

A Study to Evaluate the Chronic Effect of Exposure to Formaldehyde on First Year Medical Students: A Longitudinal Assessment

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Abstract

Original Research Article

Medical students are exposed to a variety of occupational hazards during education and training in medical schools. One of them is formaldehyde, which is commercially available as formalin and is used as a component of embalming fluids in anatomy. It causes various effects like intense mucosal irritation, decrement in lung functions, etc. The present study was therefore intended to observe the various physical reactions experienced by first year medical students after six and ten months of exposure to formaldehyde to understand its chronic effects on body's physiology. A longitudinal, descriptive study was conducted in the Department of Physiology, Rohilkhand Medical College and Hospital with eighty randomly selected first year medical students. The various symptoms were recorded on a predesigned questionnaire. Descriptive statistics and Wilcoxon signed rank test were used for analysis. A p-value < 0.05 was considered statistically significant. Considerable amount of distress was observed in the participants as indicated by the manifold physical reactions reported by them. However, by the end of ten months a significant decrease in their extent was also observed, suggesting that body adapts and develops tolerance towards this chemical. It highlights the innate physiological principle of restoring homeostasis. The exact mechanism remains to be unfolded. We should promote measures to reduce the exposure of students to formaldehyde to increase the quality of their learning experience.

Keywords: Formaldehyde, physical reactions, chronic effect, medical students.

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INTRODUCTION

One of the various occupational hazards that a doctor faces is exposure to formaldehyde. This occurs during the phase of their education and training in medical schools in the first year of their medical studies when he or she learns the basic sciences, i.e. Anatomy, Physiology and Biochemistry. Study of the human cadaver is at the epicentre of teaching anatomy. A medical student gets acquainted and learns about the body's structure by meticulous dissection of cadavers. These cadavers are embalmed with the help of formalin, which is the commercially available form of formaldehyde. Therefore, instructors and students who handle the cadavers on a daily basis during gross anatomy dissection classes are therefore consistently exposed to formaldehyde for the entire first year and often, the exposure rates are high [1, 2].

Chemically, formaldehyde (HCHO) is the simplest aldehyde. It 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. Formalin is 37% aqueous solution of formaldehyde [3] which vapourizes at room temperature. Therefore, inhalation is one of the most important portals of exposure. Respiratory system and mucosal surfaces of the body like eyes, etc are very easily affected by it.

Today, there is substantial evidence in the medical literature to suggest that formaldehyde can be toxic, allergenic and even carcinogenic [4, 5, 8]. In the course of this exposure during dissection, medical students suffer from various physical symptoms like burning sensation in eyes, lacrimation, headache, nausea, irritation of airways, and dermatitis [5-7]. Concentrations above 0.1ppm are reported to cause mucosal irritation, neurological effects and increased risk of asthma and allergies and levels more than 0.5ppm, in addition to the above symptoms, also cause altered pulmonary functions [6]. Formaldehyde is also attributed for the 'sick house syndrome' or 'sick building syndrome' which is characterized by

nonspecific complaints of mucosal irritation, headache, nausea and chest symptoms [9].

As such, there are quite a number of studies which have assessed and reported the acute physical reactions experienced by medical students on exposure to formaldehyde but apparently very few attempts have been made to survey the chronic effects of this exposure. The present study was therefore intended to evaluate the various physical reactions experienced by the first year medical students at 6 and 10 months of regular exposure.

MATERIALS AND METHODS

A longitudinal, descriptive study was conducted in the Department of Physiology, Rohilkhand Medical College and Hospital among first year MBBS students in the session 2015-16. Approval was obtained from the Institutional Ethics Committee (vide document IEC/IRB No. IEC/27/2015). Students having no history of previous exposure to formalin by inhalational route or direct contact were considered as subjects. The exclusion criteria for the study were presence of pre-existing mucosal irritation symptoms of eyes, nose and throat, etc, any acute or chronic inflammatory state, allergic dermatitis and history of food, drug or chemical hypersensitivity. Students those who were not willing to

participate were also excluded from the study. Eighty (80) medical students out of the total 150 were selected using simple random sampling technique. Informed consent was taken from every participant after explaining the nature of the study. A pre-designed and structured questionnaire was used to record the various physical reactions. There was also a provision for subjective grading of increasing level of discomfort of a particular symptom into absent, mild, moderate and severe intensities. The exercise was done once at the end of 6 months and once at the end of 10 months. Descriptive statistics and suitable statistical tests like Wilcoxon signed rank test were applied for analysis. A p-value < 0.05 was considered statistically significant.

RESULTS

The response rate with the questionnaire was 100%. The various physical reactions, both after 6 months of exposure and after ten months of exposure have been shown in Table 1. Those with positive subjective experiences were further graded into mild, moderate and severe intensities of perception of the symptom. A visible decrease can be observed in their occurrence with increase in the duration of exposure. The decrement was statistically significant decrement in all except the symptom of suffocation.

Table-1: Comparison of different physical reactions after six and after ten months of exposure

Physical reactions	After six months				After ten months				Wilcoxon signed rank test	
	Present			Absent	Present			Absent	Test-value (Z)	P-value
	Mild	Moderate	Severe		Mild	Moderate	Severe			
Eye irritation	33	7	4	36	30	2	0	48	-3.727	0.000
Nasal irritation	19	6	1	54	12	4	0	64	-2.913	0.004
Throat irritation	31	6	0	43	29	4	0	47	-2.121	0.034
Unpleasant odour	32	11	1	36	29	11	0	40	-2.121	0.034
Nausea	22	0	0	58	14	0	0	66	-2.828	0.005
Headache	19	0	0	61	11	0	0	69	-2.828	0.005
Unusual fatigue	21	1	0	58	14	0	0	66	-2.714	0.007
Suffocation	5	0	0	75	2	0	0	78	-1.732	0.083

DISCUSSION

The results show that even after six months of exposure, formaldehyde still causes a considerable amount of distress among the students, especially by causing symptoms such as mucosal irritation, unpleasant odour and nausea. However, it decreases significantly by the end of ten months suggesting that with time, the body adapts to the effect of formaldehyde as far as physical reactions are concerned. The same trend was also observed in studies where reactions were compared before and after the first month of exposure [10, 11]. To start with, the fundamental physiological basis of all these diverse effects lies in the high reactivity of formaldehyde. 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 [12]. The high reactivity in turn can consequently lead to tissue inflammation either due to chemical injury to the cells or allergenic mechanism. Reactive oxygen species and free-radical mediated oxidative stress are also factors that contribute to the detrimental effects at the cellular level.

The occurrence of various features of eyes, nose and throat can be explained by the irritant effect of formaldehyde on tissues [13-15]. These surfaces are exposed to the environment making the contact with

formaldehyde vapours easily plausible. In addition, in eyes, formaldehyde gets dissolved in the tear film due to its high water solubility further adding to the effect. With regard to the nasal mucosa also, 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 [16, 17]. A decrease in these symptoms similar to the present study was observed by Emue B *et al.* [18]. This can be due to the phenomenon of tolerance that is exhibited by formaldehyde. On repeated exposure to same levels, a person gets adapted to the effects of the chemical [19]. The occurrence of unpleasant odour can be explained by the low sensory threshold for this sensation. Nausea and headache occurring in conjunction with mucosal irritation symptoms could be a manifestation of the sick-house or sick-building syndrome. A feeling of unusual fatigue and discomfort could be due to the cumulative effect of all other physical reactions.

CONCLUSION

The present study shows that there is an adverse effect of formaldehyde on body which is expressed in the form of manifold physical reactions. This clearly implies that the normal physiology of the body is deranged. The study also demonstrates that though restoration to normalcy starts after regular exposure by the virtue of tolerance, a minimum time span of around ten months is needed for some considerable reversion. It thus underlines the body's innate desire to restore homeostasis. Apart from the various health-related impediments, it can also result in an aversion towards the dissection hall among the students. This could have an undesirable bearing on their learning and proficiency in the long run. Resolute efforts should therefore be made to reduce the exposure to formaldehyde by practicing simple steps like use of masks, goggles, improving the ventilation across the dissection hall and avoiding unnecessary spillage of formalin within the dissection hall.

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