



## **Toxic Effects of Formalin on Ist Year M.B.B.S. Students: A Cohort Study**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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**Study Protocol**

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## **ABSTRACT**

**Background:** Formalin can lead to allergy, toxicity, and carcinomas. In the anatomy department, students get exposed to formalin either by inhaling it or by the skin as fluids containing formaldehyde may be absorbed. Formalin interacts with molecules on the cell membrane producing changes in the nuclei, changes in proteins, vacuolation of cytoplasm, and changes in DNA.

**Objective:** To estimate the toxic effects of formalin on Ist year medical students.

**Methodology:** The participants for this prospective cohort study will be Ist year M.B.B.S. students at Jawaharlal Nehru Medical College, Sawangi (meghe), Wardha. The self-administered questionnaire will be given, and complete blood count and thyroid function tests will be done before the study. After cadaveric dissection, a repeat blood sample will be collected to estimate the complete blood count and thyroid function tests.

**Expected Results:** Exposure to formalin may lead to abnormal values of complete blood count(CBC) and thyroid function tests (TFT).

**Conclusion:** The study can focus on the toxic effects of formalin on Ist year M.B.B.S. students,

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which may necessitate reconsidering the formalin volume and ventilation issue in the dissecting halls. There should be regular assessment of working practices to control the effects of formalin at the department of Anatomy.

**Keywords:** Formalin; complete blood count (CBC); thyroid function tests (TFT).

## 1. INTRODUCTION

For centuries the fundamental teaching tool in anatomy has been human cadaveric dissection. Even if technology is revolutionized gross anatomy teaching over specific years, research indicated the uniqueness and value of dissection of cadavers in anatomical sciences. Cadaveric dissection can inculcate human values in medical students, as the cadaver acts as their first silent mentor. This will make the future generation of doctors more empathetic [1].

August Wilhelm Von Hofmann discovered Formaldehyde in 1867. At room temperature, it is inflammable and possesses a highly irritating odor [2]. Formalin contains 40% by volume or 37% by weight of formaldehyde gas in water. Embalming of cadavers is usually done by using formalin. There is the widespread use of formalin in tissue fixation and embalming of the corpse, but the central issue is safety [3].

Formalin can lead to allergy, toxicity, and carcinomas [4,5]. In the anatomy department, student gets exposed to formalin either by inhaling it or by the skin as fluids containing formaldehyde may be absorbed. Exposure to formalin leads to irritation and obstructive disorders of air passages, ocular irritations, clouding of the cornea, various leukemias, nasopharyngeal carcinomas [6]. It also leads to various obstetrics and gynecological problems as spontaneous abortions, congenital malformations, and irregular menstrual cycles [7]. Formalin may also lead to dermatitis [8].

As an exposed person gets habitual within some hours of exposure to formalin, toxic effects of formalin worsen. Accordingly, tan hose in the environment of gradually increased formaldehyde concentrations face increased exposure levels and may develop chronic toxic effects [9].

The standards authorities provide various standards to protect exposed workers to formaldehyde and include all occupational exposures to formalin like dissection hall staff. The exposure limit permitted for an 8-hour shift in

the working place is 0.75 ppm of air. The second limit permits exposure of 2 ppm as the maximum exposure allowed for 15-minutes.

In medical colleges, medical students and faculty members working in Anatomy department are prone to develop the toxic effects of formalin. Studies have shown that because of formalin used for embalming of cadavers in the anatomy dissection halls, students gets exposed to formalin and effects can be dangerous if the ventilation of dissection hall is not properly maintained. Formalin can interact with molecules on cell membrane producing changes in the nuclei, vacuoles in cytoplasm, changes in proteins and DNA [10]. It was observed that some female students develops menstrual cycle disorders after some months of attending cadaveric dissection. Endocrinological effects of formalin are not much explored, especially in human beings that leads us to think about the possibility of toxic effects of formalin on thyroid gland.

### 1.1 Aim

To estimate the effects of formalin on 1st year M.B.B.S. students attending cadaveric dissection at Anatomy department.

### 1.2 Objectives

1. To estimate the immediate effects of formalin.
2. To estimate the effect of formalin on complete blood count.
3. To estimate the effect of formalin on thyroid gland.

## 2. MATERIALS AND METHODS

### 2.1 Study Design: Prospective Cohort Study

At Jawaharlal Nehru Medical College, Sawangi (Meghe), Wardha one dissection hall measuring 500 sq m. is situated at the ground floor of the college main building. There are 16 windows in the side walls for natural ventilation with 20 cadavers. Artificial ventilation comprised of 38

ceiling fans, 9 exhaust fans attached to the roof and 2 suction devices in dissection hall. During practical's, cut sections and dissected parts of the cadaver are sometimes kept in formalin solution either in trays or in basins for demonstration and teaching purposes.

The study participants for this prospective cohort study will be 30 (15 male and 15 female) first year medical students attending cadaveric dissection for 2 hours daily. Study will start with first day of dissection and will end with completion of dissection of cadavers i.e. after around one year. Participants will be selected randomly by coin flip method. Self-administered questionnaire will be given and complete blood count and thyroid function tests will be done prior to study. After completion of cadaveric dissection, blood sample again will be collected to observe the chronic toxic effect of formalin on complete blood count and thyroid function tests. Comparison group will comprise of 30 (15male and 15female) final year medical students.

**2.1.1 Inclusion criteria**

1st year medical students exposed to formalin during cadaveric dissection.

**2.1.2 Exclusion criteria**

- Diagnosed cases of asthma, hypothyroidism and polycystic ovarian disease.
- Those who have undergone surgeries on thyroid.
- Those on steroids.
- Those having chronic diseases like chronic renal failure, multiple sclerosis or malignancy.

**2.2 Research Tools**

Study participants will complete a questionnaire reflecting the formalin effects. Subject experts will validate the questionnaire responses, about symptoms of exposure to formalin like unpleasant smell, unusual thirsty feeling, itching and redness in eyes, headache, unusual tiredness, sore throat, itching of the hands. Symptoms will be graded by a scale of 1–4; grade (1): absent, grade (2): minimally recognizable (3): strong and grade (4): unable to tolerate.

Blood samples will be collected from all the study participants for Complete Blood Count (CBC) and thyroid function tests, which will be done at the Clinical Pathology department, Acharya Vinoba Bhave Hospital .

**2.3 Procedure**

5ml of blood will be collected from each participant and transported to Department of pathology for doing CBC and TFT by ELISA method. The name, age, sex will be recorded in the Proforma. Each participant will be given a specific code number. After entering the data in the excel sheet, names of student will be deleted.

**2.4 Statistical Analysis**

The data will be typed onto computer files. The values of arithmetic mean (X), standard deviation (S), frequency will be calculated and Student's t test and Chi-square test will be applied to analyse data.

**Table 1. Immediate exposure symptoms of formalin.**

Symptoms of immediate exposure to formalin	Grade 0	Grade I	Grade II	Grade III
Unpleasant smell				
Unusual thirsty feeling				
Itching of eyes				
Dry, sore throat				
Redness of eyes				
Itching of the hands				
Headache				
Unusual tiredness and dizziness				

**Table 2. Distribution of exposed and unexposed female students according to Complete Blood Count findings**

Complete Blood Count parameters	Formalin exposed students	Unexposed students	Test of significance
Hb			
RBC			
Ht			
MCV			
MCH			
MCHC			
Platelets			
WBC			

**Table 3. Distribution of values of thyroid function tests in formalin exposed and unexposed students**

Parameters	Formalin exposed students	Unexposed students	Test of significance
T3			
T4			
TSH			

### 3. DISCUSSION

Medical Council of India has prescribed the standards of dissection hall in relation to its dimensions at all medical colleges. But issues like ventilation, exhaust appliances to reduce the exposure of formalin is not considered. In India, for ventilation air flowing through windows and doors is only considered. When exhaust fans and suction devices are provided, the capacity and ventilation rate of them should be considered.

In Japan, a medical school with dissection hall had 25 cadavers. Initially ventilation was provided by exhaust which has three outlets, at the rate of 247 m<sup>3</sup>/min. To reduce the exposure of formalin to staff and student, it was increased to 280 m<sup>3</sup>/min by adding local ventilation devices to every table in dissection hall [11].

In Thailand medical school, the gross anatomy dissection hall measured 420 m<sup>3</sup> had 18 cadavers . It had 2 doors, 4 windows and effective ventilation appliances like 10 air conditioners, 3 exhausts and 8 air cleaners to deodorize the hall. They were kept switched on before and after class at least for 30 minutes to minimize the exposure [12].

In Poland, study reported that formaldehyde concentrations in the anatomy practical lab with cadavers as 0.47–0.57 mg/m<sup>3</sup>. Still medical students complained of various reactions like lacrimation was reported in about 85.9%, red eyes, dry and itchy eyes, runny nose, sneezing,

and headache was observed in more than 50% students, cough and dry throat or throat irritation was the complaint found in 44% and 42% of students respectively [13].

Wineski and English [14] observed exposures of formaldehyde in an anatomy lab in a range of 0.07 to 2.95 ppm. It was observed that there was significant difference in formaldehyde concentration level in the cadaver storage room after opening of the tanks, among two institutes, which was actually about marginal before opening tanks. It was explained by difference in the total number of cadavers stored /unit floor area.

At Indian Medical College formalin levels was found as 0.11 to 1.07 mg/m<sup>3</sup> in the storage room for cadavers whereas in the gross anatomy lab it was 0.06–1.12 mg/m<sup>3</sup>. That was above the upper limit of proposed guidelines laid down by concerned authorities, definitely harmful for health status of students and staff [15].

A study in Japan found that level of formalin evaporated from cadavers was elevated at the beginning of dissection of cadaver; but, it crosses the guidelines for indoor chemical concentrations with respect to specified workplaces by 0.25 ppm each day of measurement except the last days of dissection.

Research done at the Department of Medicine and Physiology at the David Geffen School of Medicine at UCLA observed that environmental

agents like formalin interfere with thyroid function at more than one sites. They can reduce circulating thyroid hormone levels impairing their actions; these agents may act as partial thyroid hormone agonists. They may trigger autoimmune thyroid diseases also. [16].

In a cross-sectional study conducted by Asha latha PR and Anilakumari V P, it was found that 15.1% formalin exposed person had hypothyroidism as compared to only 6.4% non-exposed persons. Formalin exposed group was comprised of staff and residents of Anatomy, Pathology and Forensic Medicine departments, while non exposed group included staff and residents of Physiology, Pharmacology, Community Medicine, Microbiology department. Each group was comprised of 120 participants. They observed values of T3 and T4 were slightly elevated, but within normal limits in exposed group as compared to non-exposed group. The value of TSH was slightly lower in exposed group [17].

Elshaer N.S.M. and Mahmoud M.A.E. conducted the cross-sectional study to observe the acute effects of formalin on medical students and chronic effects on faculty members of Anatomy department. Medical students of Ist, IInd and IIIrd year were given a questionnaire to report the acute effects of formalin. They found that symptoms like unpleasant smell, dry or sore nose, unusual thirst, itching in the eyes, running or congested nose, redness in the eyes, excessive lacrimation, disturbance in sight and headache were present in more than 50% students. Whereas symptoms like syncope, dry or sore throat, nausea, gastrointestinal tract disturbances, unusual tiredness or dizziness, itching of the hands, skin eruptions on the face/neck, respiratory distress and disturbed nocturnal sleep were present in less than 50% students.

16 faculty and staff members of Anatomy department were the study participants as formalin exposed group for observing the chronic effects of formalin. More than 50% of the participants had more than 10 years duration of experience in the department. Among 16 participants, 7 were males and 9 were females. Comparison group was comprised of 19 staff members from Community medicine department as non-exposed group. They reported symptoms of skin disorders, such as burning, cracking, scaling, erythema, drying, eczema and allergic contact dermatitis in more than 50% and edema

in less than 50% of exposed participants. These symptoms were totally absent in non-exposed individual.

Also formalin-exposed female participants reported anemia and menstrual disorders as 44.4% and 33.3% respectively as compared with 6.25% and 0.0% of the unexposed female participants respectively. Besides number of formalin-exposed females having history of spontaneous abortion, baby with congenital anomalies was more as compared to the unexposed females.

Regarding ocular disorders some of formalin exposed members had eye discomfort and irritation, corneal clouding and permanent alteration of vision. All formalin exposed participants reported upper and lower airway irritation. Bronchial asthma and its exacerbation were not encountered among the unexposed members. Nausea and gastro-intestinal tract hemorrhage was also found in some study members. One staff at the Anatomy department had cancer and received treatment.

Mean value of RBCs count, mean Ht% , mean value of platelets count was significantly lower while mean corpuscular volume, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration level was significantly higher among formalin exposed group as compared to non-exposed group. White blood cell count was also abnormal in exposed group [18]. Different studies conducted among medical students on various health issues are available [19-25].

#### **4. CONCLUSION**

The study can focus on the toxic effects of formalin on Ist year M.B.B.S. students, which may necessitate reconsidering the formalin volume and ventilation issue in the dissecting halls. There should be regular assessment of working practices to control the effects of formalin at the department of Anatomy.

#### **CONSENT**

Informed consent will be taken from the study participants.

#### **ETHICAL APPROVAL**

Institutional ethical clearance will be received prior to the study.

## INTERPRETATION

This study will help to point out the toxic effects of formalin on various systems, complete blood count and thyroid gland.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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