

COMPARATIVE STUDY OF RISK ASSESSMENT OF FORMALDEHYDE EXPOSURE AMONG STUDENTS IN PUBLIC AND PRIVATE FACULTIES OF MEDICINE IN EGYPT

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Abstract:

Objectives : This study aimed at evaluation of the discomfort level produced by formalin vapors on medical students during the daily dissection schedule. **Methods:** A cross sectional study was conducted in two medical faculties, Ain Shams University (general) and Misr University (private). It explored the effects of exposure of the students of both faculties to the vapors of embalming fluids containing different concentrations of formaldehyde and related symptoms. **Results:** Higher prevalence of irritation : Itching, soreness of skin and GIT symptoms was found among Ain Shams University students exposed to higher concentration of Formaldehyde and the difference was highly statistically significant.

Conclusion: Considering the severity of the toxic symptoms caused by formaldehyde fumes the need of a standardized embalming fluid that has a lesser concentration of formaldehyde. The lesser concentration of formaldehyde will in turn reduce the toxic effects and the other chemicals that are used like surgical spirit, glycerine and carbolic acid will help in maintaining a good preservation of the cadavers.

Key Words: Embalming fluid, Formaldehyde, Formalin, Students

Introduction:

The process of embalming of a cadaver by introducing a fixative chemical into the body tissues helps to preserve the cadaver by maintaining, as far as possible, a life-like state, and in the process, retaining the normal anatomical relations as are required for dissection purposes. The embalming fluid constitutes of a combination of chemical substances that include preservatives, germicides, buffers, wetting agents, anti-coagulants, dyes, perfuming agents, etc. (Bernstein et al 1984).

The fundamental properties of an embalming chemical should be: 1) to ensure that there is no risk or fear of infection on contact with the cadaver, 2) to maintain, without mutilation, a natural colour on the body, 3) to ensure preservation of the body and prevention of putrefaction changes and disturbances, which so often results in odious purging and discharge from various orifices of the body, and 4) to prevent contamination with insects and maggots. Formalin, a commercial source of formaldehyde, is the chemical which is most commonly used for embalming purposes. Formaldehyde (HCHO) was discovered in 1856 by the British Chemist, August Wilhelm Von Hofmann. It is a noxious, flammable gas, extremely soluble in water. It is colorless at ordinary temperature and has an irritating pungent odour. It is commercially avail-

able as formalin containing 37% by weight or 40% by volume of formaldehyde gas in water. It rapidly metabolizes to formic acid. It is widely used in the chemical, adhesive, paint, plastic, construction, textile, paper and cosmetic industries (ATSDR, 1999). The concentration of formaldehyde is usually expressed in terms of parts per million (1ppm = 1.248 mg/m³.)

Anatomists, technicians in histology and embalming laboratories, as well as medical students during their dissection course, are all exposed to formaldehyde, which in many situations, crosses the threshold for irritation of eyes and upper respiratory tract. There is no doubt about the acute toxic effects and the occurrence of contact dermatitis caused by formaldehyde (Bernstein et al 1984). Prior to the Control of Substances Hazardous to Health Act (1990) there were a variety of formaldehyde-based formulae used for embalming fluids in Medical Schools in UK. Reinhard, 1989 .

In the US, the permissible limits of occupational exposure to formaldehyde are 3 ppm in a time weighted average breathing zone during an 8-hour period, a ceiling concentration of 5 ppm and an acceptable maximum peak of 10 ppm for no longer than 30 minutes during a one day shift (ATSDR, 1999).

The toxic effects due to exposure to formaldehyde can be classified as irritation of mucous membrane, contact dermatitis and mutagenicity or carcinogenicity. Formaldehyde has also been documented for initiating an allergic reaction (Reinhard, 1989).

The ideal embalming chemical should be a mixture that effectively achieves embalming and has the least hazardous health effects on exposed personnels.

Aims and Objectives:

- The present work was conducted to study toxic symptoms caused by formaldehyde fumes that were experienced by the medical students and professionals in the dissection rooms.
- To compare between both traditional and new embalming fluids as regards acute health hazards
- To find out possible recommendations to minimize health hazards in dissection rooms.

Subjects and Methods:

Type of study: Cross sectional study

Sampling: Simple random sample of 1st grade medical students in Ain Shams university and all medical students of Misr university

Sample size calculation:

EPI-INFO version 6 program was used

for calculation of sample size based on prevalence of health hazards of formaldehyde unexposed group. Confidence level 95%, Power of the test = 80%, Alfa error =5%.

- Total sample calculated: 338 first grade students from Ain Shams University having their first contact with formaldehyde.
- A total number of 172 students from Misr University were enrolled in the study. This number is the total number of students of 1.0.1 courses of Misr University.

Tools of the study:

In this study the various symptoms caused by the toxic effects of the embalming fluid on medical students and professionals were evaluated. These medical students were exposed to formaldehyde fumes during the course of their daily dissection schedule. A questionnaire was designed that included 18 symptoms that arouse from exposure to formaldehyde fumes. These symptoms were: unpleasant smell, dry or sore nose, running or congested nose, unusual thirst, itching in the eyes, redness of eyes, excessive lacrimation, disturbance of sight, nausea, headache, syncope (fainting episode), unusual tiredness or dizziness, dry or sore throat, gastrointestinal disturbances, itching of the hands, skin eruptions on the face or neck, respiratory distress and disturbed nocturnal sleep. All these symptoms

were to be graded on a scale of 1 – 4 as follows: grade 1 – not at all, not recognizable, grade 2 – barely recognizable, grade 3 – strong, prominent and irritating, and grade 4 – intolerable. The frequency of use of gloves during dissection and history of occurrence of any kind of allergy were also recorded. For the first year students in both faculties, the questionnaire was circulated amongst a total of 338 medical students in Ain Shams University and the symptoms were graded. The fluid used for embalming the cadavers that were dissected in Ain Shams was the conventional fluid contain-

ing formaldehyde as the chief preservative chemical. This was prepared by mixing the commercially available formalin solution with tap water in the proportion of 3:1. The students were exposed to the formaldehyde fumes for not more than 3 hours during one days' dissection schedule. The grades were edited on a master chart and statistically evaluated.

In the private medical faculty in this study (Misr University) a new formula was used in embalming solution. This formula contains the following.

Formal Name	Commercial Name	Quantity
Formaldehyde sol. (40% w/v)	Formalin	1 litre
Methyl alcohol	Surgical Spirit	1.5 litres
Tap Water	Water	3 litres
Phenol (Carbolic crystals)	Carbolic acid	500 ml
Glycerine BP	Glycerine	800 gm
Oil of winter green	Eucalyptus oil	10 ml
Eosine sol.	Eosine	5 ml

Inclusion criteria:

- Medical students of the first grade attending anatomy or histology courses for 2 hours per day.

Exclusion criteria:

- 1-Students with known chest or nasal problems
- 2-Students with known skin disorders.

Ethical consideration

A verbal consent was obtained from all the study subjects and confidentiality of the information was assured.

Statistical methodology

Analysis of data was done by IBM computer using SPSS (statistical program for social science version 13) as follows.

- Description of quantitative variables as mean, SD and range. ered Non significant (NS).
A P value less than 0.05 was considered significant (S).
- Chi-square test was used to compare qualitative variables between groups. A P value less than 0.01 was considered highly significant (HS).
A P value more than 0.05 was consid-

Results

Table (1) Comparison between both studied groups as regards demographic data:

Demographic data	Ain Shams N=338	Misr University N=172	P
Age	16±3	14.8±4	>0.05 NS
Gender			>0.05 NS
Male	200 (59.2%)	120(69.7%)	
Female	138 (40.8%)	52(30.3%)	

Table (2) Comparison between both groups as regard use of PPE inside the morgue

PPE	Ain Shams N=338	Misr University N=172	P
Gloves	235(69.5%)	97(56.4%)	>0.05 NS
Masks	0	0	

Table (3a) Comparison between the studied groups as regard different symptoms

Variables	No	Mild	Moderate	Severe	P
Smell					
Ain Shams	42(12.4%)	190(56%)	82(24.3%)	24(7.1%)	<0.01 HS
Misr Univ.	52(30%)	78(45%)	35 (20%)	7(4%)	
Congested nose					
Ain Shams	26(7.7%)	84(24.9%)	115(34%)	113(33.4%)	<0.01 HS
Misr Univ.	57(33%)	37(21.5%)	48(27.9%)	30(17.4%)	
Unusual thirst					
Ain Shams	19(5.6%)	38(11.2%)	111(32.8%)	170(50.4%)	<0.05 S
Misr Univ.	52(32%)	19(11%)	36(32.6%)	65(55.2%)	
Sore eyes					
Ain Shams	70(20.7%)	146(43.2%)	78(23%)	44(13%)	<0.01 HS
Misr Univ.	92(53.4%)	40(23.2%)	29(16.9%)	11(6.4%)	
Red eyes					
Ain Shams	25(7.3%)	59(17.5%)	95(28.1%)	159(47%)	<0.01 HS
Misr Univ.	10(5.8%)	29(16.9%)	59(34.3%)	74(43%)	
Lacrimation					
Ain Shams	50(14.7%)	135(39.9%)	80(23.7%)	73(21.6%)	<0.01 HS
Misr Univ.	68(39.5%)	45(26.2%)	39(22.7%)	20(11.5%)	
Sight disturbance					
Ain Shams	15(4.4%)	29(8.6%)	97(28.7%)	197(58.3%)	<0.01 HS
Misr Univ.	50(29%)	14(8.1%)	29(16.8%)	79(45.9%)	

Table (3b) Comparison between the studied groups as regard different symptoms

Variables	No	Mild	Moderate	Severe	P
Nausea					
Ain Shams	13(3.8%)	25(7.4%)	107(31.%)	193(57.1%)	<0.01
Misr Univ.	60(34.9%)	12 (7%)	40(23.3%)	60(34.9%)	HS
GIT symptoms					
Ain Shams	5(1.5%)	8 (2.4%)	35(10.4%)	290(85.8%)	<0.01
Misr Univ.	20(11.6%)	22(12.7%)	9(5.2%)	121(70.3%)	HS
Headache					
Ain Shams	18(5.3%)	48(14.2%)	139(41.1%)	133(39.3%)	<0.05
Misr Univ.	41(23.8%)	23(13.4%)	53(30.8%)	55(31.9%)	S
Syncope					
Ain Shams	8(2.4%)	9(2.7%)	42(12.4%)	279(82.5%)	>0.05
Misr Univ.	31(18%)	6(3.5%)	11(6.4%)	134(77.9%)	NS
Tiredness					
Ain Shams	19(5.6%)	56(16.6%)	121(35.8%)	142(42%)	>0.05
Misr Univ.	5(2.9%)	22(12.8%)	61(35.5%)	84(48.8%)	NS
Sore throat					
Ain Shams	13(3.8%)	53(15.7%)	117(34.6%)	155(45.8%)	>0.05
Misr Univ.	4(2.3%)	22(12.8%)	57(33.1%)	89(51.7%)	NS
Skin soreness					
Ain Shams	13(3.8%)	38(11.2%)	88(26%)	199(58.9%)	<0.01
Misr Univ.	66(38.4%)	17(9.9%)	9(8.2%)	80(46.5%)	HS

Table 1 demonstrates no significant difference between both groups as regard general data. Table 2 shows no significant difference between both groups as regard use of gloves during the practical training sessions.

Table 3 shows higher prevalence of nausea and GIT symptoms among students of Ain Shams University compared to students of Misr University and the difference is highly significant statistically.

Also table 3 shows higher prevalence of headache and syncopal attacks and skin soreness in the dissection classes in Ain Shams University students compared to Misr University students.

Unpleasant smell, itching of eyes and excessive lacrimation were also higher among Ain Shams University students.

Discussion:

Despite its toxic effects formaldehyde remains, the popular choice as a tissue fixative because of its undoubted efficiency, and consistency of results that are obtained. The standardized embalming fluid contains lesser concentration of formaldehyde.

Current study focus, on comparison between standardized solution compared to classic one in Ain Shams as regard acute health hazards, of formaldehyde. First

of all layout of morgue in Ain shams and Misr University nearly similar with no sufficient aeration and suction. Characteristic odor of the formalin vapor is described first as shown in table 3a. Moderate and severe smell perception and congested nose were more frequent among Ain Shams students, exposed to high concentration of formaldehyde. Pungent and irritating odor of formaldehyde, with 2 hours nearly to get smell adaptation. There is a highly statistically significant difference when comparing both groups. These results agree completely with a study by Bernstein et al 1984, that confirm and measure olfactory adaptation of formaldehyde among group of formaldehyde exposed students. Recent standardized embalming fluid contain a lower concentration of formaldehyde so irritant effects are less common.

Dry cough also, based on nasal congestion, and cough receptor stimulation due to upper respiratory tract congestion and severe irritation. As regard effect on mouth, throat, unusual thirst were more frequent among classic embalming fluid exposed students, with statistically significant difference between both groups. This unusual thirst is explained on the fact of metallic taste which is characteristic to formaldehyde and this taste gives a sense of thirst. Another explanation was dehydrating ef-

fect and irritant effect of formaldehyde on tongue and nasopharyngeal mucus membrane. But sore throat not significantly different between both groups. These results agree with a study by Frolich, 1984 who confirm the highly significant association between dry tongue and thirst with formaldehyde exposure. But no agreement as regard sore throat which was significantly associated with formaldehyde exposure. This issue is very important not only due to thirst and dry tongue but also due frequent need of drinking while working in the exposure area. This may increase exposure due to hand contamination and bottle contamination. Formaldehyde is freely absorbed from GIT route and by inhalation. This behavior may increase formaldehyde burden inside exposed personnel especially obese personnel. Another important behavior based on the increase desire to smoke while exposed to formaldehyde odor and its pungent odour,. Smoking had a synergistic effect with formaldehyde irritant and toxic effects especially on the respiratory system,

As regard ocular manifestations, the current study shows that Ain Shams students, had more frequent moderate, and severe lacrimation, conjunctival irritation with statistically significant difference in comparison to Misr University students. But no significant difference as regard red

eyes, which may be multifactorial in origin eg. due to lack of sleep and fatigue which is a frequent observation among first grade medical students. Insignificant difference between both groups due to occurrence of these symptoms among both groups. Ocular irritation and lacrimation were due to mucus membrane irritation, aggravated by perfuse fluids in this area due to lacrimation, which act as a viscous circle as follow – excessive irritation lead to lacrimation, which lead more dissolution of formaldehyde and more irritant effects. These ocular manifestations completely agree with Walrath study, 1983, in New York city, on 400 embalming workers, in two distant areas. Highly significant association between ocular irritation and formaldehyde exposure were detected.

As regard sight disturbance it was more frequent among students exposed to formalin fumes in Ain shams more than Misr University with highly significant difference in between. This agree with a study by ATS-DR., 1999 that confirm relation between 3 hours exposure to formaldehyde per day with instability and sight disturbance. This effect may be explained as direct irritant effect of formalin on ocular tissues or CNS effect because of ability of the formalin to cross blood brain barrier freely. Due to its fat solubility in addition to water solubility

formalin may lead to other CNS manifestations like lack of concentration, irritability and behavioral changes. Loss of consciousness also may be due to either CNS effect of formaldehyde directly, or indirectly due to irritant effects.

In the current study no significant difference could be detected between both groups as regard loss of consciousness. This may be explained by the presence of other common cause in both groups which is vasovagal due to initial look to dead body by students especially females. Another risk factor which is hypoglycemia and overcrowding especially in Ain Shams more than 50 students may located in the same session. These results agree with a study by Garry, 1980 on neurobehavioral changes due to formaldehyde domestic exposure. Highly significant association was detected between formaldehyde exposure and lack of concentration and disturbed consciousness or what is known as chronic fatigue syndrome. This reflects the great importance of proper ventilation inside formalin use areas to decrease its toxic multisystem effects. In my opinion proper ventilation is considered the corner stone of safety against formaldehyde health hazards, not only due to acute toxic effects because all of them are reversible except airway hyperresponsiveness, but

also cumulative and chronic burden of low dose exposure for long time .

Concerning GIT symptoms in the form of abdominal colic, nausea and vomiting, there is a highly significant difference between both groups as regard colic but not as regard nausea and vomiting. This may be explained due to common disgusting and sick sensation from vision of dead body but not confirmed to be due to formaldehyde exposure. This agree with a study by Frigas , 1981 which confirmed multiple GIT symptoms starting by metallic taste down to colic, and heart burn but no significant association confirmed also in that study with nausea and vomiting. This relation between formaldehyde and GIT symptoms occur due to either inhalation or GIT route from contaminated hands. So mask and gloves in addition to proper hand washing are mandatory for protection of exposed personnel.

As regard headache, moderate and severe symptoms were more frequent among Ain Shams students compared to Misr University students. This may be due to irritating effect of formalin fumes on nasopharyngeal mucus membranes, or direct CNS effects as mentioned above in Garry, 1980 study. The current study confirm highly statistically significant difference between

both groups as regard itching and soreness of skin. This may explained due to ability of formaldehyde to be absorbed in water and in fat this make the skin is considered a perfect media for free absorption. So technicians, doctors, or students which used their hands in dealing with the fromaldehyde had a great risk. This risk not only acute but also cumulative and chronic. This issue is confirmed by different studies that warn from dealing by hands with these types of chemicals. Hand washing not completely protective because 20% of formaldehyde may be absorbed through the skin within minutes. So barrier method like gloves is mandatory for protection. .

So it is mandatory to decrease the exposure to formaldehyde fumes through reduction of the concentration of formaldehyde in the embalming fluid or a more safe substances may be used instead.

Conclusion:

Considering the severity of the toxic symptoms caused by formaldehyde fumes, we are in need of a standardized embalming fluid that has a lesser concentration of formaldehyde. The lesser concentration of formaldehyde will in turn reduce the toxic effects and the other chemicals that are used like surgical spirit, glycerine and carboic acid will help in maintaining a good preservation of the cadavers. As is quoted

by BS Mitchell “reduction in formaldehyde concentration is not deleterious to specimen preservation, but leads to a safer working environment (Frigas, 1981).

Thus the toxic effects of formaldehyde fumes during dissection and embalming can be reduced by the following measures:

1. students and instructors should be aware of the potential health hazards of formaldehyde,
2. use of standardized embalming fluid,
3. good exhaust ventilation systems,
4. installation of eye washing stations in case of accidental splashing of formaldehyde into the eyes,
5. installation of negative pressure pump systems to further reduce formaldehyde vapors from the air,
6. use of protective equipment like apron, gloves and mask to avoid direct skin contact,
7. avoid working between exhaust vent and the sources of formaldehyde vapors, and
8. avoid spillage of embalming fluid.

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