OCCUPATIONAL EXPOSURE TO FORMALDEHYDE IN PATHOLOGY LABORATORIES

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INTRODUCTION

Occupational exposure to formaldehyde present in workplace air causes irritation of the mucous membranes of the eye and upper respiratory tract (nose and throat), leading to tingling, redness or burns to the nose and throat, nasal discharge and watery eyes. At concentrations below 1 ppm symptoms are usually negligible, but they become disturbing when concentrations exceed 2 to 3 ppm. According to International Agency for Research on Cancer (IARC), continuous occupational exposure to formaldehyde causes cancer of the nasopharynx and leukemia [(1)]. IARC first classified formaldehyde in group 1 (carcinogenic to humans) in 2004.

Formaldehyde is used worldwide, mainly in the production of resins and adhesives used in wood, paper, plastic and textile industry. It is also used in aqueous solutions as a disinfectant and preservative in embalming activities and pathology laboratories.

Pathology laboratories receive organ, tissue, or cell specimens collected from humans to study their structural alterations and to serve as support in the diagnosis and prognosis. The main steps are the preparation of formaldehyde solutions, macroscopy, placing the samples in cassettes and microscopic observation. Supporting tasks, necessary to laboratory operation, are emptying and maintenance of the parts prepared, elimination of specimens, recycling or elimination of the waste formaldehyde solutions.

Based on results obtained in routine exposure evaluations, formaldehyde concentrations in Portuguese pathology laboratories are not always negligible, so it is important to share them to raise awareness to the problem.

The aim of this study is to analyze results from the assessment of occupational exposure to formaldehyde in pathology laboratories performed between 1998 and 2017, identifying exposure tendencies and critical workstations and tasks.

METHODOLOGY

Between 1998 and 2017, formaldehyde air concentrations were determined in 228 workplaces/ tasks of 21 pathology laboratories. Air samples were collected in macroscopy (placing samples in formaldehyde solutions, sample observation), sample preparation (placing samples in cassettes, coloration), microscopy, supporting tasks (washing, disinfection and disposal of formaldehyde residuals), sample storage rooms and administrative areas.

Before sampling took place, all laboratories were inspected to collect information on facilities, working patterns, exposure times and other relevant data. Laboratory managers and technicians were asked about risk exposure awareness and use of personal protective equipment.

Air concentration determination was based on NIOSH 3500:1994[(2)] (samples from 1998-2014) and NIOSH 2016:2003[(2)] (samples from 2015-2017), which describe sampling and measurement procedures.

Sampling took place during laboratory activities, 9 a.m. - 5 p.m.. In administrative areas and storage areas sampling was environmental, with 2-hour duration. In all other workstations sampling was personal, placing samplers in workers' breading zone or as close as possible, with 15-minute duration.

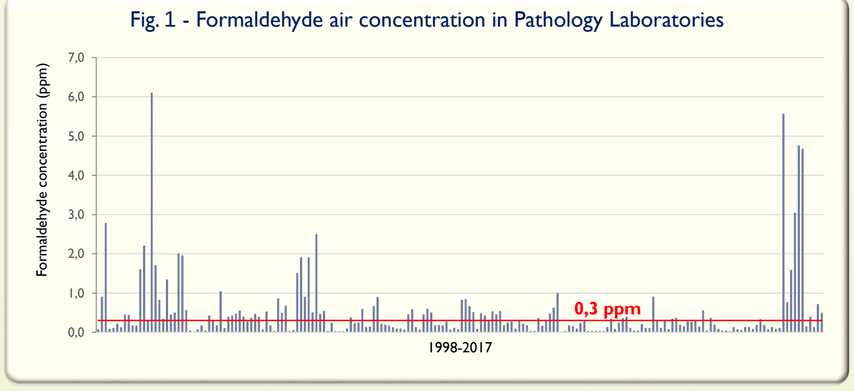
In each study, exposure assessment was based on threshold limit values (TLVs) established in ACGIH publications[(3)], Portuguese National Standard 1796[(4)] and national legislation in force at the time. Up until 2006 TLV-C (concentration never to be exceeded) of 0,3 ppm was used for all workstations; after that, following the publication of national Decree-Law 79/2006, April 4th, later replaced by Decree-Law 118/2013, August 20th, the reference value of 0,08 ppm was adopted for administrative areas. Data analysis in this study uses the same references, which apply in Portugal at present time.

Figure 2 – Macroscopy (A) , Disposal of waste solutions (B), (C).

RESULTS AND DISCUSSION

Results gathered over the years (figure 1) show that despite the awareness of the adverse health effects of exposure to formaldehyde and the technical means available, working conditions and procedures are still insufficient to reduce air concentration and control exposure.

Fig. 1 - Formaldehyde air concentration in Pathology Laboratories



In laboratory areas, where formaldehyde is manipulated, concentrations in the air range from <0,03 ppm (quantification limit) to 6,1 ppm, TLV-C (0,3 ppm) being exceeded in 43 % of the workstations. In administrative areas concentrations range from <0,03 ppm to 0,63 ppm, reference value (0,08 ppm) being exceeded in 15 % of the workstations. (table 1).

Data analysis per laboratory workstation shows that tasks in macroscopy and supporting tasks (material and equipment washing and disposal of waste solutions) are critical, since air concentration of formaldehyde exceeds 0,3 ppm in around half of the collected samples (table 1).

Table 1 – Results of formaldehyde concentration in different work environment.

Work area/ Workstation assessed	Macroscopy	Laboratory supporting tasks	Sample processing, microscopic observation, …	Specimens storage	Administrative áreas
	n=122	n=35	n=26	n=7	n=38
	n=190				
minimum – maximum $\bar{x} \pm s$	< 0,03 – 4,75 0,51 ± 0,74	0,04 – 6,10 0,83 ± 0,41	< 0,03 - 0,52 0,15 ± 0,17	0,03 – 0,21 0,11 ± 0,06	< 0,03 – 0,63 0,08 ± 0,13
TLV	0,3 ppm				0,08 ppm
n workstations ≥ TLV (%)	58 (48%)	19 (54%)	5 (19%)	0 (0%)	7 (15%)
	82 (43%)				

The main factors contributing to high concentrations in the air are inadequate dimension of the premises, having too many workstations, inadequate general ventilation, inadequate or inexistent fume hoods, inadequate working methods.

Figure 2 documents examples of positive and negative aspects identified. Positive aspects: adequate fume hood (A); dedicated room, with efficient general ventilation and respiratory protection adequate to formaldehyde (C). Negative aspects: waste formaldehyde container not under a fume hood (A); absence of fume hoods and inadequate respiratory protection (B).

CONCLUSION

Results show that over the past twenty years there has been no reduction of occupational exposure to formaldehyde in pathology laboratories, as would be expected and desirable, bearing in mind IARC's classification as human carcinogenic since 2004.
Macroscopy tasks and supporting tasks (washing and waste disposal) are critical.

In order to reduce exposure it is of the most importance to adequate premises' dimensions to the volume of work, segregate tasks, improve general ventilation, install fume hoods and improve working methods. Where critical tasks are performed and collective control means are not sufficient to reduce exposure, adequate personal protective equipment should be used.

REFERENCES

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