Research Article

Peak expiratory flow rate and reaction time analysis in formaldehyde exposed medical technicians and attendants

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Received March 01, 2016. Accepted March 17, 2016

Abstract

Background: The medical staff personnel technician and attendants working in anatomy dissection and histology labs, histopathology lab, and mortuary are constantly exposed to formaldehyde during routine duty hours, while embalming the body and processing visceral samples. Exposure to formaldehyde at low concentrations may cause health effects, such as watering and burning of eyes, running nose, throat irritation, coughing, wheezing, and skin allergies.

Objective: We decided to evaluate peak expiratory flow rate and auditory and visual reaction time in 25 technicians and attendants working in anatomy dissection lab, histology lab, histopathology lab, and mortuary and having occupational work exposure to formaldehyde of 3-5 years for work shift of 6-8 h per day.

Materials and Methods: The peak expiratory flow rate was measured using Wright's peak flow meter and auditory and visual reaction time using response analyzer. The results were compared with age matched non-formaldehyde exposed control subjects. Student's *t*-test was carried out to access the statistical significance.

Result: The study revealed decrease peak expiratory flow rate and auditory and visual reaction time in the study group.

Conclusion: Prolonged formaldehyde exposure leads to altered lung functions and neurobehavioral changes. The better control exhaust system in these labs, use of effective ventilation system, and personal protective device such as face mask and rescheduling duty posting of these personnel's to non-exposed site is recommended for control of health-related hazards of formaldehyde exposure.

KEY WORDS: Formaldehyde, anatomy, histopathology, mortuary, respiratory symptoms, PEFR, reaction time

Introduction

Formaldehyde is a colorless flammable gas at room temperature having pungent odor. It is widely used as preservative in medical anatomy, histopathology laboratories, and mortuaries. Formaldehyde is also used as a germicide, industrial fungicide, and disinfectant.[1,2] Medical teaching institute employs cadavers for training students in gross anatomy. These cadavers are preserved by embalming the body with formaldehyde. Apart from medical teachers and students, the medical technician and attendants are exposed to elevated levels of formaldehyde in the laboratory during the process of keeping the bodies in the tank and later shifting them to the dissection tables; and so also while dissection is in progress. The major toxic effects caused by acute formaldehyde exposure are irritation and watering of eyes, sneezing, running nose, sensation of throat congestion, etc. Exposure to high levels of formaldehyde may lead to allergic chronic dermatitis, recurrent respiratory tract infections, chronic bronchitis, or even precipitate bronchial asthma.[3,4] Exposure studies in animal to formaldehyde have reported effects on the nasal respiratory epithelium and lesions in the respiratory system.[2,5] The long-term exposure to formaldehyde is associated with an increased risk nasopharyngeal, oropharyngeal, and lung cancer in humans.[2,5–7]

The potential chronic and debilitating effects of formaldehyde had been attributed to the formation of biologically active

Access this article online	
Website: http://www.ijmsph.com	Quick Response Code:
DOI: 10.5455/ijmsph.2016.01032016418	

epoxides near axons. These epoxides bind to neurofilamental proteins resulting in demyelination. Technicians who are occupationally exposed to formaldehyde and solvents report frequently with complaints of memory impairment, mood and emotional disturbances, insomnia, headache, and vertigo.[7]

Many studies have been conducted to evaluate pulmonary and allergy status in medical teachers and students exposed to formaldehyde. The time spent by teachers and students in the lab and mortuary is comparatively less as compared to on an average of more than 6 h exposure out of 8-h work shift in medical anatomy, histopathology laboratories, and mortuaries technicians and attendants. Most of the studies evaluated short-term exposure effects of formaldehyde whereas studies regarding cognition and neuromuscular response functions were found to be scarce; hence we decided to evaluate peak expiratory flow rate (PEFR) and auditory and visual reaction time (RT) in technicians and attendants working in these labs.

Materials and Methods

The study was carried out in 25 technicians and attendants working in medical anatomy, histopathology laboratories, and mortuaries; and 25 age-matched health controls. They were in age group of 30–45 years and had exposure history to formaldehyde of more than 6 h a day for a period of 3-5 years. The subjects with per-diagnosed medical, pulmonary, or any illness history; smokers; alcoholics; or on any per-medication were excluded from the study. All controls selected for study were age-matched healthy individuals, nonsmokers, and nonalcoholic with no history of any exposure to formaldehyde. The study was approved by the Institutional Ethical Committee. A written consent was obtained from the participating subjects. The PEFR was measured using Wright's peak flow meter and auditory and visual RT using response analyzer.[8,9] Study and control group subjects were exposed to auditory and visual stimuli. They responded by pressing the response key and RT was noted in milliseconds. The statistical significance was evaluated using Student's *t*-test. SSPS software was used to measure *P*-value. *P*-value less than 0.05 was considered to be statistically significant.

Result

The findings of this study were described in Table 1. Statistical significant differences were observed in PEFR, auditory and visual RT in the study group and controls.

Discussion

Formaldehyde being a sensitizing agent produces an immune system response upon first exposure to the chemical. Allergic manifestations have been commonly reported among those exposed to formaldehyde at work place. When formaldehyde fumes are present in the working environment in concentration more than 0.1 ppm; there are adverse health effects such as watering and burning of eyes, running nose, throat irritation, coughing, wheezing, and skin allergic manifestations.[10,11] The higher formaldehyde concentrations results in respiratory morbidly, recurrent chest infections, impairment of pulmonary function, and asthma.[12–14] The finding of our study was in concurrence with other studies which also revealed decreased PEFR in those having history of chronic formaldehyde exposure though this difference was not found to be statistically significant.[8,10,13,15]

RT was another parameter assessed in our study. It is defined as the interval of time between the presentation of the stimulus and voluntary response of the subject toward the stimuli. The RT impulse works toward the impulse recognition of the stimuli by the nervous system. The response command is initiated from the brain to the spinal cord which then elicits a motor response.[15–17] The decreased auditory and visual RT in medical staff personnel technician and attendant exposed to formaldehyde as compared to control is attributed to the fact that there is neurobehavioral impairment associated with hours per day of formaldehyde exposure.

Formaldehyde also has neurotoxic and systemic toxic effects. The study conducted for assessing formaldehyde toxicity emphasized that the neurotoxic effects alter the neuronal morphology, behavioral pattern, and biochemical parameters. An animal study of acute low-level formaldehyde exposure using rats found that formaldehyde exposure resulted in decreased motor activity and neurochemical changes in dopamine and serotonin (5HT) neurons. These neurotransmitters are involved in both mood and cognitive functioning.[7,8,18,19]

Another study in histology technicians exposed to high concentration of formaldehyde and solvents revealed impairment of memory, emotional outburst, vertigo, and headache and sleep disorders.[7,18,20] Prolonged exposure to formaldehyde such as in overexposure from spills causes chronic irreversible neurobehavioral impairment and complaints of excessive fatigue, headaches, and irritability. They demonstrated impaired performances on the Trail Making Test, impaired fingertip number writing and slowed RT and impaired verbal and visual memory.[18–20] Thus, we speculate that the chronic exposure has lead to neurobehavioral impairment affecting cognition and thereby leading to delayed auditory and visual RT in our subjects.

The limitation of our study is the smaller sample size, but a large sample size study with prolonged exposure of 5, 10, and 15 years duration will give a better insight of health implications of chronic exposure to formaldehyde. Evaluation of auditory and visual RT and assessment of neuromuscular stability was the novelty of our study.

Hence we recommend better control exhaust system in the gross anatomy, histology, histopathology labs and mortuary, use of effective ventilation system and personal protective equipments, and regular monitoring of formaldehyde levels in environment to minimize and prevent health ill effects of formaldehyde exposure. Educating staff, faculty, and students about the personal protective measures, proper handling of the potently dangerous chemicals and storage, and disposal

Table 1: Peak expiratory flow rates (PEFR) and auditory and visual reaction time in the study group and controls

Parameter	Study group *N* = 25	Control *N* = 25	*P*-value
PEFR (mL/s)	302.00 ± 40.12	320.00 ± 56.84	0.2020*
Auditory reaction time (milli seconds)	201.00 ± 14.42	196.00 ± 22.86	0.3596*
Visual reaction time (milli seconds)	304.00 ± 12.12	298.00 ± 21.24	0.2259*

Note: * denotes $P \geq 0.05$ NS, ** significant $P \leq 0.05$, *** highly significant $P \leq 0.01$.

of hazardous materials for maintaining safer work environment practices.[7,11,15]

Conclusion

Prolonged formaldehyde exposure leads to altered lung functions and neurobehavioral changes. The better control exhaust system in these labs, use of effective ventilation system and personal protective device such as face mask and rescheduling duty posting of these personnel's to nonexposed site is recommended for control of health-related hazards of formaldehyde exposure.

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How to cite this article: John J, Laitha V, John N. Peak expiratory flow rate and reaction time analysis in formaldehyde exposed medical technicians and attendants. Int J Med Sci Public Health 2016;5:2095-2097

Source of Support: Nil, **Conflict of Interest:** None declared.