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EVALUATION OF OCCUPATIONAL EXPOSURE TO GLUTARALDEHYDE AMONG ENDOSCOPY NURSING STAFF IN MENOUFIYA UNIVERSITY HOSPITAL

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ABSTRACT

Background: Glutaraldehyde is the best disinfectant for fibreoptic endoscopes. A number of studies has reported that glutaraldehyde is an irritating substance affecting ocular and nasal mucosae and may give rise to sensitization. Cases of allergic dermatitis, rhinitis, epistaxis, asthma, lacrimation and headache were also reported among exposed workers.

Aim of the work: This study aimed at finding the nature and prevalence of work-related symptoms (WRSs) among nurses working in endoscopy units and assessment of the concentration of glutaraldehyde in the work environment.

Subjects and Methods: Thirty non-pregnant non-smokers nurses occupationally exposed to glutaraldehyde (GA) in various endoscopy units in Menoufiya University hospital were chosen as subjects of this study. An equal number of nurses never occupationally exposed to GA were chosen as a non-exposed group. The Medical Research Council Respiratory Questionnaire was used to record work-related symptoms, spirometric measurements and laboratory measurement of total immunoglobulin E

(IgE). Environmental study to assess GA concentration in the work place was also done.

Results: The concentration of glutaraldehyde in the work environment of the exposed nurses was lower than the recommended threshold limit value (TLV) but was significantly higher than that of the control environment. The most prevalent diseases and symptoms encountered among exposed nurses were work-related symptoms (WRSs) of contact dermatitis (36.66%), followed by eye irritation (26.66%), then nasal irritation (23.33%) and lastly lower respiratory tract symptoms (20%), all were significantly higher among exposed than non-exposed nurses ($P<0.5$). Spirometric measurements were significantly lower among exposed than non-exposed nurses ($P<0.05$). Also, with increasing years of employment in endoscopy units, the spirometric measurements were significantly lower among exposed nurses ($P<0.05$). The mean value of total IgE was significantly higher among exposed than non-exposed nurses ($P<0.05$). Furthermore, a significant negative correlation was observed between values of total IgE and FEV1 among exposed nurses ($P<0.05$).

Recommendations: More attention should be paid to raise nurses' awareness and knowledge about the hazards of GA. It is a must to use suitable protective devices as gloves and masks while working with GA to reduce exposure, good ventilation of the endoscopy rooms to reduce GA environmental level and threshold limit value (TLV) for glutaraldehyde must be revised.

Introduction

The excellent biocidal activity of glutaraldehyde (GA), a 5-carbon dialdehyde (structural formula ($OHC.CH_2.CH_2.CH_2.CHO$) has long been recognized (Ross, 1966). Gastrointestinal, endoscopy and bronchoscopy units have used GA for long periods. It displays broad spectrum antimicrobial activity that is effective against viruses, gram negative and gram positive bacteria, bacterial spores, mycobacterium species and fungi (Hanson et al., 1989 and Tyler et al., 1990). Also, its non-corrosive nature makes GA the main choice as a cold sterilizing agent or disinfectants for fibreoptic endoscopes (Babb and Bradley, 1991).

The disinfecting/sterilizing process consists of the immersion of the endoscopes, after decontamination and cleansing, in basins or plastic tubes containing a 2% solution of glutaraldehyde activated with sodium bicarbonate, for a contact period not shorter than 20 minutes. After ac-

tivation of the glutaraldehyde solution, it maintains its efficacy for about 2 weeks in the basins and tubes (Koda et al., 1999).

Many hygiene studies have related exposure to GA to one or more work-related symptoms (WRSs) which have been increasing over the last few years (Naidu et al., 1995). The highest exposures, and therefore presumed health risk, occur during spillage or during biocide changeover (Sallie et al., 1994 and Health and Safety Excutive, 1996).

The immune system consists of two major components; B and T lymphocytes; the former ones are responsible for the synthesis of immunoglobulins (Robert, 2003). In the presence of an antigen, IgE binds to mast cells which release histamine and other substances leading to hypersensitivity reactions (Smith et al., 1998).

Glutaraldehyde is an irritating substance affecting skin, nasal and ocular mucosae; and may give rise to sensitization. In the literature cases of allergic dermatitis, rhinitis, epistaxis, asthma, lacrimation and headache were reported (Norback, 1988 and Vays et al., 2000). Recent studies do not indicate that it has carcinogenic or mutagenic effects (Vergnes and Ballantyne, 2002). The American Conference of Governmental Industrial Hygienists (ACGIH) proposed a TLV for GA of 200 μg/m3, an odor and a sensorial irritation threshold of 164 μg/m3 and 1000 μg/m3, respectively (Pacenti et al., 2006).

Aim Of The Study

This study aimed at finding the nature and prevalence of work-related symptoms (WRSs) among nurses working in endoscopy units and assessment of the concentration of glutaraldehyde in the work environment.

Subjects and Methods

All non-pregnant non-smoking nurses occupationally-exposed to glutaraldehyde (GA) in various endoscopic units in Menoufiya University hospital were chosen as the exposed group of this study (after exclusion of non-responders). Their ages ranged from 19-36 years (±SD = 26.14±3.65). An equal number of non-pregnant non-smoking, nurses, never occupationally-exposed to GA, working in outpatient clinics in the same hospital were taken as a non-exposed comparable group. Their ages ranged from 21-34 years (±SD =28.23±2.37). Both groups were matched regarding age, socio-economic status and educational level. A written formal consent was signed by each participant before sharing and after explaining the aim of the study. All participants were subjected to:

*A pre-designed questionnaire including personal demographic data about age, educational level, income and social level, detailed occupational history (current and previous occupations, mean hours of the daily work, number of days worked/ week, the use of personal protective devices, previous exposure to spillage) and previous medical diagnosis of asthma, bronchitis, eczema or hay fever. A Modified Medical Research Council Respiratory Questionnaire (1986) was used to assess the presence of work-related upper and lower respiratory tract and skin symptoms. The work-related symptoms (WRSs) were defined as symptoms improving on rest days or symptoms aggravated during a work shift. Also, the questionnaire defined chronic bronchitis as daily cough for at least 3 months in one year for two consecutive years. Additional data for WR contact dermatitis were defined as contact skin rash which occurred when working in the endoscopy unit and could not be attributed to known non-occupational agents (after exclusion of contact urticaria and latex gloves dermatitis).

*Spirometric measurements were made using a portable computerized spirometer (Spirolab II) at the end of the work shift (or at the end of endoscopy session). The device measures ventilatory function parameters in addition to predicted values according to age, sex, height, weight, and race as follows: forced vital capacity (FVC), forced expiratory volume in 1st second (FEV1), FEV1/ FVC % and peak expiratory flow (PEF).

Each spirometric test was repeated 3 times to allow the choice of the best values, according to the American Thoracic Society (1987) criteria (2 values of FEV1 and FVC should not differ by more than 5% or 100 mL) and all measured values were expressed as percentages of predicted ones.

*Measurement of: Total immunoglobulin E (IgE): three ml of venous blood were collected from every subject into a sterile tube, left to stand and clot and the serum was separated after centrifugation and stored at -70º until analysis of IgE.

IgE assay: using Enzyme Linked Immunosorbent Assay for quantitative determination of IgE concentration supplied by Clinotech diagnostics and pharmaceuticals, inc, where the level for normal allergy free individual was less than 150 IU/ ml. This method is based on a solid phase Enzyme Linked Immunosorbent Assay in

which the IgE molecule is sandwiched between the solid phase and the enzyme linked antibodies (Kulczyski, 1981).

*Environmental study: Achieved through:

A) Visual inspection of the work place: Usage of protective devices as well as the work practice in the different endoscopy units (6 units), where the following was observed:

-All nurses used gloves, but no masks during working.

-There was a high GA concentration in the endoscopy room during filling the basins or tubes (through its characteristic odor).

-The majority of the endoscopic units, except the gastroentrology medical department, contained non-efficient natural or mechanical ventilation.

-The offices of the nurses for administration and changing clothes were in close vicinity to the endoscopy room.

B) Assessment of glutaraldehyde in the working environment: Using Personal Sampler Casella T (using gas chromatography) during replacement of glutaraldehyde in basins and tubes in the endoscopy units (6 units) and after work in 10 out patient clinics.

Data were collected, tabulated and analyzed using SPSS software version 11 for Chi-square (X2), student t- test and correlation test at 5% level of significance.

Results

Table (1): Mean value of glutaraldehyde concentration in the working environment of the exposed and non-exposed nurses.

Site	Environmental Glutaraldehyde ($\mu g/m^3$)		t- test	P-value
	No. of samples	$\bar{X}$ ±SD		
Exposed nurses' environment	6	119 ± 43	6.89	<0.000
Non-exposed nurses' environment	10	24 ± 9		

This table shows that the mean value of GA in the working environment of exposed was significantly higher than that of the non-exposed nurses (P<0.000).

Table (2): Prevalence of work-related symptoms (WRSs) and diseases among studied group.

Clinical manifestations	Exposed (n=30)		Non-exposed (n=30)		X2	p-value
	No.	%	No.	%		
#Lower respiratory tract symptoms	20.00	6	3.33	1	4.04	<0.05
Nasal irritation	23.33	7	3.33	1	5.19	<0.05
Eye irritation	26.66	8	6.66	2	4.32	<0.05
Contact dermatitis	36.66	11	6.66	2	7.95	<0.001
No WRSs	53.33	16	83.33	25	6.24	<0.05

Any one of the lower respiratory tract symptoms and diseases: chronic bronchitis (6.66%), persistent cough (13.33%), wheeze (10%), shortness of breath (6.66%) or chest tightness (13.33%).

This table shows that the most prevalent WRSs among exposed nurses were contact dermatitis (36.66%), followed by eye irritation (26.66%), then nasal irritation (23.33%) and lastly lower respiratory tract symptoms (20%), all were significantly higher among exposed nurses than non-exposed (P<0.5).

Table (3): Results of spirometric measurements among studied group.

Spirometric measurements	Exposed (n=30) $\overline{X}$ ±SD	Non-exposed (n=30) $\overline{X}$ ±SD	t- test	P-value
FVC% of pred.	82.03±9.14	88.06 ±10.77	2.34	< 0.05
FEV1% of pred.	80.76±9.17	89.91 ± 9.83	3.73	< 0.000
FEV1 / FVC%	114.75±8.87	120.13 ± 10.12	2.19	< 0.05
PEF% of pred.	95.83±8.78	101.62 ±10.63	2.30	< 0.05

This table shows that spirometric measurements were significantly lower among exposed than non-exposed nurses (P<0.05).

Table (4): Mean value of total immunoglobulin E (IgE) among studied group.

Immunoglobulin (IU/ml)	Exposed (n=30) $\overline{X}$ ± SD	Non-exposed (n=30) $\overline{X}$ ± SD	t- test	P-value
Total IgE	162.35±33.67	124.21±18.96	5.41	<0.000

This table shows that mean value of total IgE was significantly higher among exposed than among non-exposed nurses (P<0.05).

Table (5): Results of spirometric measurements among exposed nurses (n=30) according to duration of employment in years.

Spirometric measurements	<10 y (n=19) $\overline{X}$± SD	>10 y (n=11) $\overline{X}$± SD	t- test	P-value
FVC% of pred.	86.87±7.81	78.16±8.12	8.71	< 0.000
FEV1% of pred.	84.13±8.01	77.39±7.84	3.29	< 0.001
FEV1 / FVC%	117.38±10.12	112.13±9.13	2.11	< 0.05
PEF% of pred.	100.61±9.83	91.05±7.89	4.15	< 0.000

This table shows that with increasing years of employment in endoscopy units, the spirometric measurements were significantly lower among exposed nurses (P<0.05).

Table (6): Correlation between values of total immunoglobulin E (IgE) and results of spirometric measurements among exposed nurses (n=30).

Spirometric measurements	Total IgE	
	r	P-value
FVC%	0.16	>0.05
FEV1%	-0.34	<0.05
FEV1 / FVC%	0.12	>0.05
PEF%	0.14	>0.05

This table shows a significant negative correlation between values of total IgE and forced expiratory volume in 1st second (FEV1) among exposed nurses (P<0.05).

Discussion

The mean value of GA in the working environment of exposed nurses (119 µg/m3) was obviously lower than the recommended TLV (200 µg/m3) and was significantly higher than that in the areas with no exposure (24 µg/m3). Pacenti et al. (2006) reported the same finding of lower mean value of environmental GA concentration than the recommended ACGIH level in eight endoscopy units in an Italian Hospital in spite of finding adverse health effects over skin and respiratory system among exposed nurses. This also agrees with Gannon et al. (1995) who reported an environmental GA concentration lower than the recommended TLV in 13 endoscopy rooms in Birmingham Heartlands Hospital, UK (a mean of 160 µg/m3), although he reported finding high prevalence of asthma between the exposed personnel.

The most prevalent symptom encountered among exposed nurses was contact dermatitis (36.66%). This finding agrees with Vyas et al. (2000) who reported a prevalence of 44% for contact dermatitis. Also this prevalence is similar to that found by Gannon et al. (1995) in UK and Pisaniello et al. (1993) in South Australia in nurses working in endoscopy units. Work-related ocular and nasal irritation (26.66% and 23.33%, respectively) were more prevalent than lower respiratory tract symptoms (20%). The most prevalent lower respiratory tract symptoms were persistent cough and chest tightness (13.33% for both). Vyas et al. (2000) found similar results of 13.5% for eye irritation, 19.8% for nasal irritation and 8.5% for lower respiratory tract symptoms.

Spirometric measurements were significantly lower among exposed than among non-exposed nurses. Stenton et al. (1994) in Newcastle General Hospital, UK, reported a significant fall of mean value of FEV1 among nurses exposed to GA. Gannon et al. (1995) reported PEF records suggestive of occupational asthma and positive specific bronchial challenge tests to GA.

The mean value of total IgE was significantly higher among exposed than among non-exposed nurses which is in agreement with Curran et al. (1996) who reported that GA can produce a raised in IgE in only some exposed workers via its low molecular weight but in the rest, GA would act through non-immune and other unknown immune mechanisms. Also, Vyas et al. (2000) reported the occurrence of positive indications of GA specific IgE among GA-exposed nurses.

It was observed that with increasing years of employment in endoscopy units, results of the spirometric measurements were significantly lower among exposed nurses. Similarly, Gannon et al. (1995) found that the prevalence of occupational asthma due to GA exposure in endoscopy departments increased with increasing years of employment.

In this study a significant negative correlation between values of total IgE and forced expiratory volume in the 1st second (FEV1) was observed among exposed nurses which may be an early indication of susceptibility to occupational asthma of an allergic etiology and/or bronchial hyperactivity. This finding is similar to that reported by Gannon et al. (1995). Also, Anees et al. (2002) mentioned that occupational asthma is diagnosed when a worker had wheeze/chest tightness and breathlessness temporally related to work exposure, with a latent interval between first exposure and first symptoms, and has at least one confirmatory test: serial measurement of PEF, specific bronchial provocation test, >3.2-fold change in non-specific bronchial reactivity in relation to workplace exposure, or specific IgE to a relevant low molecular weight agent.

Recommendations

To decrease the hazards of occupational exposure to glutaraldehyde among endoscopy nursing staff, much attention should be paid to raise nurses' awareness and knowledge about the hazards of GA. It is a must to use suitable protective devices as gloves and masks during working with GA to reduce exposure. Good ventilation of the endoscopy rooms is an important item. Complete recording system for following up nurses occupationally exposed to GA which should include health records of nurses from the start of their work and serial pulmonary function tests must be kept. IgE levels, which denote past and current exposure, should be measured periodically. Periodic environmental survey to measure GA concentration as well as assure proper procedures, practice and proper equipment operation must be done.

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