TOXIC EFFECTS OF EMBALMING FLUID ON MEDICAL STUDENTS AND PROFESSIONALS

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ABSTRACT

Vapours of embalming fluid in the dissection room are a perennial cause of irritation to the mucous membranes of the pharynx, upper respiratory tract and eyes. We made an attempt to assess the discomfort level produced by formalin and that produced by the standardized embalming fluid used in our department.

A list of twenty symptoms was made and circulated among students attending dissection and students were asked to grade the severity of each symptom experienced on a scale of 1 to 4. Individual scores of each symptom were statistically compared and summated, and the same reflected the general acceptability of the embalming fluid.

Key Words: Embalming fluid, Formalin, Students, Symptoms.

INTRODUCTION

Preservation of cadavers is normally achieved through the process of embalming, in which, a fixative is introduced into body tissues, in such a way as to maintain, as far as possible, a life-like state, and in the process, retaining the relationships of human anatomy as are required for dissection purposes. 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 dead body, 2) to produce, without mutilation, a natural colour and effect 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.

The embalming fluid consists of a group of chemicals that include preservatives, germicides, buffers, wetting agents, anticoagulants, dyes, perfuming agents, etc. These groups are combined in various proportions to produce the embalming fluid.

Formalin, a commercial source of formaldehyde, is the chemical most used for this purpose. Formaldehyde (HCHO) was discovered in 1856 by the British chemist, August Wiheld Von Hoffmann. It is a noxious, flammable gas, extremely soluble in water. It is colourless at ordinary temperature and has an irritating pungent odour. It is commercially available as formalin containing 37% by weight or 40% by volume of formaldehyde gas in water. Formalin contains an average 7% of methyl alcohol, 37% formaldehyde and the remaining is water. It rapidly metabolizes to formic acid. It is widely used in the chemical, adhesive, paint, plastic, construction, textile, paper and cosmetic industries [1]. The concentration of formaldehyde is usually expressed in terms of parts per million (1 ppm = 1.248 mg/cu.m.)

Formaldehyde is the commonest preservative used for embalming. 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. 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 the UK [2]. In the US, the permissible limits of occupational exposure to formaldehyde are 3 ppm in a time-weight 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 [1].
The toxic effects of 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 [3].

The increased formaldehyde fumes in the dissection rooms and embalming rooms are due to: 1) poor working practices leading to spillages of fluid during embalming, 2) poor condition of cadavers causing embalming fluid to leak out of the cadaver, 3) using high concentrations of formaldehyde in the embalming fluid, and 4) poor ventilation of dissection rooms.

MATERIALS AND METHODS

In our study, we evaluated the various toxic effects of the embalming fluid on the medical students and the medical professionals who are exposed to the formaldehyde fumes during the course of their dissection schedule. We framed a questionnaire containing 20 symptoms that were arising due to inhalation of formaldehyde fumes. These were circulated amongst the students and medical professionals of four different medical colleges in Mumbai. The symptoms that were evaluated 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 graded on a scale of 1 to 4 as follows: grade 1 - not at all, not recognizable, grade 2 - barely recognizable, grade 3 - strong, prominent and irritating, and grade 4 - intolerable.

They were also asked to report the frequency of use of gloves during the dissection and the history of occurrence of any kind of allergy in the past.

In all the four medical colleges, the embalming fluid that was used contained formaldehyde as the chief preservative chemical. The students were exposed to the formaldehyde fumes for not more than 6 hours during a one-day dissection schedule. The medical students and professionals filled and returned a total of 338 questionnaires. These grades were then edited on a master chart, and total and average grades for each symptom were calculated and the graphs were plotted.

OBSERVATIONS

The total score of all the 20 symptoms ranged from 5 to 58. As is seen in graph 1, which shows the total scores plotted on the x-scale versus the number of cases having that total grade on the y-scale. This graph shows a peak of 26 cases having a total of 33 and the range extending from 5 to 58. The average grades were between 2 and 3. Out of the total of 338 cases 234 students were using gloves while dissection. This comes to about 69.2% and there were 9 students that were having a past history of allergy, making it 2.66%. Graph 2 shows the remaining 18 symptoms, plotted on the x-scale vis-à-vis the average grade for each symptom on the y-scale. This graph clearly shows that the three most disturbing symptoms were: 1) unpleasant smell, 2) itching of the eyes, and 3) excessive lacrimation.

Graph 1: Total score Vs the number of cases

Graph 2: Symptoms Vs Average score

DISCUSSION

The toxic effects of the formaldehyde are due to the formalin fumes that arise in the dissecting and embalming rooms. Decreasing the concentration of formaldehyde in the embalming fluid can reduce the formaldehyde fumes. An embalming fluid measuring 8 litres is used for one
normal built adult cadaver. This embalming fluid is a combination of formaldehyde, spirit (methyl alcohol), distilled water, carbolic acid (phenol), glycerine, turpentine, sodium borate and eosine). A good ventilation system in these rooms will reduce the formaldehyde concentrations by almost half. This can be achieved by installation of negative pressure pump systems. Further, the use of mask also helps in combating the unpleasant smell. As for the irritant effects of formaldehyde on the eyes leading to itching and excessive lacrimation, the use of an eye washing station in the dissection room would help in reducing these irritant effects. Nowadays there is a legal requirement for the use of formaldehyde in embalming fluids in the United States of America [4].

As for the other alternative chemicals in place of formaldehyde, Frolich et al in 1984 had tried using phenoxyethanol as its non-toxic substitute. It proved to be impractical as the amount required was large i.e. about 600 litres for each cadaver, needing continuous immersion to prevent mould formation and the fixation process taking 5 to 10 months [5]. Glutaraldehyde is an aldehyde related to formaldehyde, with similar fixation qualities. It would be a feasible alternative, but because of the volumes that would be required, it is prohibitively expensive.

A similar study on "formaldehyde vapour emission in embalming rooms" by Edward J Kerfoot clearly demonstrated that formaldehyde is mainly an upper respiratory irritant, causing eye and nose burns, sneezing, coughing and headache [6]. Despite of its toxic effects formaldehyde remains the popular choice as a tissue fixative because of its undoubted efficiency and the consistency of results that are obtained. A reduction in proportion of formaldehyde in the embalming fluid resulted in vapour levels that were within the limits set by the US Government, i.e. 1 ppm or less over an 8-hour period or no more than 2 ppm over a 15-minute period. Also, reduction in formaldehyde concentration is not deleterious to specimen preservation, but leads to a safer working environment as is quoted by B.S. Mitchell. In 1980 Walrath et al presented a study on the "Carcinogenic effects of formaldehyde on embalmers" at the CIIT Conference, New York, wherein they concluded that embalmers showed a slightly elevated mortality from cancer, a significant excess of arteriosclerotic heart disease and a low incidence of pneumonia deaths. The sites at special risk for cancer were skin, nasal passages, buccal cavity, pharynx and larynx [7].

CONCLUSION

The toxic effects of the formaldehyde fumes during dissection and embalming can be reduced by the following measures: 1) use of embalming fluid with a lesser concentration of formaldehyde, 2) good exhaust ventilation systems, 3) installation of eye washing stations and negative pressure pump systems, 4) use of gloves, apron and mask to avoid direct skin contact, 5) avoid working between exhaust vent and the sources of formaldehyde fumes, and 6) avoid spillage of embalming fluid.

References