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POTENTIAL HEALTH HAZARDS OF FORMALDEHYDE USAGE IN GROSS ANATOMY DISSECTION HALL ON STUDENTS AND INSTRUCTORS

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ABSTRACT

Formaldehyde is the most frequently used chemical for embalming in dissection halls and tissue fixation in histopathological laboratories. Exposure to formalin by direct contact or in vapourised form by inhalation can produce various local and/or systemic toxic effects in students, instructors and staff working in dissection rooms. Its toxicity ranges from local irritation and allergic reactions to congenital defects and certain malignancies. This account highlights these adverse effects on medical students, demonstrators, and other staff handling the cadavers at the Anatomy department. It also suggests certain measures and precautions that can minimize formaldehyde toxicity to students and staff in gross anatomy laboratories.

KEY WORDS: Formaldehyde, Toxicity, Embalming, Students, Symptoms.

INTRODUCTION

Formaldehyde is being used for embalming dead bodies in the Anatomy laboratory for years. It is also used for tissue fixation. Students, faculty members, staff of dissection halls, embalmers in funeral homes and workers in histopathology laboratories are chronically exposed to its toxic vapors.

In this article,we are reviewing the hazardous effects of acute as well as chronic exposure to the most frequently used embalming fluid, formalin and formaldehyde and also advise certain precautions and self protection measures that can protect our students, faculty and workers from the known toxic effects of formaldehyde to a significant extent.

Formaldehyde belongs to aldehyde group of chemicals, is a colorless gas at room temperature, inflammable, with irritating odor and extremely soluble in water. It is commercially available in aqueous form, called formalin. Formalin is formaldehyde gas dissolved in water (40% by volume) (1).

Formaldehyde exerts its toxic effects by formalin fumes that emanate in the dissecting and embalming rooms. An embalming fluid measuring 8 litres is used for one normal built adult cadaver. Formaldehyde can prove toxic in many ways when someone is repeatedly exposed to it by inhalation, or via absorption through the skin on contact. Its toxicity clinically manifests in the form of dermatitis in the areas of contact, irritating effects on the nasal, oral and pharyngeal mucosa, and mutagenicity or carcinogenicity. Formaldehyde has also been documented for initiating an allergic reaction (2). Its toxicity also manifests in the form of obstructive disorders of respiratory tract like bronchial asthma (3), ocular irritations, corneal clouding (4), leukemia, nasopharyngeal cancers (5), spontaneous abortions, congenital malformations, menstrual irregularities (6) and allergic skin conditions and dermatitis (7).

Formaldehyde exposure is frequent in undergraduate and postgraduate medical students, faculty and other staff members like dissection hall attendants and helpers at the Anatomy department of a Medical college. Several studies from all over the world clearly mention that formaldehyde vapours present in the areas of dissection may lead to raised levels of exposures(8) which inturn may lead to its harmful effects of varying severty.

The toxicity is further enhanced by students not taking adequate precautions like wearing apron, gloves, head gear and masks, working in dissection halls that are inadequately ventilated, using embalming fluid which has more than prescribed concentrations of formaldehyde, spilling of formaldehyde during handling and procedures, poorly kept cadavers leading to leaking out of formaldehyde, absence of specific instructions regarding working on formalin-preserved cadavers and specimens at departmental or college

level, and the staff may itself be unaware of the harmful effects of formalin exposure(9).

Acute symptoms of formalin exposure

Irritating odour, dryness of nasal and pharyngeal mucosa, rhinorrhea, conjunctival chemosis, epiphora, heaviness in head with visual disturbances, nausea, syncope, nausea, dizziness, abnormal fatigue, asthenia, cutaneous manifestations on exposed areas, gastrointestinal discomfort, difficulty in breathing and sleep disturbances(1).

Complications from chronic exposure:

Skin disorder: White discoloration, burning, drying, cracking, scaling, erythema, edema, eczema, allergic contact dermatitis.

Reproductive disorders: Menstrual disorders, anemia, spontaneous abortions, LBW babies, congenital anomalies.

Ocular disorders: Discomfort and irritation, corneal clouding, visual dissturbances, blindness.

Airway disorders: Upper airway irritation, lower respiratory tract irritation, allergic asthma, exacerbations of bronchial asthma.

Gastrointestinal disorders: Nausea/vomiting, abdominal spasms, GI hemorrhage, gastric outlet obstruction (last two are late complications).

Carcinogenic potential of formaldehyde

In humans, a few types of malignancies have been linked with formaldehyde exposure like, Ca paranasal sinuses, nasopharyngeal carcinoma, leukemias (mainly myeloid), lymphomas, and cancer breast(1). One study on professionals exposed to formaldehyde, reported that white blood cells from the bone marrow, in early stages, exhibited chromosomal changes that were above the levels considered normal. This finding suggests that exposure to formaldehyde may be linked to development of leukemia(17). Numerous surveys of National Cancer Institute have reported an higher than average rate of brain cancer and leukemia among workers exposed to formaldehyde. Another study performed by National Cancer Institute on 25,619 industrial workers exposed to formaldehyde reported an increased mortality rate due to leukemia, especially myeloid leukemia. National Institute for Occupational Safety and Health conducted a study with a cohort of 11,039 textile workers and reported that there is an association between leukemia deaths and duration of exposure to formaldehyde (18-19).

In 2007, Masaaki Takayanagi et al, measured formaldehyde concentration in the air 20 cm above a cadaver, from gross anatomy laboratory at the Faculty of Medicine of Toho University. They reported high levels of formaldehyde in the dissection area ranging from 0.24 to 3.04 (mean 1.71) ppm during dissections. These results showed that students and instructors are exposed to higher than recommended levels of formaldehyde. Formaldehyde exposure upto an average level of 0.75 ppm during eight working hours and 2 ppm for a short duration of fifteen minutes is considered to be within safe limits (10). In 2017, Alexandria Faculty of Medicine reported increased mortality and morbidity in staff members working in the Anatomy department for 15 to 20 years. Three workers died one each renal failure, multiple myeloma, and cancer pancreas. A professor succumbed to undiagnosed retrosternal mass. Three female staff had cancer breast. A professor was diagnosed with lymphoma and another developed lung fibrosis (1). Emue et al. (2011) reported that 81% students experienced general discomfort when initially exposed to formalin treated cadaver, 50% had abnormal sensations in nose and 48% had ocular symptoms (8). Zhang et al. (2010), in China, studied hemopoietic function of workers exposed to formaldehyde and found lower levels of platelets, RBCs counts, and total WBC counts (11). Dixit et al. in 2005, looked for adverse effects of formaldehyde on medical college students and found that apart from irritating odour, ocular symptoms like irritation of the eyes and excess tearing from eyes, were the most distressing(2). In 1980 Walrath et al in their study on the "Carcinogenic effects of formaldehyde on embalmers" reported that embalmers showed an elevated morbidity and mortality from cancer of skin, nasal passages, buccal cavity, pharynx and larynx and a significant excess of arteriosclerotic heart disease(12). In 1990, R.B. Hayes et al reported a higher incidence of colon cancer in U.S embalmers and funeral directors along with increased incidence of hematopoietic and lymphatic malignancies, myeloid leukemia and other types of leukemias. They also found elevations in risk for polycythemia, non-Hodgkin's lymphoma, and myelofibrosis(5).

Formaldehyde has been labeled as a cancer-causing agent by International Agency for Research on Cancer, in June 2004 (13).

Precautions advised

In the dissection halls, there should be a separate cadaver storage area with refrigerators. The dissection rooms should have properly spaced windows for natural ventilation. Artificial ventilation should include exhaust fans or suction devices or negative pressure pump systems. Cadavers or dissected parts of cadavers that are kept in 10% formalin solution should be in closed containers. Eyes and hands washing

stations should be installed in dissection halls. Personal protection should be by means of eye goggles, masks covering nose and mouth, hand gloves, and apron or laboratory coat and one should work in an area which is not directly in between the source of formaldehyde fumes and exhaust ventilation system. Decreasing the concentration of formaldehyde in the embalming fluid can reduce the formaldehyde fumes.

Alternatives to formaldehyde

A safe and effective alternate to formaldehyde for embalming is being researched all over as there is a growing concern about its harmful effects. Some of the suggested alternatives are glutaraldehyde, ethyl alcohol/polyethylene glycol, phenoxyethanol, diazolidinyl urea, tetrakis phosphonium chloride, N-vinyl-2-pyrrolidone, alcohols like methanol, ethanol, isopropanol, phenoxyethanol, sodium borate/boric acid, and sodium nitrate(14-16). Although none of these are completely free of any untoward effect and do pose other safety concerns, for e.g., glutaraldehyde has asthmagenic potential, even then as compared to formaldehyde, they are less toxic. Even saturated solution of salt helps in reduction of formaldehyde concentration in embalming fluid to a large extent(17). Virtual/video dissection is another option that is being discussed nowadays.

CONCLUSION

This article highlights the health hazards of cadavers treated with formaldehyde on students and staff working in dissection halls. From the above account, it becomes clear that we need re-evaluate the dissection hall environment to which our students, faculty and staff is exposed. They should be instructed regarding proper usage of personal protection devices. There should be regular monitoring of the concentration of formalin that is being used, dissecting rooms should be adequately ventilated, and handling and storage of cadavers and dissected parts should be according to proper guidelines.

As now, it is a proven fact that there is a raised incidence of local as well as systemic disorders including certain malignancies in people chronically exposed to formaldehyde and formalin. Keeping in mind its toxicities and following the above suggested precautions may go a long way in preventing our students, faculty and workers from the known toxic effects of formaldehyde to a significant extent.

REFERENCES

1. Noha Selim M E, Madiha Awad E M. Toxic effects of formalin-treated cadaver on medical students, staff members, and workers in the Alexandria Faculty of Medicine. Alexandria Journal of Medicine. 2017; 53(4): 337-343.
2. D. Dixit. Toxic effects of embalming fluid on medical students and professionals. JIAFM. 2005; 27: 209-211.
3. B.K. Binawara. Acute effect of formalin on pulmonary function tests in medical students. Pak J Physiol. 2010; 6: 8.
4. D.S. Raja. Potential health hazards for students exposed to formaldehyde in the gross anatomy laboratory. Environ Health. 2012; 74: 36-40.
5. M. Hauptmann. Mortality from solid cancers among workers in formaldehyde industries. Am J Epidemiol.2004; 159: 1117-1130.
6. J.D. Thrasher, K.H. Kilburn. Embryo toxicity and teratogenicity of formaldehyde. Arch Environ Health. 2001; 56: 300-311.
7. C.E. Keil. Characterizing formaldehyde emission rates in a gross anatomy laboratory. Appl Occup Environ Hyg. 2001; 16: 967-972.
8. B.E. Emue et al. Acute effects of formalin-treated cadaver on nigerian medical students. Am J Trop Med Pub Health. 2011; 1: 89-96.
9. J. Balmes. Formaldehyde poisoning and drug overdose (5th ed.). New York: McGraw Hill; 2004.
10. Takayanagi M et al. Vertical distribution of formaldehyde concentration and simulated temperature and wind velocity from computational fluid dynamics in a gross anatomy laboratory. 2008; 83(1): 7-13.
11. L. Zhang et al. Occupational exposure to formaldehyde, hematotoxicity and leukemia-specific chromosome changes in cultured myeloid progenitor cells. Can Epidemiol Biomark Preven. 2010; 19: 80-88.
12. Walrath J. Proportionate mortality among New York embalmers, in formaldehyde toxicity. New York. Hemisphere Pub. Corp. 1983; 13: 227-236.
13. International Agency for Research on Cancer IARC. Monographs on the evaluation of carcinogenic risks to humans 88, formaldehyde, 2-butoxyethanol and I-tert-butoxypropranolol-2-ol. In: IARC. 2006; 14: 36-325.
14. Erich Brenner. Human body preservation – old and new techniques. J. Anat. 2014; 224(3): 316-344.
15. Yoshinori Haizuka, Miki Nagase, Satoshi Takashino, et al. A new substitute for formalin: Application to embalming cadavers. Clin Anat. 2018; 31(1): 90-98.
16. Yoshinori Haizuka, Miki Nagase, Satoshi

Takashino, et al. Clinical Anatomy. (07 Nov.2017). Availabe from: https://doi.org/10.1002/ca.23011.

17. Gosomji IJ. Saturated salt solution an alternative reagent in reducing formaldehyde concentration in embalming. Anatomy and Physiology. 2018; 5 3: 80-82.
18. American Cancer Society. Available from: https://www.cancer.org/about-us/policies/content-usage.html.
19. National Cancer Institute. Available from: https://www.cancer.gov/about-cancer/causes-prevention/risk/substances/formaldehyde/formaldehyde-fact-sheet.

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