HEALTH HAZARDS DUE TO FORMALINE EXPOSURE IN THE DEPARTMENT OF ANATOMY

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ABSTRACT

Introduction: Formaldehyde is the simplest aldehyde that can be obtained from its cyclic trimertriorxane and the polymer paraformaldehyde. From the 1990’s on, a massive amount of research regarding health effects and exposure hazards of formaldehyde has been conducted. Very little, if any, of this research focuses on embalming. Methodology: This study aims at reducing the toxic effects caused by the formaldehyde fumes yet maintaining good preservation of the cadaver, as is required for dissection purposes. This study is conducted in Dept. of Anatomy in one of the medical college of Surat. however, it affects Medical students, teachers & laboratory technicians who are exposed to formaldehyde fumes on regular basis during the daily dissection schedules and during Embalming procedure. so In this study, the various symptoms caused by the toxic effects of the embalming fluid on the medical students & employees were evaluated and A questionnaire was framed containing list of symptoms that arose due to exposure to formaldehyde fumes and they are recorded. Observation: The most common feelings and symptoms among studied on first exposure to formalin include general discomfort 18 (81%), eye irritation/itching 11 (48%) and nasal irritation/itching 11(50). Conclusion: So far, this study demonstrates the irritating and sensitizing actions of formalin on respondents, the concentration of formalin for cadaver dissection should be kept minimal and controlled for adaptability by student. Again the exposure time to formalin should be planned and integrated in the dissection schedule.
AIMS AND OBJECTIVES
- From the 1990’s on, a massive amount of research regarding health effects and exposure hazards of formaldehyde has been conducted.

- Very little, if any, of this research focuses on embalming so this study is basically conducted for this purpose because Medical students, Teachers & laboratory technicians are exposed to formaldehyde fumes on regular basis during the daily dissection schedules and during the embalming procedure.

The reasons of exposure to formaldehyde fumes are enlisted below
1.) Poor working practices leading to spillage of fluid during Embalming.
2.) Poor condition of cadavers causing embalming fluid to leak.
3.) Using high concentrations of formaldehyde in the embalming Fluid.
4.) Poor ventilation of the dissection room.

This study aims at reducing the toxic effects caused by the formaldehyde fumes yet maintaining good preservation of the cadaver, as is required for dissection purposes

METHODOLOGY
In this study, the various symptoms caused by the toxic effects of the embalming fluid on the medical students & employees were evaluated. This study is conducted in Dept. of Anatomy in one of the medical college of Surat. A questionnaire was framed containing list of symptoms that arose due to exposure to formaldehyde fumes.

The symptoms enlisted were
unpleasant smell, dry/sore nose, running or congested nose, itching in the eyes, redness of eyes, excessive lacrimation, disturbance of sight, nausea, headache, syncope, unusual tiredness/dizziness, dry/sore throat, G.I disturbances, itching of hands, skin eruptions on face/neck, respiratory distress and disturbed sleep etc.

The frequency of use of protective equipments during dissection and History of occurrence of any kind of allergy were recorded & What precautions to be taken while handling of formaldehyde are instructed.

INTRODUCTION
Formaldehyde is the simplest aldehyde that can be obtained from its cyclic trimer trioxane and the polymer paraformaldehyde. Aqueous solutions of formaldehyde are referred to as
formalin. In 1867, the German chemist August Wilhelm von Hofmann discovered formaldehyde. (Schwarcz L et al 1943) Occupational exposure to formaldehyde by inhalation is mainly from three types of sources.

1. Thermal or chemical decomposition of formaldehyde-based resins,
2. Formaldehyde emission from aqueous solutions (for example, embalming fluids) and
3. The production of formaldehyde resulting from the combustion of a variety of organic compounds (for example, exhaust gases). *International Agency for Research on Cancer, 2006.*

Formaldehyde solution is prepared by mixing the commercially available formalin solution with tap water in the proportion of 3: 1. (Dixit D. Et al 2006) *Formaldehyde enters in body by breath or when it comes in contact with your skin.* Formaldehyde is quickly absorbed from the nose and the upper part of lungs. Once absorbed, formaldehyde is very quickly broken down. Almost every tissue in the body has the ability to break down formaldehyde. It is *usually converted to a non-toxic chemical called formate,* which is excreted in the urine and is converted to carbon dioxide and breathed out of the body.

Formaldehyde can be toxic, allergenic, and carcinogenic. (Public Health Service, 1999) Formaldehyde exposure is a safety concern in anatomical pathology, and it is considered a carcinogen by the International Agency for Research on Cancer (IARC). The Occupational Safety and Health Administration (OSHA) determined a set of regulations for formaldehyde industrial and laboratory use. There are no clinical and epidemiological data on increased morbidity or mortality from cancer among workers in the histology laboratory, where a 10% formalin or 4% formaldehyde water solution is used.

Based on the literature and personal experience, this article presents recommendations for handling adverse situations of formalin use in anatomical pathology. There is an emphasis on spills, clean up, and splashes. Regular monitoring of formaldehyde exposure, appropriate engineering controls, and the culture of professional laboratory work can help to employ formalin. Formalin, as formaldehyde’s water solution, became the prevalent fixative in the anatomical pathology laboratory and in embalming in the 20th century. The goal of this article is to offer a pragmatic approach to formalin use in anatomical pathology.
FORMALDEHYDE USES
The U.S. manufacture of formaldehyde easily exceeds 8.2 billion pounds per year and that doesn’t count what we import from other countries. Worldwide production is well over 16 billion pounds per year.
- 60% of all formaldehyde used ends up in wood and construction related industries as urea-formaldehyde, phenol-formaldehyde and melamine-formaldehyde glues, resins and stiffeners.
- 30% is used as a chemical intermediate (e.g. pentaerythritol, hexamethylenetetramine, butanediol) to manufacture another chemical of commerce. 7% is accounted for by use in specialty thermoplastic resins.
- 2% ends up in the textile/apparel industry as a whitener/finisher/stiffener for shirts and other items of clothing and an additive for wrinkle-resistance and crispness of appearance.
- 1%, or less, is used as preservative additives (usually as derivatized releaser chemicals) in soaps, lotions, shampoo, etc.

-→ As a fixative for microscopy and histology.
-→ Also used in embalming to disinfect and temporarily preserve human and animal remains.

The worst recorded exposure problems occur in the wood product/construction industry and the textile/apparel industry because of the quantities used and the long exposure scenarios.

METHODS OF PREVENTION OF FORMALDEHYDE EXPOSURE
REGULATED AREAS
Regulated areas shall be established where airborne formaldehyde levels exceed either the permissible exposure level of 0.75 ppm or the STEL. The following sign shall be posted at all entrances and accessways.

DANGER FORMALDEHYDE IRRITANT AND POTENTIAL CANCER HAZARD
AUTHORIZED PERSONNEL ONLY
Guidelines to prevent hazards of formalin exposure
1. EXPOSURE MONITORING
Formaldehyde gas, all mixtures or solutions composed of greater than 0.1 percent formaldehyde, and materials capable of releasing formaldehyde into the air under any normal
condition of use at concentration reaching or exceeding 0.1 ppm shall be considered a health hazard.

Exception
Monitoring is not required if by using objective data it can be documented that the presence of formaldehyde or formaldehyde releasing products in the workplace cannot result in airborne levels of formaldehyde at or above the action level or STEL under foreseeable condition of use.
- Initial Monitoring
- Periodic Monitoring at least every six months and those exposed at or above the STEL shall be monitored at least once a year under the worst conditions.
- Employee Notification: Within 15 days of receiving monitoring results, affected employees shall be notified of the result either by written copies or by posting the results.

2. ENGINEERING AND WORK PRACTICE CONTROLS shall be instituted to reduce and maintain formaldehyde exposures at or below the PEL of 0.75 ppm and STEL.

3. PROTECTIVE EQUIPMENT AND CLOTHING
Employees shall comply with provisions of OSHA 29 CFR 1910.132 and 29 CFR 1910.133, and shall select protective equipment and clothing based upon:
- the form in which formaldehyde is encountered,
- the conditions of use, and
- the hazards to be prevented.

Eye and skin contact with liquids containing one percent or more formaldehyde shall be prevented by use of clothing impervious to formaldehyde and use of goggles and face shields as appropriate to the operation. Full body protection shall be worn for entry into areas where concentration exceed 100 ppm and emergency entry into areas of unknown concentration.

Employer Responsibility
The employer shall assure that.
- Only persons trained to recognize the hazards of formaldehyde are assigned to cleaning, laundering or disposal.
- No employee takes contaminated equipment or clothing home.
All required protective clothing and equipment is repaired and replaced for each affected employee as necessary for continued effectiveness; and.

-Any person who launders, cleans or repairs contaminated equipment or clothing is informed about potentially harmful effects of formaldehyde and of procedures to safely perform their assignment.

4. HOUSEKEEPING

- Spills and Leaks: Regular inspection & Preventive maintenance
- Containment, Decontainment and Disposal: formaldehyde waste and debris are disposed of in sealed containers bearing a label warning of the presence of formaldehyde and hazards associated with it.

5. MEDICAL SURVEILLANCE

- Clinical
- Laboratory examination for respirator wearer consisting of baseline and annual pulmonary function tests.
- Counselling employees with medical conditions that would be directly or indirectly aggravated by formaldehyde exposure on the increased risk of health impairment.

6. EMPLOYEE INFORMATION AND TRAINING

All employees assigned to workplaces having a formaldehyde health hazard, Information and training shall be provided at the time of initial assignment and whenever a new formaldehyde hazard is introduced; and at least annually for employees exposed to formaldehyde at or above the action level or STEL.

Training Program

The training program shall be conducted in a readily understood way.

7. RECORD KEEPING

OBSERVATION

Table 1: Feelings and Symptoms experienced on first exposure to formalin- fixed cadaver Symptoms in the affected body areas/ Number of respondents (%), N=22.

EYES:- Tearing 9 (40) Redness 2 (9) Irritation/itching 11(50) Blurring 1 (4.5) Spasm 1 (4.5)

NOSTRILS:- Irritation/itching 10 (45) Discharge 7 (34) Sneezing 3(12) Blockage 1 (4.5) Suffocation 0 (0).
SKIN:- Irritation/itching 10 (45) No symptoms 22(99)
OTHERS:- Discomfort 18 (81) Nausea 2(9) Vomiting 9 (40) Collapse 2 (9) Normal 1 (4.5)
% = percentage

Table 2. Durations for relief of symptoms on first exposure to formalin- fixed cadaver
Relieved affected body areas/ Number of respondents (%), N=22.

<table>
<thead>
<tr>
<th>Duration</th>
<th>Eyes</th>
<th>Nostrils</th>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 Hour</td>
<td>8 (37)</td>
<td>8 (37)</td>
<td>2 (9 )</td>
</tr>
<tr>
<td>1 – 5 Hours</td>
<td>9 (40)</td>
<td>10 (45)</td>
<td></td>
</tr>
<tr>
<td>6 Hours – 1 Day</td>
<td>4 (19)</td>
<td>4 (9)</td>
<td></td>
</tr>
<tr>
<td>&gt; 1 Day</td>
<td>6 (27)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Durations for relief of symptoms](image)

Table 3: Cohort bodily adaptations to subsequent exposure to formalin- fixed cadaver
Symptoms in the affected body areas/ Number of respondents (%), N=22.

<table>
<thead>
<tr>
<th>Degree of symptoms</th>
<th>Eye</th>
<th>Nostrils</th>
<th>Skin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nil</td>
<td>11 (50)</td>
<td>20 (88)</td>
<td>22 (99)</td>
</tr>
<tr>
<td>Mild</td>
<td>7 (33)</td>
<td>2 (9)</td>
<td>1 (4.5)</td>
</tr>
<tr>
<td>Moderate</td>
<td>3 (12)</td>
<td>1 (4.5)</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>1 (4.5)</td>
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RESULTS
Out of 22 questionnaires distributed, 22 were filled & returned (RR-100%) The most common feelings and symptoms among studied on first exposure to formalin include general discomfort 18 (81%), eye irritation/itching 11 (48%) and nasal irritation/itching 11 (50) (Table 1).

The estimated duration for relief of bodily symptoms among the study group after their first exposure to formalin is as in Table 2. By the fifth hour after the first exposure most of the respondents were relieved of eye 18 (78%) and nasal 18 (82%) symptoms (Table 2).

Following subsequent exposures, most 20 (88%) were no longer having nasal symptoms and many 11(47%) were no more having eye symptoms. However, many still experienced at least mild eye 12 (53%) and nasal 3(12%) symptoms (Table 3).

**SCIENTIFIC REFERENCE VALUES OF FORMALDEHYDE.**

<table>
<thead>
<tr>
<th>REGULATORY BODY</th>
<th>P.E.L</th>
<th>S.T.E.L</th>
</tr>
</thead>
<tbody>
<tr>
<td>OSHA</td>
<td>0.75ppm</td>
<td>2.0ppm</td>
</tr>
<tr>
<td>ACGIH</td>
<td>0.37 mg/m3</td>
<td></td>
</tr>
<tr>
<td>NIOSH</td>
<td>0.12 mg/m3</td>
<td></td>
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</tbody>
</table>

**CONCLUSION**
So far, this study demonstrates the irritating and sensitizing actions of formalin on respondents, Thus the toxicity is of importance to both the trainer and students. Therefore, the concentration of formalin for cadaver dissection should be minimal and controlled for
adaptability by student. Again the exposure time to formalin should be planned and integrated in the dissection schedule. Also, there should be concerted effort towards getting user friendly alternative preservative to formalin. Finally, trainers should educate students on the formalin related health hazards ahead of their first exposure and encourage the use of protective measures among them.

REFERENCES