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Toxic effects of formalin-treated cadaver on medical students, staff members, and workers in the Alexandria Faculty of Medicine

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ABSTRACT

Background: Formaldehyde can be toxic, allergenic and carcinogenic. Evaporation of formaldehyde from formalin-treated cadavers in the anatomy dissection rooms can produce high exposure. This study was conducted to assess acute and chronic toxic effects of formalin-treated cadavers on medical students, staff members, and workers at the Anatomy department in the Alexandria Faculty of Medicine (AFM).
Methods: A cross sectional approach was adopted to investigate medical students (n = 454). Staff members and workers at the Anatomy department (n = 16), and unexposed staff members and workers in the AFM (n = 19) were included in the study. Medical students filled self-administered predesigned questionnaire. Formalin-exposed and unexposed staff members filled a questionnaire and a Complete Blood Count was done for them.
Results: The most frequently reported symptoms by medical students were unpleasant smell (91.2%), itching in the eyes (81.3%), and excessive lacrimation (76.1%). Majority of them reported duration of relief within one hour (>80%), and more than two thirds reported wearing laboratory coats and hand gloves. Formalin-exposed staff reported symptoms of skin disorders as drying (75%), eczema (68.8%), and allergic contact dermatitis (87.5%), besides, eye irritation (68.8%), respiratory tract irritation (93.8%), and work-related bronchial asthma (53.3%). The mean RBCs and platelets counts were significantly lower among formalin-exposed staff ($4.08 \pm 0.65 \times 10^6$/ul and $237{,}375 \pm 71745.73$/ul respectively) compared with unexposed staff ($4.95 \pm 0.50 \times 10^6$/ul and 280473.68 ± 54456.27/ul respectively). WBCs count was abnormal (low or high) among formalin-exposed staff members (6.2%, and 18.8% respectively), while all unexposed staff had normal WBCs counts.
Conclusion: The research highlighted the irritating action of formalin on medical students, and chronic toxic effects on staff members. This necessitates re-evaluation of the concentration of formalin, proper ventilation and assessment of working practices in the dissecting rooms at the Anatomy department.
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1. Introduction

Formaldehyde was discovered in 1867 by the British chemist, August Wilheld Von Hofmann. It is a simple aldehyde with the molecular formula CH_2O. At room temperature, it is a colorless gas, has flammable properties and irritating repugnant odor.[1] Formalin, an aqueous form of formaldehyde, contains 37% by weight or 40% by volume of formaldehyde gas in water. Formalin is the chemical most commonly used for embalming.[2] Despite the widespread usage of formaldehyde in tissue fixation and embalmment, a major concern about formaldehyde is safety.[1]

Formaldehyde can be toxic, allergenic and carcinogenic.[3,4] Exposure occurs primarily by inhalation, or via skin absorption of formaldehyde containing fluids. Disorders of exposure include airway irritation and obstructive disorders such as bronchial asthma,[3] ocular irritations, corneal clouding,[2] leukemia, nasopharyngeal cancers,[5] spontaneous abortions, congenital malformations,[2] and menstrual irregularities.[6] Moreover, it has been documented as an allergic skin sensitizer that may lead to dermatitis.[7]

The toxicity of formaldehyde gets worse by the tendency of the exposed individuals to develop tolerance within a few hours of exposure. Accordingly, those individuals remain in environments of gradually raised formaldehyde concentrations without being

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appreciative of the increased exposure levels and consequent hazards.[8] The Occupational Safety and Health Association (OSHA) recommended permissible exposure limit (PEL) of formaldehyde is 0.75 ppm averaged over an eight-hour work shift and 2 ppm not to be exceeded during any 15-min work period. The National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) of formaldehyde is 0.016 ppm averaged over a 10-h work shift and 0.1 ppm not to be exceeded during any 15-min work period.[9,10]

Amongst the groups who are at risk of the effects of formaldehyde exposure are medical students and staff members at the Anatomy department. Studies have shown that evaporation of formaldehyde from formalin-treated cadavers in the anatomy dissection rooms can produce high exposures[8] which may be due to poor ventilation of dissection rooms, poor working practices that may lead to spillage of formaldehyde during embalming, using high concentrations of the embalming fluid, leak out of formaldehyde due to poor conditions of the cadavers, lack of strict guidelines for handling embalmed cadavers and specimens, and ignorance of consequences of formalin exposure.[11,12]

During the last decade, at the department of Anatomy at the Alexandria Faculty of Medicine (AFM), high number of deaths, at different age groups, has been noticed among the staff members and workers who had duration of employment ranged from 15 to 20 years. Some of them were diagnosed before death, while others died suddenly without diagnosis. For example, two workers died after they had cancer pancreas and renal failure respectively. Moreover, a young staff member died after he had been diagnosed as having multiple myeloma. Another professor died shortly after she has been subjected to investigations that revealed a retrosternal mass, she died before completion of the diagnosis (Agwany, personal communication, June 4th, 2014).

In addition to the frequently reported deaths, three female staff, who have been working at the Anatomy department for a considerable period of time, had cancer breast. Another professor has been diagnosed as having lymphoma. Furthermore, a worker had lung fibrosis and left the department after diagnosis (Agwany, personal communication, June 4th, 2014). This research was conducted to assess the acute toxic effects of formalin-treated cadaver on medical students, as well as chronic toxic effects of formalin exposure on staff members and workers at the Anatomy department in the AFM.

2. Material and methods

At the Anatomy department in the AFM, there are three dissecting rooms, one of them has been transformed into cadaver storage area where refrigerators are located. Dissecting rooms are located in the basement of the building. The rooms have few windows located in the upper third of the walls, which represents natural ventilation. Artificial ventilation comprised of few number of suction devices fixed on the wall as well as fans attached to the roof of the dissecting rooms. During anatomy sections, body parts of the cadaver are sometimes kept drenched in 10% formalin solution in open containers or basins to be readily used for demonstration and teaching purposes.

A cross sectional approach was adopted to investigate medical students on the first, second, and third year (n = 454) on their first exposure to formalin or within the first 14 days of exposure at dissection room at the Anatomy department in the AFM. In addition, all staff members and workers at the Anatomy department were invited to participate in the study. Similarly, staff members and workers at the Community Medicine department were asked to participate to represent an unexposed group in the present study. However, those who agreed to participate in the research were 16 formalin-exposed and 19 unexposed staff members and workers. The fieldwork was carried out from September 2015 through February 2016.

2.1. Research tools

The medical students were subjected to a self-administered predesigned questionnaire to collect information about symptoms of acute exposure to formalin-treated cadavers such as unpleasant smell, dry or sore nose, running or congested nose, unusual thirst, itching in the eyes, redness in the eyes, excessive lacrimation, disturbance in sight, nausea, headache, syncope, unusual tiredness or dizziness, dry or sore throat, GIT disturbances, itching of the hands, skin eruptions on the face/neck, and respiratory distress and disturbed nocturnal sleep. All these symptoms were graded on a scale of 1–4; grade (1): not at all, not recognizable, grade (2): barely recognizable, grade (3): strong, prominent and irritating, and grade (4): intolerable. Moreover, they were asked to report the duration of relief of symptoms on first exposure to formalin-treated cadavers, and the use of personal protective devices (PPDs) to prevent toxic effects of formalin.

Regarding formalin-exposed and unexposed staff members and workers who participated in the present study, they filled a predesigned questionnaire to collect information about their personal and occupational characteristics, as well as symptoms of systemic disorders. Additionally, blood samples were collected from them and a Complete Blood Count (CBC)[13] was done at the Clinical Pathology department at the AFM.

Before collection of data, a pilot study was conducted on a randomly selected number of medical students and staff to examine the suitability of the questionnaire forms and estimate the average time needed to fill the questionnaire and carry out the investigation.

2.2. Statistical analysis

The collected data were coded and typed onto computer files using. SPSS/Pc+ software program version 20.0.[14] Descriptive and analytic statistics including frequency, percentages, arithmetic mean ($\overline{X}$), standard deviation (S), Fisher's Exact test, Mann Whitney test, *t* test, and Monte Carlo test were used to demonstrate the distribution of the medical students and staff according to their symptoms of acute and chronic exposure to formalin as well as CBC findings.

2.3. Ethical clearance

The work was performed at the AFM. The study was approved by the Research Ethics Committee at the AFM. The overall study objectives, procedures, and publication were explained and written informed consent was obtained from each participant in the study. Collected data were dealt with great confidentially.

3. Results

3.1. Acute toxic effects of formalin-treated cadaver on exposed medical students (n = 454)

Most of medical students complained of symptoms of acute exposure to formalin-treated cadavers such as unpleasant smell (91.2%), dry or sore nose (74.2%), running or congested nose (69.5%), unusual thirst (53.9%), itching in the eyes (81.3%), redness in the eyes (72.4%), excessive lacrimation (76.1%), disturbance in sight (58.6%), and headache (53.6%). To a less extent, students reported syncope (29.1%), unusual tiredness or dizziness (45.2%),

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