

Indoor air quality and health

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ABSTRACT

In recent years, there has been a growing concern in the medical community regarding the hazardous effects of poor IAQ on the health of individuals. People tend to spend 90% of their time indoors and studies have shown that in some air conditioned and mechanically ventilated buildings, the levels of contaminants like environmental tobacco smoke, volatile organic compounds and biological microorganisms like Fungi, Bacteria and Viruses in the indoor air can often be several times more than outdoor air.

Poor IAQ leads to an increased incidence of health related symptoms like headache, dizziness, eye and throat infection, fatigue, memory loss and certain diseases like Allergy and Asthma, Legionnaires disease, Humidifier fever, and even Lung cancer. All this leads to loss of productivity, absenteeism and tremendous health and economic burden on individuals, their families and organizations they are working for.

INDEX TERMS

IAQ; IAQ in hospitals; Effects of IAQ; Common indoor air pollutants; Methods of improving IAQ

INTRODUCTION

What is IAQ

'IAQ' stands for 'Indoor Air Quality' and relates to the nature of Air which we breathe, where we work, eat and live. The issue is most directly related to 'Human Comfort'. Human Comfort in a building was primarily measured in terms of temperature, humidity and odour. Today, comfort is also measured by Indoor air quality, lighting characteristic and background noise level.

Defining acceptable air quality is difficult and the American Society for Heating, Refrigeration and Ventilation Engineers (ASHARE) define acceptable indoor air quality which provides acceptable comfort level to 80% of people composed to it.

Therefore, in practical terms if 20% of the people in a building, work place suffer from severe or recurring discomforts such as Nausea, Headaches, dry mucous, eye/nose/throat irritation, drowsiness, dizziness, fatigue, etc. Then we have a serious Indoor Air quality problem.

THE IMPORTANCE OF IAQ IN HOSPITALS/NURSING HOMES

The importance of IAQ is the most critical in hospitals and health care facilities. Continual advances in medicine and technology necessitates the air conditioning of hospitals and medical facilities. Hospital air-conditioning assumes a more important role than just the promotion of comfort. In many cases, proper air-conditioning is a factor in patient therapy. In some instances, it is the major treatment. However, the relatively high cost of air-conditioning has led to inadequate and improperly designed systems with not enough care for specific requirements of ventilation, filtration and cross-contamination.

Effects of Poor IAQ on Health of Individuals at their Work Place (Sick Building Syndrome)

In recent years, the attention of environmental research has been focused on indoor air pollution as a result of reports of symptoms or specific diseases that have been identified among the occupants of air-conditioned buildings, by a phenomenon called 'Sick Building Syndrome'. 'Sick Building Syndrome' is a term that describes the presence of acute non-specific symptoms in the majority of the people, caused by working in buildings with an adverse indoor environment. It is a cluster of complex irritative symptoms that include irritation of the eyes, blocked nose and throat, headache, dizziness, lethargy, fatigue, irritation, wheezing, sinus congestion, dry skin rash, sensory discomfort from odours and nausea. The potential health effects like headache, dizziness, fatigue, allergy, etc., are very commonly seen in the buildings where HVAC systems are poorly maintained and there is inadequate quantity of fresh air or ventilation.

Health effects from indoor air pollutants fall into two categories; those that are experienced immediately after exposure and those that do not show up until years later.

'Sick Building Syndrome' should be suspected when a substantial proportion of these peoples' spending extended in a building (as in daily employment) report or experience acute discomfort on site. It is important, however, to distinguish SBS from problems of building-related illness. The latter term is reserved for situations in which signs and symptoms of diagnosable illness are identified and can be attributed directly to specific airborne building contaminants. Legionnaires disease and sensitivity pneumonitis, for example, are building-related illness. Another diagnostic label of multiple chemical sensitivity (MCS) also referred to as 'chemical hypersensitivity' or 'environmental illness' is being applied increasingly. Persons with MCS are said to suffer multi-system illness as a result of contact with or proximity to a spectrum of substances including airborne agents. The health professionals should look for key signs and symptoms to help determine the cause of the health problem.

The economic consequences of the SBS and building-related illness (BRI) relate to decreased productivity, absenteeism and the cost of providing the correct environment. While there is no proof that maximum comfort leads to maximum productivity, there is ample evidence that an improved environment decreases worker complaints and absenteeism, thus enhancing productivity.

SBS in buildings maybe due to:

- inadequate maintenance of the HVAC (Heating, Ventilation and Air conditioning);
- increased load (occupancy and activities) than designed;
- inadequate fresh air or ventilation;
- poor circulation of outside air due to badly placed vents;
- improperly located outdoor vents bringing in contaminated air from automobile exhausts or restrooms.

However, poor IAQ is generally associated with improperly managed HVAC systems and inadequate ventilation. Adequate amounts of fresh air and appropriate ventilation can address the problem completely.

LIST OF SOME COMMON INDOOR AIR POLLUTANTS, SOURCE, HEALTH EFFECTS AND CONTROL METHODS

Pollutants	Source	Health effects	Control methods
Environmental tobacco smoke (ETS)	Cigarette + smoke exhaled by smoker	Leading cause of lung cancer, headache, eye irritation, wheezing, cough, asthma and bronchitis in children	<ol style="list-style-type: none"> 1. Most effective solution is to eliminate all smoking from the environment 2. Otherwise: 3. Improve ventilation of indoor space 4. Restrict smoking to designated rooms 5. Use IAQ enhancers
Bacteria, fungus, mould, mildew	Wet or moist walls/ ceilings, carpets, furniture, poorly maintained ACs	Allergic reactions, infections, e.g. influenza, measles and chicken pox, eye, nose, throat irritation	<ol style="list-style-type: none"> 1. Provide outdoor air ventilation to dilute human source 2. Keep equipment/water reservoir clean 3. Ensure that there is no standing water in the AC 4. Repair leaks and seepage 5. Keep relative humidity below 50%
Volatile organic compounds and formaldehyde	Paints, paint strippers and other solvents, wood preservatives, carpets, varnishes, ETS, cleaning and disinfecting agents, wood adhesives, textiles and glues	Eye, nose and throat irritation, headache, loss of coordination, nausea, damage to liver, kidney and central nervous system, allergic reactions	<ol style="list-style-type: none"> 1. Increase ventilation 2. Do not store opened containers of unused paints, etc., indoors 3. Identify and if possible, remove the source 4. Reduce exposure: use polyurethane on cabinets, panelling and furnishing 5. People sensitive to formaldehyde should avoid press fabric and mattress ticking 6. Professional chemical fumigation may neutralize formaldehyde
Carbon monoxide	ETS, combustion	Fatigue, chest pain in heart patients, impaired vision, headache, dizziness, nausea and respirator irritation, coma	<ol style="list-style-type: none"> 1. When cooling, use a kitchen exhaust fan that is vented to the outside 2. Keep combustion appliance properly adjusted 3. Do not use unvented combustion appliances 4. Do not warm up car in attached garage 5. Use pilot-less ignition on gas

		and death	appliances
			6. Exhaust smoking area and provide a fresh air supply
			7. Inspect and maintain all fuel burning equipment
			8. Properly maintain chimneys, stoves and fire places to avoid leaks
Asbestos	Fire proofing material, floors and tiles	Chest and abdominal cancer and lung infections	1. Avoid using materials containing asbestos
			2. Use fibreglass wood stove gaskets
			3. Do not disturb materials containing asbestos
			4. If a material containing asbestos is damaged or needs repairs, contact a certified asbestos abatement contractor
			5. Do not sand floors that have vinyl floor tiles with asbestos
Radon	Granite	Lung cancer	1. Seal cracks and holes in foundation walls and concrete slabs
			2. Install water traps in basement floor drain pipes
			3. Install a ventilation system under basement slabs
			4. Tight-seal sump holes in basement slabs or ventilate them
			5. Filter well water if it contains radon

Methods of Improving Indoor Air Quality

Poor Indoor Air Quality can arise from many types of air contaminants arising from many sources. In office buildings, they can be classified into three groups, which are gases and vapours, such as CO₂ from people, butyric acid from roads and highways, CO from adjacent parking lots, tobacco smoke, VOCs from paints, wood panelling, office equipment, formaldehyde from carpeting and furnishings. Another source is inert particles like dust and manmade fibres and thirdly microorganisms like fungus, bacteria, virus and moulds resulting from high humidity and damp corners.

Inadequate maintenance of the HVAC systems can become a breeding ground for most of the pollutants and inadequate ventilation leads to a concentration of pollutants indoors.

There can be two basic solutions to improving the indoor air quality.

- Source control
- Pollutants removal
 - Ventilation
 - Air cleaning

Source Control, though a preferred approach, may not often be practical. Source control measures are pollutant specific and may include use of low formaldehyde emitting materials, banning of cigarette smoking, prevention of radon entry through sealing of foundations, eliminating use of asbestos and storing of paints and chemicals outside the occupied space. Controlling of relative humidity will prevent the growth of mould, mildew and microbial contaminations. Routine or regular maintenance of HVAC system is another method of reducing the pollutant level. We are constantly cleaning the ducts with bacillocid (commonly used disinfectant) and also fumigating the ducts. The results are positive and have shown considerable reduction in infection levels.

Air cleaning is the second method of removal of pollutants. It is not a substitute for fresh outside air. Air filters, ionizers and electrostatic precipitators can effectively rid indoor air of some microscopic particles such as dust and some smoke, but they do not totally purify and revitalize the air. These devices must be sized and maintained properly in order to work effectively.

An advantage of some air cleaners is their ability to remove some particles such as pollen that originate outside. A disadvantage is that they have no effect at all on the concentration of some pollutants such as formaldehyde, carbon monoxide and other gases.

Ventilation is the natural movement of air through a building. Removal of contaminants from a building or reducing its concentration within a work space can be accomplished by either passive or active ventilation.

CONCLUSION

Maintaining the IAQ is of prime importance in Hospital and to ensure a clean environment, I recommend appointing a 'cleanliness monitor'. This person should evaluate the environment weekly or monthly for overall cleanliness as well as general condition. The monitor should also evaluate storage areas because dust and moisture can increase the risk that supplies like sterile tape and gauze will become contaminated. Researchers have linked SSI outbreaks to contaminated supplies. It would be the responsibility of the cleanliness monitor to inspect the service areas, stores, air handling unit, CSSD, operation theatre, incinerator, water coolers and desert coolers on regular basis. This monitoring programme will be in addition to the services of infection control committee and will go a long way in preventing the infections in hospitals.

When creating this monitoring programme, be sure to make it achievable, efficient and reliable. Regulatory and accrediting agencies will expect you to adhere to any programme that you incorporate into your policies and procedures.

Environment controls play an essential role in preventing cross-contamination in the hospitals. By following these common-sense principles, we can go a long way to ensuring a safe environment for the patients.

REFERENCES

ASHRAE Handbook (1999). HVAC applications. Health Technical Memorandum 2025.