Is Occurrence Of Sick Building Syndrome A Possibility In The Dissection Hall?

Dipak Kumar Dhar*, Ritik Arora, Sudeepa Chaudhuri*****

*Assistant Professor, Dept. Of Physiology, ** MBBS Student, Himalayan Institute Of Medical Sciences, Swami Rama Himalayan University, Jolly Grant, Dehradun.***Retd. Professor And Head, Dept. Of Physiology, Rohilkhand Medical College And Hospital, Bareilly, Retd. Senior Faculty Of Physiology, Govt. Of Assam And Govt. Of Tripura

Abstract: "Sick building syndrome" (SBS) refers to a condition where people working in a building experience a constellation of non-specific mucosal, skin, and general symptoms that are temporally related to their occupancy in the particular building and which usually disappear once the duration of work is over and they leave the confines of the building. Formaldehyde is a volatile organic compound which has been substantially implicated in its genesis in numerous studies. The gross anatomy dissection hall in medical colleges provides a space where there is considerable amount of formaldehyde emission from the formalin-embalmed cadavers. Added to this are factors such as crowding, humidity and psychosocial demands of the new lifestyle. The present article intends to review the current understanding of this entity and provide insight into whether it is possible that medical students, teachers and staff could actually be suffering from sick building syndrome in the time spent in the dissection hall.[D D Natl J Integr Res Med, 2020; 11(4):66-71]

Key Words: Sick Building Syndrome, Sick House Syndrome, medical students, dissection hall, formaldehyde

Author for correspondence: Dr. Dipak Kumar Dhar, Department Of Physiology, Himalayan Institute Of Medical Sciences, Swami Rama Himalayan University, Jolly Grant, Dehradun. Mobile: 8794314360
E- mail: dkdharagmc@gmail.com

Introduction: The first exposure to dissection hall is one of the most profound experiences of a doctor's life. Apart from providing a hands-on experience of the basics of anatomy, it is also the place where a budding doctor first comes across the dead. But it is a matter of common experience that medical students experience myriads of symptoms in the premises of the dissection hall, some of which have been linked to an entity called the "sick building syndrome".

The term "sick building syndrome" (SBS) , also known as sick house syndrome (SHS) refers to a condition where people working in a building experience mucosal, skin, and general symptoms that are temporally related to their occupancy in the particular building. The symptoms usually disappear once the duration of work is over and they leave the confines of the building[1,2,3]. No specific illness can be attributed as a cause of these except for the time spent in the building. It has been recognized as an occupational health issue by the National Institute of Occupational Safety and Health (NIOSH)[4]. The idea of Sick Building Syndrome was first floated in the 1970's as a generic term for a number of non-allergic reactions related to indoor air quality problems.

These years also saw the gradual advent and rising use of air-conditioning systems, increased insulation, building wraps, modern interiors and décor, etc all of which somehow made modern buildings seemingly packed and suffocative. From an occupational perspective, Sick Building Syndrome eventually reduces the proficiency and productivity of the persons spending working hours in the building. According to estimates of the Environmental Protection Agency, SBS has been linked to 10% to 25% of all buildings in the United States[5].

Research articles and works on effects of formaldehyde on medical students and instructors was searched on data bases like Google Scholar, Pub Med, Cochrane Library and Medscape using search engines from 1980 onwards. The search was done with various words and combinations like formaldehyde, formalin, health effects, physical reactions, mucosal effects, sick building syndrome, sick house syndrome, medical students, instructors, staff, etc. The types of articles studied for this review were original research, review papers, letters to the editor, guidelines, gazette notifications, chapters from books, policy documents from international agencies, etc. The salient features and inferences have been summarized in the form of narrative review in the present article.

Sick Building Syndrome: A working group of the World Health Organization has defined sick building syndrome as a constellation of various non-specific symptoms such as eye, skin and upper airway irritation, headache and fatigue[6]. It refers to the acute sickness or discomfort that appears to be linked to time spent in a building[5]. Broadly, health problems associated with occupancy in buildings can divided into sick-building syndrome and building-related illness.

The former is characterised by non-specific features are of mucosal irritation like redness, itchiness and watering of eyes, stuffy or blocked nose, dryness of throat, lethargy, headache, etc. In building-related illness, there are specific symptoms attributable to a diagnosable illness[7].

The etiological factors of this entity include chemical agents like volatile organic compounds (VOCs) like formaldehyde, dust, mechanical ventilation systems and air conditioning, microbiological agents (like bacteria, fungi, pollen, dust mites and viruses) and physical properties of building occupancy like lighting, humidity, temperature, noise, vibration and crowding[8-12]. Psychological factors like job demands, dissatisfaction, inter-personal relationships, etc have also been attributed to exert a causative influence by some authors[13]. A set of criteria have been used to designate features as Sick Building Syndrome in various studies[14]. They are:

- Symptoms aggravate when staying at the room or building.
- Symptoms either immediately or gradually disappear after leaving the room or building
- Symptoms recur when returning to the room or building.
- Symptoms disappear when the room is ventilated or cleaned.

Formaldehyde (HCHO) is an aldehyde which is produced by the oxidation of methyl alcohol. At room temperature, it exists as a gas which has noxious and irritating properties and a strong pungent odour. [15] It is one of the volatile organic compounds strongly implicated in the genesis of sick building syndrome by numerous authors. It is released to the air from many home products like latex paint, fingernail hardener, and fingernail polish, plywood and particle board, as well as furniture and cabinets made from them, fiber-glass products, new carpets, decorative laminates, etc[4,5,8,16-19]. The World Health Organization has also linked formaldehyde with causation of sick building syndrome[20].

Formaldehyde Exposure In Dissection Hall:

Source Of Exposure: Embalming Fluid: One of the key scenarios where the exposure to formaldehyde occurs because of its considerable presence in the ambient atmosphere is the gross anatomy dissection hall in medical colleges. It is the place where a medical student learns about the basics of the body's structure by scrupulous dissection of cadavers. These cadavers are embalmed with the help of embalming fluids which chemically is a composite mixture of various substances acting as fixatives, preservatives, germicides, buffers, wetting agents, anticoagulants, dyes, perfuming agents, etc[21].

Formalin, which is a 37% by weight or 40% by volume aqueous solution of formaldehyde, is used as the preservative in these fluids. [15] The formalin concentrations in arterial fluid and cavity fluid are 10% and 60% respectively. While keeping a provision for spillage, approximately 10 litres of arterial fluid are needed for an adult body weighing 65-75 kg[22]. In addition, formalin is also the main preservative used in the tank (immersion) fluids where the cadaver and their parts are stored after the dissection class. Formalin on vaporization yields formaldehyde. Therefore, with substantial amount of formaldehyde prevailing in the ambient atmosphere, a condition similar to the classically described sick building syndrome is very much plausible.

The teachers, students and staff of the dissection hall spend a considerable part of their daily time in the premises of the dissection hall. In India, medical students usually have dissection classes for 2 hours every day for 6 days per week throughout the first year.

Formaldehyde vapours emitted from the cadavers therefore result in substantial exposure-rates of medical students and their teachers[23,24]. The exposure to medical students occurs over a period of one year, whereas to the teachers and staff, there is a persistent and cumulative exposure over years of their service.

In a study conducted at Alexandria Faculty of Medicine on the effects of formal-dehyde on the staff working in the department, the researchers found that skin symptoms (68.8%), ocular irritation (68.8%) and nausea (18.8%) were substantially present among them, apart from problems such as anaemia and menstrual disturbances among the female staff[25]. Apart from this, two factors, i.e. crowding of the students around a cadaver and psychosocial demands of the new lifestyle of a medical student could also be contributing to a certain extent because both crowding and psychological demands of the work have been attributed as causative factors of Sick Building Syndrome.

Exposure Limits: The concentration of formaldehyde is generally expressed in terms of parts per million (ppm). 1ppm of formaldehyde vapour is equivalent to 1.248mg/m^3 [26]. Various exposure limits have been proposed by international agencies to restrict the occupational exposure of formalin within scientifically reasonable limits. Some of the terminologies used in this context are:

Ceiling Limit: A limit that should not be exceeded even instantaneously at any time during the work day.

Short-Term Exposure Level (STEL):The concentration to which employees can be continuously exposed for 15 min without any adverse health effects.

Time-Weighted Average Concentration (TWAC): An 8-h (working-day or 40 h work-week) average concentration under which it is believed that nearly all the employees may be repeatedly exposed to throughout their lifework without any adverse health effects. The standards recommended by the premier global organizations are shown below in Table 1[27-29]. The NIOSH standards are the most scientifically acknowledged recommendations[28].

Table 1: Standards Of Global Organizations

Sr No.	Organization	Type	Concentration (ppm)
1	Occupational Safety And Health Administration (USA-OSHA)	TWAC	0.75
		STEL	0.2
2	American Conference Of Governmental Industrial Hygienists (USA-ACGIH)	Ceiling	0.3
3	National Institute For Occupational Safety And Health (USA-NIOSH)	Ceiling	0.1 (0.12 mg/m3)
		TWAC	0.016 (0.02 mg/m3)

Symptoms consistent with sick building syndrome have been reported with ambient concentrations of 0.1-0.5 ppm[30]. Some studies which employed sampling of air have reported that formalin concentrations in air of gross anatomy laboratories were sometimes higher than the safe exposure limits[31]. This explains why medical students suffer from various mucosal irritation symptoms during the dissection hours.

Factors Influencing Formaldehyde Emission: The exact chemical composition of embalming fluids varies to some extent as it depends on factors such as age, weight and fat content of the cadaver and humidity and refrigeration facilities available. Skin is one of the protective factors against formaldehyde release. And it has been reported that levels rise dramatically just after the skin is incised. It has also been proposed that subcutaneous adipose tissue, especially of the thoracoabdominal region, is one of the important emitting sources in embalmed cadavers. Few authors have also observed some differences in emission between male and female cadavers.

Sugata Y et al[21] observed that even though statistically non-significant, female cadavers released higher levels of formaldehyde vapour than male cadavers in each stage of dissection. Takayanagi et al in their study reported that formaldehyde levels at the height of breathing

zone in the room was 0.50 ppm after decortication of the ventral trunk, 2.00 ppm after decortication of the superficial muscles of the dorsal trunk, 2.64 ppm after digestive tract, 3.04 pm after posterior abdominal wall and 1.92 ppm after decortication of the upper and lower extremities during the process of dissection[32]. Also, when the whole hall is taken into consideration, the concentrations near dissecting tables during dissection sessions were understandably higher than at a distance away[33]. Levels in the immediate vicinity of the cadaver were found to be about double those in dissection room air in a study[31].

Health Effects Of Exposure: The existing pool of research literature about the effect of formalin on human physiology is replete with reports of medical students suffering from various physical symptoms like burning sensation in eyes, lacrimation, headache, nausea, irritation of airways, and dermatitis[30]. As formalin vaporizes at room temperature, mucosal surfaces like the eyes and nose and respiratory tract are the

critical targets of its effects. The fundamental physiological basis of all these diverse effects lies in its high reactivity. The oxygen atom of aldehyde group of formaldehyde is highly electronegative. This can react easily with nucleophilic sites on cell membranes and in body tissues such as the amino groups in protein and DNA, forming cross-links between protein and DNA in vivo. [34] The high reactivity also produces tissue inflammation either due to chemical injury to the cells or allergenic mechanism. In fact, formaldehyde is a known agent of chemical hypersensitivity[35]. Reactive oxygen species and free-radical mediated oxidative stress[30] are also factors that contribute to the detrimental effects at the cellular level.

The irritant effect of formaldehyde on tissues[36] can be elucidated by all these probable mechanisms ultimately causing stimulation of branches of the trigeminal nerve. In eyes, it could also possibly excite mast cells and causes release of inflammatory mediators like histamine, serotonin, etc which result in redness, irritation and lacrimation. It has also been proposed that most likely, near 100% absorption of formaldehyde vapour occurs from the upper respiratory tract, making the irritant effects on nasal mucosa and throat a natural consequence of the process[37]. Formaldehyde, being water soluble, is proposed to get dissolved in the moisture of the mucosa of the respiratory tract and then incite degenerative, inflammatory and hyperplastic changes in the mucosa[38].

Studies have also reported that the mucociliary clearance of the epithelial lining of upper respiratory tract, paranasal sinuses, etc is delayed due to exposure to formaldehyde[37]. Therefore inflammatory changes in the mucosa in the setting of a delayed ciliary clearance especially in the sinuses could contribute to experience of stuffiness and headache. Symptoms of mucosal irritation in conjunction with headache, discomfort, etc which are consistent with sick building syndrome have been reported by Akbar-Khanzadeh F et al[24], Elshaer NSM et al[25], Jain SR et al[38], Patil GV et al[39], Yadav A et al[40],Kundu S & Gangrade P[41] , Dhar DK et al[42] and Oniyje FM et al[43] in their studies investigating the effects of formaldehyde on first year medical students. Some authors have even reported neuro-behavioral changes upon chronic exposure to formaldehyde manifested as prolonged audio-visual reaction time[44].

Conclusion: Research has yielded that ventilation and thermal comfort and humidity are the critical steps by which quality of the working environment can be improved. Quite understably, inadequate ventilation amplifies the effect of volatile compounds and particulate matter. Thermal discomfort and humidity has been associated with stuffiness, headache and dizziness. The occurrence of symptoms of sick building syndrome can thus be reduced by targeting these two elements. With regard to ventilation, it has been recommended that fresh air flow rate should be 15 litres per second (lps) per person in building rooms that are occupied by people performing work tasks. It has been suggested that the most comfortable temperature inside a building is between 20 and 23°C in winter and 20–25°C in summer with relative humidity of 40–60%[35,45]. This can be ensured in the dissection hall by proper air conditioning, exhaust and ventilation facilities.

We should also make focussed efforts to reduce exposure to formaldehyde by practicing simple steps like use of masks, goggles and avoiding unnecessary spillage of formalin within the dissection hall. Options like modifying the conventional process of embalming are also being explored by use of accessory chemicals or alternative embalming fluids.

Studies have also reported a reduction in the ambient concentration of formaldehyde with the use of a specially-engineered local ventilation apparatus which comprised of a grid type of hood with a downward suction that can be attached to ordinary dissection tables and connected to the ventilation duct. A significant decrease in the occurrence of symptoms was also observed. [46] Measures like this therefore can therefore reduce the general discomfort and aversion of the medical students and improve the performance of the students and preserve the proficiency of the teachers and staff in the long run.

References:

1. Ishibashi M, Tonori H, Miki T, Miyajema E, Kudo Y, Tsunoda , et al. Classification Of Patients Complaining Of Sick House Syndrome And/Or Multiple Chemical Sensitivity. Tohuku J. Med. 2007; 211: 223-33.
2. Burge PS. Sick Building Syndrome. Occup Environ Med 2004;61:185–190.
3. World Health Organization Regional Office for Europe. Sick Building Syndrome. Available

online:www.euro.who.int/Housing/pamphlet. (accessed on 1 September 2008).
4. Kreiss K. Environmental and occupational medicine. 3rd ed, 1998. Philadelphia, PA: Lippencott-Raven Publishers :1471-1477.
5. Environmental Protection Agency. Indoor Air Facts No. 4 (revised) Sick Building Syndrome, 2007. Available online at: http://www.epa.gov/iaq/pubs/sbs.html. (accessed on 1 June 2019).
6. AkimenkoVV, AndersenI, LebowitzMD, Lindvall T. The"sick"building syndrome. In: Berglund B, Berglund U, Lindvall T, Sundell J (eds). Indoor air. Vol 6. Evaluation and conclusions for health sciences and technology. Stockholm: Swedish Council for Building Research; 1986:87-97.
7. Puroshottam K. The sick building syndrome. Indian Journal of Occupational Health 2001; 44: 36-40
8. Hodgson M (2000) Sick building syndrome. Occup Med 2000; 15:571–85.
9. Seltzer JM (1994) Building-related illnesses. J Allergy Clin Immunol 94, 351–62.
10. Kipen HM, Fiedler N. Environmental factors in medically unexplained symptoms and related syndromes: the evidence and the challenge. Environ Health Perspect. 2002;110(Suppl 4):597.
11. Mendell MJ, Fisk WJ, Petersen MR, Hines CJ, Dong M, Faulkner D, et al. Indoor particles and symptoms among office workers: results from a double-blind cross-over study. Epidemiology. 2002;13(3):296–304.
12. Chapman JA, Terr AI, Jacobs RL, Charlesworth EN, Bardana EJ. Toxic mold: phantom risk vs science. Ann Allergy Asthma Immunol. 2003;91(3):222–32.
13. Boxer P. Indoor air quality: a psychosocial perspective. J Occup Med 1990; 32: 425–28.
14. Belachew H, Assefa Y, Guyasa G, Azanaw J, Adane T, Dagne H et al. Sick building syndrome and associated risk factors among the population of Gondar town, northwest Ethiopia. Environmental Health and Preventive Medicine 2018; 23:54.
15. Raja SD, Sultana B. Potential Health Hazards for Students Exposed to Formaldehyde in the Gross Anatomy Laboratory. Journal of Environmental Health 2012; 74(6): 36-40.
16. Main OM, HoganTJ. Healtheffects of low-level exposure to formaldehyde. J Occup Med 1983;25:896-900.
17. Norback D, Michael I, Widstrom J. Indoor air quality and personal factors related to the sick building syndrome. Scand J Work Environ Health 1990;16(2):121-128.
18. Joshi SM. The sick building syndrome. Indian Journal of Occupational and Environmental Medicine 2008; 12 (2): 61-64.
19. Agency for Toxic Substances and Disease Registry. Toxicological profile for Formaldehyde. Atlanta. July 1999; 4.
20. Sugata Y, Miyaso H, Odaka Y, Komiyama M, Sakamoto N, Mori C et al. Levels of formaldehyde vapor released from embalmed cadavers in each dissection stage. Environ Sci Pollut Res 2016 23:16176–82.
21. Dixit D. Role of standardized embalming fluid in reducing the toxic effects of formaldehyde. Indian J Forensic Med Toxicol 2008; 2:1.
22. Ajmani ML, editor. Embalming: Principles and Legal aspects. 1st edition. Jaypee Brothers; 1998. Chapter 7, Embalming chemicals and fluids; p. 111-118.
23. Akbar-Khanzadeh F, Vaquerona MU, Akbar Khanzadeh M, Bisesi MS. Formaldehyde exposure, acute pulmonary response and exposure control options in a gross anatomy laboratory. Am J Ind Med1994; 26: 61–75.
24. Keil CE, Akbar-Khanzadeh F, Konecny KA. Characterizing formaldehyde emission rates in a gross anatomy laboratory. Appl Occup Environ Hyg 2001; 16: 967–72.
25. Elshaer N.S.M., Mahmoud M.A.E. Toxic effects of formalin-treated cadaver on medical students, staff members, and workers in the Alexandria Faculty of Medicine. Alex J Med 2017; 1-7.
26. World Health Organization. Formaldehyde. Air quality guidelines (2nd edition) 2001; 4-5.
27. American Conference of Governmental Industrial Hygienists (ACGIH). TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents, Biological Exposure Indices. Cincinnati, OH; 2002.
28. National Institute for Occupational Safety and Health (NIOSH). Pocket Guide to Chemical Hazards. U. S. Department of Health and Human Services; 2004:103.
29. Occupational Safety and Health Administration (OSHA). Code of Federal Regulations, U.S Department of Labour; 2005.
30. Agency for Toxic Substances and Disease Registry. Formaldehyde. Addendum to the toxicological profile for Formaldehyde. Atlanta: Division of Toxicology and Environmental Medicine; 2010; 2-54.
31. Shirashi N. Levels of formaldehyde, phenol and ethanol in dissection room air and

measures for reduction. Jpn J Occup Med Traumatol 2006;54:1-10.
32. Takayanagi M, Sakai M, Ishikawa Y, Murakami K, Kimura A, Kakakuta S, Sato F. Formaldehyde concentration in the breathing zone of medical students during gross anatomy laboratory in Toho University. Kaibogaku Zasshi 2007; 82 (2):45-51.
33. Vohra MS. Personal formaldehyde exposure level in the gross anatomy dissecting room at College of Medicine King Saud University Riyadh. Int J Occup Med Environ Health 2011;24: 108-13.
34. Feron VJ, Til HP, de Vrijer F et al. Aldehydes: occurrence, carcinogenic potential, mechanism of action and risk assessment. Mutat Res. 1991;259:363-385.
35. Jansz J. Theories and Knowledge About Sick Building Syndrome. In: S.A. Abdul-Wahab (ed). Sick Building Syndrome. Springer Verlag Berlin Heidelberg; 2011: 25-58
36. Doty RL, Cometto-Muniz JE, Jalowayski AA, Dalton P, Kendal-Reed M, Hodgson M. Assessment of upper respiratory tract and ocular irritative effects of volatile chemicals in humans. Crit Rev Toxicol. 2004;34(2):85–142.
37. Lyapina M, Kisselova-Yaneva A, Krasteva A, Tzekova–Yaneva M, Dencheva-Garova M. Allergic contact dermatitis from formaldehyde exposure. J of IMAB. 2012; 18(4):255-262.
38. Jain SR, Nahar PS, Baig MM. Study of Formalin Toxicity in I MBBS Students. International Journal of Science and Research 2012; 1(3): 233-35.
39. Patil GV, Kumar S, Thejeshwari, Apoorva D, Sharif J, Sheshgiri C, Sushant NK. Physical Reactions of Formalin used as Cadaver Preservative on First Year Medical Students. Journal of Evidence Based Medicine and Healthcare 2014;1 (5): 279-283.
40. Yadav A, Yadav M. A Study of the Effects of Formalin on First Year MBBS Students. Sch. J. App. Med. Sci. 2014; 2(5B):1588-90.
41. Kundu S, Gangrade P. Study of the toxic effects of formaldehyde vapours within dissection hall on the first year Indian medical students. Int J Anat Res 2015;3 (2):1179-1190.
42. Dhar DK, Chaudhuri S. A study to assess acute physical reactions experienced by first year medical students on exposure to formaldehyde during gross anatomy dissection. Indian Journal of Applied Research 2019; 9 (1) : 19-20.
43. Onyije FM, Avwioro OG. Excruciating effects of formaldehyde exposure to students in gross anatomy dissection laboratory. The International Journal of Occupational and Environmental Medicine 2012;3: 92-95.
44. John J, Laitha V, John N. Peak expiratory flow rate and reaction time analysis in formaldehyde exposed medical technicians and attendants. Int J Med Sci Public Health 2016;5:2095-2097
45. Roy P. Sick? Sick, or Real Sick? Presented at the AIOH June Sundowner. Chemistry Centre. Curtin University, Bentley, WA; 2010.
46. Kunugita N, Nakashima T, Kikuta A, Kawamoto T, Arashidani K. Exposure to formaldehyde during an anatomy dissecting course. J UOEH. 2004;26:337–348.

Conflict of interest: None

Funding: None

Cite this Article as: Dhar D, Arora R, Chaudhuri S. Is Occurrence Of Sick Building Syndrome A Possibility In The Dissection Hall? Natl J Integr Res Med 2020; Vol.11(4): 66-71