Formaldehyde Exposure in Some Educational Hospitals of Tehran

Mehdi GHASEMKHANI*, Farahnaz JAHANPEYMA and Kamal AZAM

Occupational Health Department, School of Public Health and Institute of Public Health Research, Tehran University of Medical Sciences, P.O.Box: 14155-6145 Tehran, I.R. Iran

Received June 1, 2004 and accepted July 12, 2005

Abstract: This research was conducted to determine formaldehyde exposure of staffs in pathology laboratories, surgery rooms and endoscopy wards in eight large hospitals of Tehran University of Medical Sciences located at Tehran, Iran. Air sampling have been made by both long and short-term methods. Total numbers of samples were 160 for both methods. Nineteen samples of 160 samples were collected as blank in other non-exposed environments such as administrative sections. The mean (SD) levels of formaldehyde in long-term methods were 0.96 (0.74), 0.25 (0.21) and 0.13 (0.18) ppm, at pathology laboratories, surgery rooms and endoscopy wards, respectively. The results of measurements showed that mean (SD) concentration of formaldehyde in one hour sampling at short intervals were 0.83 (0.29), 0.23 (0.16) and 0.75 (0.25) ppm at pathology labs, surgery rooms and endoscopy wards, respectively. There were significant differences in the mean levels of formaldehyde (long-term) at surgery rooms (p<0.02) and endoscopy wards (p<0.005) in eight hospitals of this study. It is concluded that the concentration levels of formaldehyde at pathology laboratories exceed recommended limit which established by the American Conference of Governmental and Industrial Hygienists ACGIH (TLV-C=0.3 ppm). It is recommended that local exhaust ventilation should be installed to minimize the contact to formaldehyde in the staffs.

Key words: Formaldehyde, Concentration, Pathology, Endoscopy, Surgery

Introduction

Formaldehyde is a colorless gas with a strongly pungent and irritating odor, and is produced worldwide in a large scale by catalysis, through vapor phase oxidation of methanol. Annual world production of formaldehyde is reported about 12 million tons. Formaldehyde is widely used in manufacturing of insulating foams, resins and wood industries. Formaldehyde is also a byproduct of engine exhaust, photochemical smog and incinerator and cigarette smoke1, 2).

One of the most important uses of formaldehyde is for its disinfectant properties and pathology laboratory for tissue fixation in hospitals. Formaldehyde is used in the hospital setting for cold sterilization of endoscopes and other medical instruments inadequate to put into autoclave. The Mean levels of formaldehyde in American hospitals vary from 0.1–0.8 ppm1, 2). OSHA reported that one-third out of 1.3 million American workers exposed to formaldehyde are working in medical and paramedical institutions and organizations3, 4).

The main objective of this research was to determine formaldehyde exposure level of staffs in pathology laboratories, surgery rooms and endoscopy wards of eight large hospitals of Tehran University of Medical Sciences (TUMS) located at central area of Tehran, Iran.

Materials and Methods

Cross-sectional study has been made through air sampling measurements by both long and short-term methods. In this study formaldehyde exposure assessment has been made at pathology laboratories, surgery rooms and endoscopy...
wards of TUMS in 8 large hospitals in Tehran, Iran in 2001.

Formaldehyde is used for disinfecting the surgery rooms in liquid form (formalin) and the endoscopy wards in solid form (Para-formaldehyde). Formaldehyde gas may be given off by either liquid formalin or paraformaldehyde powder. The amount of formaldehyde consumption at surgery rooms was 500 ml per 45 m² and at each endoscopy wards were 15–50 tablets (each tablet 1 mg) per day.

Total number of samples exposed staffs were 141 for both methods (99 long-term samples, 42 short-term samples in pathology laboratories, surgery rooms and endoscopy wards), and unexposed staffs were collected to be 19 samples (16 long-term samples and 3 short-term samples) as blanks in other non-exposed environments such as administrative sections. At each studied location 1 to 8 staffs were working and the total numbers of staffs, which exposed to formaldehyde were 124 in one shift.

The long-term samples in breathing zone were sampled by personal samplers with flow rate 1 lpm for 60 min and analyzed by the US National Institute for Occupational Safety and Health (NIOSH) recommended method No. 3500 (99 exposed staffs and 16 controls). The long-term samples in breathing zone (personal samples) were randomly collected during a workday at pathology laboratories, surgery rooms and endoscopy wards. In long-term sampling, due to limitations of the study, samples were not collected from all of departments at eight hospitals which shown in Table 2.

The short-term samples in area sampling were sampled by bellows pump and Dräger tubes (formaldehyde 0.2/a) manufactured by Dräger Germany (42 exposed staffs and 3 controls). The short-term measurements have been made in two methods. The samples of first method were collected in one hour sampling consisted of six samples at short intervals each 10 min at first hour of starting workday of hospitals No. 2. The samples of second method were collected in eight hours sampling consisted of eight samples at long intervals each one hour in length over a workday. In short-term sampling the hospitals at first step, were coded and then, one hospital was selected randomly for sampling by use of random sampling numbers.

Analysis of variance (ANOVA) and 95% confidence interval for mean were used in this study to multiple comparison the results between mean levels of long-term measurements.

Results

The results of long-term measurements in departments were shown in Table 1. Staffs in the pathology laboratories were exposed to the highest levels of formaldehyde with mean levels of 0.96 ppm (SD=0.74), with a range of 0.73 to 1.19, 95% CI for mean. Staffs in the surgery rooms and endoscopy wards were exposed to moderate levels of formaldehyde with mean levels of 0.25 and 0.13 ppm (SD=0.22 and SD=0.18), with a range of 0.18 to 0.32 and 0.03 to 0.32, 95% CI for mean, respectively. There were found significant differences in the mean levels of formaldehyde (long-term) at surgery rooms (p<0.02) and endoscopy wards (p<0.005) in eight different hospitals. No differences were found between mean levels of formaldehyde at pathology laboratories. The results of long-term measurements in hospitals and departments are presented in Table 2. Mean formaldehyde levels in pathology departments of all the hospitals were higher than 0.3 ppm. Moreover five hospitals (62%) in these departments had formaldehyde levels above 1 ppm. Also two hospitals’ surgery rooms (40%), and one of endoscopy wards (20%) had formaldehyde levels higher than 0.3 ppm. There were found significant differences between mean levels of formaldehyde at pathology laboratories in comparison with surgery rooms and endoscopy wards (p<0.001). Whereas no differences were found between mean levels of formaldehyde at surgery rooms and endoscopy wards in hospitals. The distribution of environmental control facilities in pathology laboratories are shown in Table 3, only 12.5% of pathology laboratories were equipped by local exhaust ventilation.
Figure 1 shows distribution of formaldehyde short-term exposure levels at long intervals each one hour in length over a workday. The mean (SD) levels of formaldehyde were of 3.09, 0.39 and 0.21 ppm (SD=2.17, SD=0.94 and SD=0.22), with a range of 4.97 to 1.22, 1.17 to 0 and 0.37 to 0.03, at pathology laboratories, surgery rooms and endoscopy wards, respectively.

Figure 2 shows distribution of formaldehyde short-term exposure levels at short intervals each 10 min in one hour sampling. The mean (SD) levels of formaldehyde were 0.83, 0.20 and 0.75 ppm (SD=0.29, SD=0.18 and SD=0.25), with a range of 1.12 to 0.54, 0.36 to 0.04 and 0.99 to 0.50 at pathology laboratories, surgery rooms and endoscopy wards, respectively.

The mean (SD) levels of formaldehyde samples blank were 0.00 to 0.01 ppm at long and short-term, respectively.

Discussion

Formaldehyde products have a wide variety of uses in hospitals, in disinfectants, in tissue preservatives in pathology departments and in setting for cold sterilization of endoscopes1,2). In our study, staffs in work areas of the hospital, which may involve exposure to formaldehyde, were monitored to determine exposure concentrations. Representative monitoring have been conducted to determine long- and short-term exposures to formaldehyde. The results indicate that maximum of concentrations of formaldehyde in pathology laboratories, surgery rooms and endoscopy wards in long-term and short-term of concentrations sampling exceeded recommended limit which was established as TLV-C=0.3 ppm by the American Conference of Governmental Industrial Hygienists (ACGIH)9). The significant differences in the

Table 2. The distribution of formaldehyde levels (long-term) in hospitals

<table>
<thead>
<tr>
<th>Work areas</th>
<th>HCHO levels (ppm)</th>
<th>Hospitals</th>
<th>P_value*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pathology laboratory</td>
<td>n</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgery room</td>
<td>n</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endoscopy ward</td>
<td>n</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Min.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Max.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*: Mean levels of formaldehyde at hospital departments by multiple comparison ANOVA, n: Number of sample, SD: Standard deviation, NS: Not significant.

Table 3. The distribution of environmental control facilities in pathology laboratories

<table>
<thead>
<tr>
<th>Type of facilities</th>
<th>Local exhaust ventilation</th>
<th>Usual fan</th>
<th>Proper window</th>
<th>Proper tissue storage</th>
<th>Biological safety cabinet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Available</td>
<td>No. 12.5</td>
<td>No. 100</td>
<td>No. 62.5</td>
<td>No. 25</td>
<td>No. 25</td>
</tr>
<tr>
<td>Not available</td>
<td>7 87.5</td>
<td>0 0</td>
<td>3 37.5</td>
<td>6 75</td>
<td>6 75</td>
</tr>
</tbody>
</table>
results obtained from surgery rooms and endoscopy wards seem to be due to the differences in workload and shift work. Staffs in pathology department work at time other than the usual “9-to-5” workday and they work a schedule other than a regular day shift. Therefore, they had more workload (or occupational activity) in comparison with staffs in the surgery rooms and endoscopy wards. Finally, improper processing and control of formaldehyde exposure in pathology laboratories are major results of increase formaldehyde levels. Also the significant differences in the results between mean levels of formaldehyde at pathology laboratories and surgery rooms and endoscopy wards may be due to the differences in process and room type of these three departments. The main cause of high formaldehyde exposure in the pathology departments may be due to lack of proper biological safety cabinet and local exhaust ventilation (75% and 87.5%, respectively) as shown in Table 3. Approximately similar results found in this study in comparison with other studies. The results of studies on sampling of formaldehyde in air by Salisbury10 in 1983 Belange10 and Lawrence11 in 1981
showed that formaldehyde concentrations variations in pathology laboratories are 0.09–1.8 ppm and 0.04–6.79 ppm, respectively. Rosen in Sweden\(^{10}\) and Triebig\(^{10}\) in Germany found that mean average of formaldehyde concentrations in pathology laboratories are 0.5 ppm and 0.6 ppm. Whereas, the mean levels of formaldehyde at surgery rooms and endoscopy wards contained 0.25 and 0.13 ppm, respectively, which were below the ACGIH TLV\(^9\). Only one-third of exposure measurements long-term in the surgery rooms exceeded the TLV. In general, formaldehyde exposure in the surgery room area was slightly higher than those in the formaldehyde endoscopy wards area. It was observed that at first hour of a workday at endoscopy wards all dish plates of cold sterilization are enclosed, and formaldehyde level is near to 0, but gradually increases when dish plates are opened and formaldehyde releases into the workplace. The first hour of a workday, when the surgery room’s doors are opened, formaldehyde level decreases due to air current and natural ventilation (Figs. 1 and 2). As the results indicated in Fig. 2 the results of measurement of short-term sampling in one hour at short intervals each 10 min was rapidly increasing the level of concentration of formaldehyde in the initial time (1–2 h) than the rest of shift work (Fig. 1).

In similar study, an assessment of exposure to glutaraldehyde in cold sterilization was undertaken in 14 locations at six hospitals in southeast England. The results of the study indicated that the means of exposures of hospital workers were 0.7 mg/m\(^3\) (0.57 ppm)\(^{12}\). In surgery rooms where formaldehyde is used as disinfectant material, high level of formaldehyde occurs after main door is opened, and gradually decreased due to air entering and ventilation systems. Surgery room staffs are working in safer place rather than pathology laboratories due to high levels of formaldehyde concentration.

In conclusion, as the results shown, the concentration of samples: formaldehyde was exceeded from recommended limit (ACGIH) in the pathology laboratories. To avoid the personal exposure to the formaldehyde the local exhaust ventilation should be used for this purpose whenever possible. Cooperation between work practices and administrative procedures are also an important part of the control system.

References


5) Formaldehyde [online] (www.afscme.org/health/faq.fah.htm).


9) ACGIH (2002) TLV, and BEI, Threshold limit values for chemical substances and physical agents and biological exposure indices, 32, ACGIH, Cincinnati, OH.

