syndrome are common in the general population, it is the pattern of their expression that points to the diagnosis: in sick building syndrome, symptoms are associated with being in a particular building and are relieved by leaving or staying away from that building.

The symptoms of sick building syndrome include eye and nose irritation, runny or stuffy nose, fatigue, headache, nausea, sore throat and general respiratory problems. Environmental tobacco smoke is often blamed for these symptoms, particularly since it can be seen or smelt, but many other less visible pollutants, as well as environmental conditions, can cause similar problems. For example, identical symptoms to those described above are suffered by people who are exposed to formaldehyde, ammonia, nitrogen oxides, cotton dust and fibreglass particles; by those who are allergic to dusts and microbial spores; and by those exposed to low relative humidity for long periods of time (Robertson et al, 1985).

The responsibility of the Built environment professionals

The number of different people and professionals involved in the design and construction of an average building provides much scope for poor decision-making leading ultimately to unhealthy working conditions (Vischer 1989). The developer might assign 'quality control' decisions to the architect, who is then at the mercy of the engineers brought in to design heating and ventilation systems and lighting. Architects are not engineers, so they have to rely on engineers' design specifications. Routine formulae are used to calculate air distribution systems throughout a building, and standard systems are cheapest to design and

install. If specific user requirements are not known, or are not taken into account because of cost constraints, a standard system is installed which turns out to be inappropriate to the ultimate users of the building. In a similar way uniform lighting is often fitted, with little attention paid to the need for local lighting for particular tasks.

Architectural and engineering decisions may be made with little reference to each other. For instance, an attractive architectural space such as a high, glassed-in sunny atrium may have no means of exhausting the heated air that collects at the top of it. Once building starts, responsibility for quality control shifts by default to the contractor. Many changes are made as the building is constructed, so that design specifications are altered. For instance, chunks of concrete in the air mixing chamber of the ventilation system may be left there if the cost of their removal is too high. Concrete may not be given enough time to dry out before a screed coating is applied. Plastic parts may be substituted for metal ones in the ventilation ductwork if the specified parts cannot be obtained in time or are too expensive. Waiting for parts costs time and money, so short-cuts are taken.

Once the building has been constructed, the space is prepared for use. Walls and partitions are put up and finally equipment and machines are installed, often with no notice being taken of the siting of ventilation inlets and outlets or assumed pathways of air flow across a space. An office may be walled in with a supply air vent but no extract outlet. And to make matters worse the air-conditioning system may never be properly 'commissioned' by the installation engineer once the building has been occupied so that the system is not correctly balanced. A catalogue of errors and poor decisions may mean that problems are 'built in' to the structure, only to be added to by incorrect operation and poor maintenance.

Causes of sick building syndrome and building related illness.

Both SBS and BRI are caused by poor indoor air quality. These are the main factors that can cause or contribute to SBS or BRI:

1. Inadequate ventilation – poorly installed HVAC systems, insufficient air exchange rates.
2. Indoor chemical contaminants – carpeting, paints, wood products, pesticides, cleaning agents, indoor smoking etc.
3. Outdoor chemical contaminants – exhaustion fumes, building exhausts, combustion products.
4. Biological contaminants – mold, pollen, bacteria, insects and others.

In the discussions, much emphasis is placed on air-conditioning and ventilation systems since inadequate ventilation has been considered to be a causal factor in 50 per cent of sick buildings in the United States and in 68 per cent of Canadian investigations (Melius, 1984). However, precise causal factors are rarely found in sick building investigations. Many reports conclude that inadequate ventilation was the cause of sickness because no other factor could be found, and improving the ventilation helped to remedy the situation. But improving the ventilation would in turn reduce the amount of contamination with chemicals or micro-organisms, so that increased ventilation can be seen as an effective treatment rather than a cause. Despite numerous investigations, journal articles and conferences, little has actually been proven about the causes of sick building syndrome. Different experts have different theories - some say the main cause is chemicals, others that fungi are primarily to blame, or physical factors such as humidity, temperature or lighting, or the air-conditioning system itself.

In the USA, investigations carried out up to the end of 1983 by the National Institute for Occupational Safety and Health (NIOSH), a governmental organisation, showed 'inadequate ventilation' to be the causal factor in about half of buildings with health complaints (see Table 2). Inadequate ventilation was often given as the cause when no other, more precise, cause, could be found.

What is certain is that these symptoms are more common in buildings with air-conditioning or mechanical ventilation. Six building features are strongly associated with symptoms of sick building syndrome (McIntyre and Sterling 1982): A hermetically sealed, airtight shell mechanical heating, ventilation and air-conditioning systems use of materials

and equipment that give off a variety of irritating and sometimes toxic fumes and/or dust fluorescent lighting that may produce photochemical smog application of energy conservation measures lack of individual control over environmental conditions.

Table 2: Types of problem found in indoor air quality investigations carried out by NIOSH

PROBLEM	NUMBER	PERCENTAGE (%)	NOTES
Contamination (inside)	36	18	Exposure to chemical or other toxic agent generated within the office space, e.g. methyl alcohol from spirit duplicator, methacrylate from a copier, sulphur dioxide from a heating system, amines used in a humidification system, chlordane used as a pesticide
Contamination (outside)	21	10	Exposure to a chemical or other toxic substance originating from a source outside the building, e.g. motor vehicle exhaust fumes, construction activity, underground petrol spillage
Contamination (building fabric)	7	3	Problems from the material used to construct the building (figure excludes asbestos), e.g. formaldehyde, fibreglass.
Inadequate ventilation	98	48	Symptoms may be due to low levels of multiple contaminants and/or poor ventilation
Hypersensitivity pneumonitis	6	3	
Cigarette smoking	4	2	
Humidity	0.9	4	
Noise/illumination	2	1	
Scabies	1	0.5	
Unknown	19	9	

Source: NIOSH (1983).

how to protect ourselves from sick building syndrome (sbs) and building related illness (bri).

A systematic approach is needed to determine which of these factors, or combination of factors, is likely to be responsible in a particular building. It is easy to throw money at a building without improving things at all. Therefore, the following steps might be taken to solve sick building syndrome (London Hazards Centre, 1990; EPA, 2010).

1. Pollutant source removal or modification is an effective approach to resolving an IAQ problem when sources are known and control is feasible. Examples include routine maintenance of HVAC systems, e.g., periodic cleaning or replacement of filters; replacement of water-stained ceiling tile and carpeting; institution of smoking restrictions; venting contaminant source emissions to the outdoors; storage and use of paints, adhesives, solvents, and pesticides in well ventilated areas, and use of these pollutant sources during periods of non-occupancy; and allowing time for building materials in new or remodelled areas to off-gas pollutants before occupancy. Several of these options may be exercised at one time.
2. Increasing ventilation rates and air distribution often can be a cost effective means of reducing indoor pollutant levels. HVAC systems should be designed, at a minimum, to meet ventilation standards in local building codes; however, many systems are not operated or maintained to ensure that these design ventilation rates are provided. In many buildings, IAQ can be improved by operating the HVAC system to at least its design standard, and to ASHRAE Standard 62-1989 if possible. When there are strong pollutant sources, local exhaust ventilation may be appropriate to exhaust contaminated air directly from the building. Local exhaust ventilation is particularly recommended to

remove pollutants that accumulate in specific areas such as rest rooms, copy rooms, and printing facilities.

3. Air cleaning can be a useful adjunct to source control and ventilation but has certain limitations. Particle control devices such as the typical furnace filter are inexpensive but do not effectively capture small particles; high performance air filters capture the smaller, respirable particles but are relatively expensive to install and operate. Mechanical filters do not remove gaseous pollutants. Some specific gaseous pollutants may be removed by adsorbent beds, but these devices can be expensive and require frequent replacement of the adsorbent material. In sum, air cleaners can be useful, but have limited application.
4. Education and communication are important elements in both remedial and preventive indoor air quality management programs. When building occupants, management, and maintenance personnel fully communicate and understand the causes and consequences of IAQ problems, they can work more effectively together to prevent problems from occurring, or to solve them if they do.
5. You should obtain as much information as possible; particularly examples of other cases of sick building syndrome you have had to deal with. Talk to as many people as possible to elicit their opinions on the working conditions, symptoms and possible causes.

Conclusion

This paper has been able to examine the meaning of sick building syndrome in the built environment and identified that professional have an immense role to play in design and construction to keep the building users safe and in good health.

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