Examining the harmful effects of formaldehyde vapours on Indian medical students while they are in the dissection hall

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ABSTRACT

Introduction: Since many years, formaldehyde has been employed as a tried-and-true component of embalming fluids, either by itself or in combination with methyl alcohol, thymol crystals, glycerin, and water. To create the embalming solution for cadavers, Medical College, Santosh University uses 37% formaldehyde, 7% methyl alcohol, and the remaining water. Formaldehyde concentrations are often stated in parts per million (1 ppm = 1.248 mg/cu.m.). All medical personnel, including students, faculty, and technicians, may be at risk for health problems due to the vapours that the cadavers in the dissection hall emit. The discomfort results in skin allergies as well as irritation of the mucous membranes of the nose, respiratory system, and eyes.

Materials and Methods: We made a sincere effort to categorize the effects of formaldehyde fumes on 100 first-year MBBS students at Medical College, Santosh University based on the unintentionally produced complaints as they have never been exposed to formalin.

Results: The outcomes were pretty striking. The greatest numbers of students among the numerous symptoms described were positive.

Discussion: Formaldehyde exposure to medical students during their dissection training is being one of the causes of numerous chemical sensitivities in recent times. This study essentially reflects harmful consequences on the first batch of Indian medical students pursuing MBBS.

Conclusion: In order for the medical students to approach the dissection hall without any mental stress related to the toxicity of formalin vapours, the presentation also suggests potential strategies for reducing formalin exposure.

Key words: Formaldehyde, toxicity, MBBS students, dissection, questionnaire.

Introduction:

"Formalin" is a 37–50% aqueous solution of dissolved formaldehyde, $CH_2(OH)_2$ and $HO(CH_2O)NH$. (37% by weight or 40% by volume of formaldehyde gas in water) [1] . August Wilheld Von Hofmann, a British chemist, developed formaldehyde in 1856 [2]. It is a very soluble gas in water that is toxic and combustible. In the medical field, formalin, a colourless (at room temperature) [1] irritant that emits strong formaldehyde vapours, is frequently used as a fungicide, germicide, disinfectant, and preservative [3] solution in Anatomy Mortuary (Cadaveric preservative), Anatomical and Pathological gross specimens in medical institutes and hospitals, as well as in the wood and plastic industries [4].Additionally, the production of pressed wood products (urea resins in plywood wall panelling, particle board, and fibre board), fertilizers,

permanent press products and other textiles, paper, glue, and the chemical, adhesive, paint, plastic, construction, textile, and cosmetic industries all make extensive use of formaldehyde (Bernstein et al., 1984). Smoke from cigarettes contains it and is produced when organic materials are burned (U.S. Environmental Protection Agency [U.S. EPA], 2011).

A corpse in a medical school is embalmed by injecting chemicals such as formalin, which contains formaldehyde, alcohol, glycerin, carbolic acid, and colour into the bodily tissues [4]. These substances, which are typically infused via the femoral arteries or the internal carotid arteries, have specific functions (e.g., fixative, preservation, denaturation, solidification of tissue protein, disinfection and maintenance of the integrity of the anatomic relation germicides, buffers, wetting agents, anticoagulants, dyes, perfuming agents, etc.) [3]. (Coleman and Kogan, 1998). By keeping the cadaver as lifelike as possible while maintaining the necessary normal anatomical relationships for dissection, this aids in the preservation of the specimen [3].Embalming fluid is prepared using a variety of formulas. It depends on the lab as well as other elements such the cadaver's size, degree of edoema, and stage of decomposition [3].

As a result, formaldehyde exposure occurs often in the work environments of anatomists, lab technicians in biological science, and medical school students in the dissection classroom. The length of time spent in the anatomy practical hall and museums, the working environment there, and the type of embalming done all affect how much exposure to that substance there is (Pabst 1987).High formaldehyde concentrations in the air (>0.50 ppm) or cadaveric tissues (0.22 ppm), poor ventilation in the dissection rooms, a lack of strict and appropriate guidelines for handling embalmed Cadavers and prosected specimens, ignorance of the effects of formalin, and a work environment that facilitates the spillage of formalin can all contribute to excessive formaldehyde vapour in the working area (Balmes, 2004).

According to the American Conference of Governmental Industrial Hygienists (2001), formaldehyde has a threshold limit value of 0.3 ppm, which must never be exceeded. According to the Formaldehyde, Occupational Safety and Health Standards, 1998, the legal airborne allowable exposure limits are 0.75 ppm averaged over an eight-hour work shift and 2 ppm not to be exceeded during any 15-minute work session. According to the Agency for Toxic Substances and Disease Registry (ATSDR), 1999, the recommended airborne exposure limits are 0.016 parts per million (ppm) averaged throughout a 10-hour work shift and 0.1 ppm not to be exceeded during any 15-minute work period.

Despite the fact that formalin is regularly employed in several industries, its toxicity is typically overlooked [4]. Formaldehyde breaks down into formic acid very quickly inside the body [4]. The degree of formaldehyde intoxication can be determined by measuring the amounts of formate (formic acid minus one hydrogen ion). Parts per million (ppm) is a common unit of measurement for formaldehyde content in the air (1 ppm = 1.248 mg/m) [1].

The following categories can be used to group the harmful effects of formaldehyde exposure: mucous membrane irritation, contact dermatitis, teratogenicity, and carcinogenicity (NIOSH, 2009). As 95%

of inhaled formalin is absorbed by the upper respiratory tract, most frequently at 1ppm, upper airway irritation is the most frequent respiratory effect observed after exposure to formalin [5,6]. Dry or sore throat, stinging and burning in the nose, and nasal congestion are all signs of upper airway irritation.

Within one to two hours, tolerance to this amount of exposure may appear [6]. This tolerance may allow workers to continue working in a setting with steadily rising formaldehyde levels without being aware of the dangers of their exposure [6]. As formaldehyde's concentration rises, its harmful effects become more pronounced [6]. Irritation of the throat, nose, eyes, and skin are typical signs of acute formalin exposure [7]. Additionally, it may result in neurophysiologic effects, irritation of the upper respiratory tract, which may aggravate the symptoms of asthma and other respiratory conditions, as well as dyspnea, coughing, and burning in the nose, eyes, and pharynx [7].Bronchitis and pneumonia can result from long-term exposure [7]. It can cause sudden death when swallowed [7]. According to occupational data, chronic exposure to formalin at work may result in severe abnormalities in pulmonary, respiratory, and cardiac function [8]. It is widely recognized that formaldehyde can lead to sick building syndrome (sick house syndrome), which is characterized by symptoms of the chest, including headache, nausea, and mucosal irritation [8]. Additionally a hapten, formaldehyde-protein complexes have the potential to trigger an immune response [3].

In the US, 3 ppm in a timeweight average breathing zone over an 8-hour period, a ceiling concentration of 5 ppm, and an allowable maximum peak of 10 ppm for no more than 30 minutes during a single day shift are the permitted limits of occupational exposure to formaldehyde [11].

Dissection of the human body and solid anatomical knowledge continue to be the cornerstones of the first-year medical curriculum. The anatomy department has a higher level of ongoing formaldehyde exposure than other departments [3]. The embalmers, histology technicians, instructors, and students of anatomy are all regularly exposed to the hazardous vapours of formaldehyde. Thus, for many medical students, the anatomy dissection laboratory provides a substantial emotional difficulty [9]. Therefore, this study evaluate the results of acute formaldehyde exposure, describe the toxicity's likely aetiology and list the potential preventive steps that could be taken to lessen its toxicity.

Materials and Methods:

Over the course of two years (2013–2014), the study was conducted on 100 first-year MBBS students (both male and female) at the department of human anatomy at Medical College, Santosh Univesity (Ghaziabad), which offers 50 MCI-recognized admissions each year. Fortunately, there was a 1:1 ratio of men to women each year. The medical college's ethical committee issued a letter of ethical clearance. The students were told of the study's goals, and proper, written informed consent was obtained in order to reduce the possibility of participant bias [9].The students were between the ages of 18 and 20; healthy; non-obese; non-smokers; and without a history of epilepsy, cardiac, pulmonary, dermatological system, or pulmonary disorders [13,4,9,11].(inclusion criteria & exclusion criteria). An extensive

medical exam validated the student's state of health. Inadvertent formaldehyde fume exposure occurred frequently while the students were working on dissections (2 hours each day for 6 days a week). The source of the cadavers, the procedure of embalming them, the embalming solution, the legal preparations, disposal, and burial of cadavers were all explained to the students.A questionnaire about the signs and symptoms of breathing in formaldehyde fumes in the dissection room was given to the students [3, 4, 11]. (Questionnaire 1). On a scale from 0 to 3, these symptoms were rated as follows: Grading systems include Grade 0 (not recognised), Grade 1: Mildly recognizable; Grade2:Moderately recognizable and irritating; and Grade 3(severely recognisable, intolerable, and requiring medical treatment). In Questionnaire 2 [3, 4, 9, 11], the students were also asked to specify which symptom appeared first and which was the most unbearable.One student had bronchial asthma, two were known smoker, and three of the 100 case sheets that were provided were not returned. These six case papers were classified as excluded. 94 instances in total were evaluated for the study as a result. Three graphs were drawn as a result of the results: graph 1 depicts the percentage severity of each significant symptom, graph 2 the incidence of the significant initial symptom, and graph 3 the most irritable symptom as a proxy for all symptoms.

Results:

Unpleasant odour was noted by 91.66% of students, running nose was a complaint for 52.77%, redness of the eyes bothered 49.07% students, unusual tiredness was experienced by 37.03% of participants, excessive lacrimation bothered 84.25% of students, sleeping time was prolonged for 21.29% of subjects, itching eyes was a symptom for 50.92% of students, vision was blurred for 32.40% of participants, unusual thirst was experienced by 26.85% students, 33.33% of students reported having a dry nose, 39.81% of students reported having a congested nose, 30.55% of participants reported having a disturbed appetite, 25% of students reported having a Fainting episode, 23.41% of subjects reported seeing skin eruptions, 27.77% of participants reported having itchy hands, 30.55% of students reported having a dry cough, and 38.88% of participants reported having a sore throat. Students reported sore throats, tingling in the nose that was bothersome in 40.74% of cases, problems with concentration in 31.48% of cases, feelings of weakness from formaldehyde inhalation in 20.37% of cases, restlessness from formalin inhalation in 18.08% of cases, and skin peeling in 16.66%% of cases. Nail discoloration was not a significant symptom.

Some of the many symptoms continued to manifest even hours after the dissection. They include 7.40% of kids experiencing post-dissection vomiting, 12.03% experiencing post-dissection nausea, 19.14% experiencing post-dissection decreased hunger, and36.11% experiencing post-dissection eye redness.Unpleasant scent was reported as the first symptom by 55.55% of students, the most irritating symptom by 18.51% of students, and the most problematic symptom by 38.88 percent of students was excessive lacrimation. None of the other symptoms were particularly noteworthy in terms of frequency or irritation.

Discussion:

Methyl alcohol is oxidised to create formaldehyde gas [8]. In their dissection classes, medical students are exposed to formaldehyde, whose exposure is now thought to be one of the causes of multiple chemical sensitivity [8]. The current study explains the hazardous consequences on the first-year Indian medical students who were unknowingly exposed to formaldehyde fumes from embalmed cadavers in the Anatomy dissecting room at the appropriate time.

These impacts were quantified in a tabular chronological order of (1) the symptoms experienced, (2) the symptom that occurs first, and (3) the symptom that is the most disturbing of all.All of the symptoms were shown in a bar graph with the proportion they had determined. The odor of formalin was found to be the most unsettling, troubling, and first-appearing symptom (68/94=72.34%). (The Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT) has established guidelines which recommend reducing the use of gaseousformaldehyde in gross anatomy dissection laboratories because formaldehyde has been linked to nasopharyngeal tumours in humans, according to a report from Japan [3].Additionally, it is consistent with research conducted in Vienna, where exposure to formaldehyde fumes resulted in shortness of breath, a mild irritation of the upper respiratory tract, and impaired pulmonary function. Large quantities of formaldehyde vapour inhaled have been linked to malignancies in lab animals, especially those of the upper airways [3]. As they were first exposed to formaldehyde vapours, 53.19% (50/94) (Table 2) students reported that excessive lacrimation was the symptom that they felt most agonisingly and was the most troublesome.

In accordance with studies from Belgium and India that formaldehyde produced eye discomfort, excessive exposure to formaldehyde could result in poor vision later in life [3].Because little or nothing may be grasped during dissecting when one is sleepy, woozy, and experiencing other symptoms like a headache [3], formaldehyde may also hinder assimilation during dissection. Only 26 out of 94 students (27.67%) (Table 1) thought formaldehyde would significantly hinder their absorption, though. In this study, we discovered that "skin-related disorders," one of formaldehyde's most prevalent side effects, had a low occurrence.

As a result of the small batch size (17 students out of 50) and the lack of cadavers at the new medical institution, one or two students were chosen to serve as group leaders for each batch.The group in charge actively participated in the dissection and was instructed by lecturers and practical instructors who covered their hands and other exposed body parts with protective clothing, making skin symptoms the least significant consequence of formaldehyde (10.64%). (Table 1).

It is unknown exactly how formaldehyde exerts its cytotoxic, corrosive, and irritating properties. Aldehydes collectively (inside formaldehyde) are highly electronegative oxygen-containing compounds that readily react with nucleophilic sites on cell membranes, in bodily tissues, and fluids, such as the amino groups in proteins and DNA, generating cross linkages between protein and DNA in vivo [12, 21].

According to Casanova-Schmitz et al. (1984a), metabolic incorporation into macromolecules (DNA, RNA, and

proteins) in the respiratory and olfactory mucosa and bone marrow was the main pathway for formaldehyde metabolism.

Cross-linked macromolecule concentrations in respiratory and olfactory mucosa tissues increased linearly with dose; at all doses, respiratory mucosa tissue concentrations were around two to three times higher than those in olfactory mucosa tissue [12, 22].

In later research, Casanova et al. (1991a, 1991b) revealed the development of DNA-protein cross linkages in the respiratory system using data from Rhesus monkeys and male Fischer 344 rats. There was no sign of the creation of DNA-protein cross links in the sinus or lung tissues at any exposure concentration, while DNA-protein cross link concentrations were highest in the middle turbinate tissues and lowest in the nasopharyngeal tissues [12, 23].Formaldehyde rapidly reacts with free, unprotonated amino groups of amino acids to generate hydroxyl-methyl amino acid derivatives and a proton (H+), which is thought to be connected to its germicidal qualities. The exact mechanism by which formaldehyde exerts its toxicological effects is unknown. Protein will precipitate at higher quantities [12, 24].

The irritating effects associated with exposure to formaldehyde may be brought on by one of these mechanistic qualities or potentially by additional unidentified properties [12].Formaldehyde toxicity most likely happens when intracellular levels exceed formaldehyde dehydrogenase activity, overcoming the body's defences against it, and allowing the intact, unmetabolized molecule to have an impact locally [12]. Formate, the principal metabolite of formaldehyde, is thought to be less reactive than formaldehyde itself and is capable of being excreted as a salt in the urine, incorporated into other cellular components through the one-carbon metabolic pool, or further processed to carbon dioxide [12].

Formaldehyde toxicity is route-dependent. Inhalation, oral, and cutaneous methods can all detect irritation at the point of contact. High doses are cytotoxic and cause mucosal and epithelial cell layers to degenerate and necrotize.These findings support the idea that formaldehyde itself, rather than its metabolites, mediates harmful effects. Although DNA-protein cross linkages have been found, no particular target molecule has been identified [12, 25].

In the nasal epithelium of rats, a local action of formaldehyde vapour was revealed. The no-effect level for exposures lasting 6 hours per day for 9 days in rat experiments where cell turnover was assessed (as a marker of formaldehyde cytotoxicity) is roughly 2 ppm (Monticello et al. 1991; Swenberg et al. 1983). Higher rates of cell turnover were reported at higher concentrations (6, 10, or 15 ppm) and a dose-response was noted (Monticello et al. 1991). Wilmer et al. 1987, 1989 [12] reported similar findings.

According to studies, the degree of nasal injury may depend more on the formaldehyde concentration in the inspired air than on the exposure time (Wilmer et al. 1987, 1989). The size of the nasal cell target population, increased cell proliferation of particular target cells, and the nonlinear kinetics of formaldehyde binding to DNA were also found by Monticello et al. (1996) to be additional explanations for why certain regions of the rat nose are more likely to develop formaldehyde-induced nasal squamous cell carcinomas than other sites in the nasal cavity [12].

Monticello et al. investigated the relationship between proliferating populations of cells and regional and nonlinear formaldehyde-induced nasal carcinoma (1996). Squamous cell carcinomas and polyploidy adenomas made up the majority of the formaldehyde-induced neoplasms, whereas formaldehyde exposures of 6.01 ppm or less had no effect on cell growth [12]. Although there is evidence to show that exposure concentration, not exposure time, determines the degree of damage caused by formaldehyde to the nasal epithelium.

First, repeated exposures for extended durations are necessary to cause nasal cancer in rats; a single high dosage (40 ppm) for acute durations is probably insufficient to cause squamous cell carcinoma cancer (Bhalla et al. 1990; Monteiro-Riviere and Popp 1986; Wilmer et al. 1987).Second, the data show that for nasal carcinomas to develop, a series of cellular activities must take place. Unmetabolized formaldehyde causes cellular and tissue damage, which is then followed by a regenerative hyperplasia and metaplasia phase that causes the mucosa's cell turnover rates to increase (Chang et al. 1983; Feron et al. 1988; Rusch et al. 1983; Wilmer et al. 1987; Woutersen et al. 1987, 1989).

According to studies by Basler et al. (1985), Donovan et al. (1983), Grafstrom et al. (1985, 1993), Rithidech et al. (1987), Snyder and Van Houten (1986), Valencia et al. (1989), Woodruff et al. (1985), and Yager et al. (1986), formaldehyde is genotoxic. In this way, repeated and extended exposure to cytotoxic amounts of formaldehyde may serve as a full carcinogen (offering initiation, promotion, and progression). Five of the eleven nasal tumours studied from rats exposed to 15 ppm formaldehyde for two years had point mutations in the p53 tumour suppressor gene (Recio et al. 1992) [12].

Neo-antigens can occasionally arise when formaldehyde binds to endogenous proteins. Such neo-antigens may cause an immunological reaction, which could explain why asthma and other respiratory problems appear [3]. Thus, the harmful effects of formaldehyde found in formalin on numerous human tissues can have a negative impact on I MBBS students' health [3].

Therefore, appropriate safety measures must be implemented to avoid formalin toxicity. The World Health Organization (WHO) has created a recommendation for formaldehyde in non-occupational environments at 100 ppb (0.1 mg/m3) for 30 minutes in light of this problem. The WHO claims that this recommendation also indicates a level of exposure at which there is a low risk of upper respiratory tract cancer in humans (Neeraj R, Rastogi SK in 2007). This recommendation was created to guard against sensory irritation in the general population.

Recommendations and future prospects:

Since our study is a longitudinal study, it has this advantage. The same subjects were surveyed using a questionnaire on our own Medical College students, who are known to us and are in the same age bracket.

Individual variances were therefore nearly nonexistent. The study's biggest drawback is that it's impossible to gauge and detect the precise level of formaldehyde exposure. However, it was unquestionably at a concentration that can irritate the skin, eyes, and nose.

According to an environmental assessment done in the anatomy lab, formalin levels between 0.02 ppm and 2.7 ppm may result in considerable exposure and produce discomfort in the majority of exposed participants [8].

Our investigation could be expanded to include more participants. By conducting the trial once a year, the chronic effects of formalin exposure might also be evoked, in addition to the effects of formalin on lung function. To determine the various impacts of formalin at various concentration levels, the environmental air concentration of formalin vapours may be evaluated at levels of gradual reduction or gradual increase.

According to Wei et al's research, the time spent in the dissecting room during the anatomy dissection course was associated with subjective symptoms [8].According to their research, reducing the number of cadaver tables and cutting the duration of each Anatomy dissection practical lesson may assist to alleviate the symptoms [8].

Dissection is a tried-and-true method of teaching anatomy that gives students a tactile and spatial understanding of the topic in a way that is impossible with current electronic teaching aids. Students gain control over their conflicting emotions and learn to respect the dying and the deceased. For the freshly enrolled medical students, the anatomy dissection lab poses a substantial emotional challenge [9]. Therefore, the following suggestions might be made to help medical practitioners avoid the biological side effects of formaldehyde:

1. Medical professionals need to be informed about the potential negative health effects of formalin inhalation.

2. The dissection room for anatomy should have sufficient ventilation. The ventilation rate should be greater than 15 room changes per hour, according to the American Conference of Governmental Industrial Hygienists (2001) [4].

3. To lessen exposure to formaldehyde vapours, negative pressure ventilation and monitoring systems should be implemented (inside the dissection halls) [4].

4.Cadaveric trash must be properly disposed of within labelled plastic bags, which must be opened outside in a public place to enable the formalin vapours to escape.

5.Professionals should be urged to wear protective laboratory coats, goggles, and gloves to reduce direct skin contact with the agent.

6. Refrain from wearing contact lenses in the dissection room.

7. Installing several water jets for cleansing the eyes within the dissection room.

8. Regularly empty the formalin collection containers under the dissection table.

9. It is not advisable to allow excessive formalin spills inside the dissection hall, and any such spills should be immediately drained.Professional embalmers should perform the process.

10.For the dissection technique, two pairs of latex gloves or nitrile gloves should be required.Plastic gloves should be recommended for use during dissection and embalming procedures for medical personnel allergic to latex.

11.Professionals who are pregnant should avoid being around formalin vapours. Students who become pregnant while taking an anatomy course should tell their instructors right away and should resume the course after child birth.Students who are pregnant should wear properly fitted double masks designed to reduce formalin

exposure inside the dissection room. They should be instructed to take a 15-minute rest after each session of dissection and to keep sessions under an hour [4].

12. When dissecting animals, asthmatic students should use full-face or half-face respirators [4].

13. Coleman R. advised using specialised dissection beds with an internal motor and replacement active carbon filter system to force the formaldehyde-rich gases to flow downward. 5.

14. Whitehead MC et colleagues discovered that standard formaldehyde solution can be swapped for influ-trace and ideal solution to reduce the amount of formaldehyde in the cadaver vasculature.

15. Regarding the various substitute compounds for formaldehyde, Frolich et al explored employing phenoxy-ethanol as its non-toxic replacement in 1984. It turned out to be problematic because the amount needed was large—600 litres for each corpse—continuous immersion was required to avoid the growth of mould, and the fixation process took 5 to 10 months. A comparable aldehyde to formaldehyde with similar fixing properties is glutaraldehyde. Although it would be a workable option, the volumes needed would make it prohibitively expensive [11].

16. It has also been established that arterial injection is the embalming process with the lowest exposure and the least impact on the total exposure values, thus these techniques should be used. Some researchers also think that formaldehyde and phenol embalming may be replaced by ethanol glycerin fixation with thymol conservation. (2012) (Hammer N. Loffler S.) [3, 5].

17. In the United States of America nowadays, the use of formaldehyde in embalming fluids is legally required [11]. If at all possible, the Indian subcontinent may see the same.

Conclusion:

Despite the harmful effects of formaldehyde fumes, the majority of medical professionals—students, instructors, technicians, or embalmers—are frequently exposed to the agent and, considering the situation in India, most of the time, are not aware of the poisonous effects. Since it is a cost-effective, superior preservative and fixing solution, and a widely recognised antifungal agent, formaldehyde continues to be the most effective agent to use as an embalming solution or to be blended with other comparable solutions. Therefore, its usage should be carefully controlled, and embalming and dissection professionals should always assume the extra responsibility of adhering to the foregoing suggestions in order to lessen the deleterious effects of formalin for the benefit of the study of anatomy in general. The need of the hour is for large, numerous longitudinal studies with a large sample size and the adoption of preventative measures.

Acknowledgement:

The authors are grateful to the department of Anatomy Medical College, Santosh University, India for the valuable guidance and kind cooperation.

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Table 1: Symptoms due to formaldehyde exposure (their grading, frequency and extent)

Symptoms	Gradation			
	Grade0	**Grade1**	**Grade2**	**Grade3**
1.Unpleasant smell	9 (8.33%)	35 (32.41%)	47 (43.52%)	17 (15.74%)
2.Excessive lacrimation(Wateryeyes)	17 (15.74%)	56 (51.85%)	25 (23.15%)	10 (9.26%)
3.Headache	38 (35.19%)	35 (32.41%)	22 (20.37%)	13 (12.04%)
4.Running nose	51 (47.22%)	36 (33.33%)	13 (12.04%)	8 (7.41%)
5.Redness of the eyes	55 (50.93%)	38 (35.19%)	9 (8.33%)	6 (5.56%)
6.Itching or sore eyes	53(49.07%)	37 (34.26%)	10 (9.26%)	8 (7.41%)
7.Nausea	61(56.48%)	29 (26.85%)	13 (12.04%)	5 (4.63%)
8.Congested nose	65 (60.19)	27 (27.66%)	11 (6.38%)	5 (2.13%)
9.Tingling sensation of the nose	64 (59.26%)	26 (24.07%)	9 (8.33%)	9 (8.33%)
10.Dry or soreness in throat	67 (61.47%)	19 (17.43%)	15 (13.76%)	8 (7.34%)
11.Unusual tiredness or dizziness	69 (63.89)	30 (27.78%)	9 (8.33%)	00 (0%)
12. Post dissection redness of eyes	71 (65.74%)	29 (26.85%)	8 (7.41%)	00 (0%)
13.Low concentration	74 (68.52%)	22 (20.37%)	7 (6.48%)	5 (4.63%)
14.Dryness or soreness of nose	72 (66.67%)	21 (19.44%)	11 (10.19%)	4 (3.70%)
15.Disturbed appetite	75 (69.44%)	17 (15.74%)	9 (8.33%)	7 (6.48%)
16.Soreness of throat	72 (66.67%)	24 (22.22%)	5 (4.63%)	07 (6.48%)
17.Itching or sore skin on hands	72 (66.67%)	22 (20.37%)	7 (6.48%)	7 (6.48%)
18.Cough (Dry/Productive)	77 (71.30%)	31(28.70%)	00 (0%)	00 (0%)

19.Respiration difficulties	79 (73.15%)	17 (15.74%)	9 (8.33%)	3 (2.78%)
20.Blurring of vision	73 (67.59)	17 (15.74%)	12 (11.11%)	6 (5.56%)
21.Skin eruptions	78 (72.22%)	16 (14.81%)	8 (7.41%)	6 (5.56%)
22.Post dissection decreased hunger	82 (75.93%)	12 (11.11%)	9 (8.33%)	5 (4.63%)
23.Prolonged sleeping time	85 (78.70%)	15 (13.89%)	5 (4.63%)	3 (2.78%)
24.Restlessness	80 (74.07%)	23 (21.30%)	5 (4.63%)	00 (0%)
25.Fainting episode	81 (75%)	18 (16.67%)	6 (5.56%)	3 (2.78%)
26.Unusual thirst	79 (73.15%)	17 (15.74%)	7 (6.48%)	5 (4.63%)
27.Disturbed sleep at night	84 (77.78%)	19 (17.59%)	5 (4.26%)	00 (0%)
28.Weakness	87 (80.56%)	15 (13.89%)	6 (5.56%)	00 (0%)
29.Peeling of skin	90 (83.33%)	13 (12.04%)	5 (4.63%)	00 (0%)
30.Postdissection nausea	95 (87.96%)	9 (8.33%)	4 (3.70%)	00 (0%)
31.Postdissection vomiting	101(93.52%)	7 (6.48%)	00 (0%)	00 (0%)
32.Discoloring of nails	104 (96.30%)	4 (3.70%)	00 (0%)	00 (0%)

Table 2: Incidence of occurrence and severity of the symptoms of formaldehyde inhalation

Symptoms	Symptom appearing first	Most irritable symptom
1.Unpleasant smell	77(71.29%)	31(28.70%)
2.Running nose	9(8.33%)	17(15.74%)
3.Redness of the eyes	10(10.64%)	2(2.13%)
4.Unusual tiredness or dizziness	4(3.70%)	0(0%)
5.Excessive lacrimation(Wateryeyes)	19(17.59%)	63(58.33%)
6.Prolongedsleeping time	0(0%)	0(0%)
7.Itching or sore eyes	0(0%)	0(0%)
8.Blurring of vision	0(0%)	0(0%)
9.Unusual thirst	0(0%)	0(0%)
10.Respiratory distress	0(0%)	0(0%)
11.Dry or sore throat	0(0%)	0(0%)
12.Nausea	4(3.70%)	11(10.18%)
13.Headache	0(0%)	5(4.62%)
14.Disturbed nocturnal sleep	0(0%)	0(0%)
15.Dry or sore nose	0(0%)	0(0%)
16.Congested nose	0(0%)	0(0%)
17.Disturbed appetite	0(0%)	0(0%)
18.Fainting episode	0(0%)	0(0%)
19.Skin rash	0(0%)	3(2.77%)
20.Itching or sore skin on hands	0(0%)	0(0%)

21.Cough(Dry/Productive)	0(0%)	0(0%)
22.Irritation of throat	2(1.85%)	0(0%)
23.Tingling sensation of the nose	0(0%)	0(0%)
24.Low concentration	0(0%)	0(0%)
25.Weakness	0(0%)	0(0%)
26.Restlessness	0(0%)	0(0%)
27.Peeling of skin	0(0%)	0(0%)
28.Discoloring of nails	0(0%)	0(0%)
29.Post dissection vomiting	0(0%)	0(0%)
30.Post dissection nausea	0(0%)	0(0%)
31.Post dissection decreased appetite	0(0%)	0(0%)
32.Post dissection redness of eyes	0	0(0%)