Región de Murcia

EXHALED BREATH MEASUREMENT FOR BIOLOGICAL MONITORING OF ORGANIC COMPOUNDS FROM ENVIRONMENTAL EXPOSURES

J.F. Periago, A. Zambudio, C. Prado
Gabinete de Seguridad e Higiene en el Trabajo, Murcia

INTRODUCTION

The organic constituents of exhaled human breath are representative of blood concentrations through gas exchange in the blood/breath interface in the lungs. The presence of specific compounds can be an indicator of recent exposure or biological response of the subject. The analysis of breath is preferred to direct measurement from blood samples because breath collection is a non-invasive procedure and the measurement of gas-phase analytes is much simpler in a gas matrix than in a complex biological tissue like blood. Between the several types of exhaled breath samples used, alveolar air (end- exhaled breath) sampling permits valid estimation of partial compound pressure in arterial blood, additionally, this technique and can be used as a indicator of the partial solvent pressure of mixed venous blood if the samples are suitably obtained.

In this study we present the results of biological monitoring by means exhaled breath, of n-hexane, toluene and styrene in several industry workers, and of isoflurane (2-chloro-2,2,2-trifluoroethyl difluoromethyl ether) in anaesthetists, surgeons, and nurses in operating theatres.

EXPERIMENTAL

Biological sampling

A portable system for end-exhaled breath sampling shown in figure 1 was used. The system is based in a Haldane-Priestley tube modified to concentrate aliquots of end-exhaled air from one or more exhalations into a sorbent cartridge, has been previously designed and validated in our laboratory [1]. Activated charcoal -for solvent desorption- and Chromosorb 106 or Tenax -for thermal desorption- were used as sorbents. The samples were taken at the end-shift.

Diffusive sampler for thermal desorption ATD 50

Diffusive sampler for solvent desorption SM-3000

Fig 2

Ambient air sampling

For each occupationally exposed subject, an evaluation of environmental level of these compounds was carried out during the shift, by means of personal diffusive samplers attached to the clothing within the breathing zone during the exposure. Diffusive sampler for thermal and sorbent desorption (figure 2), were used. Experimental conditions for biological and environmental sampling are shown in table I.

Analysis

For thermal desorption, direct analisys by means of ATD 50 system-gas chromatograph, equipped with a 25-m FFAP capillary column and FID, was used.
For solvent desorption, after desorption with CS_2, an aliquot was injected into gas-chromatograph equipped with a 3-m column packed with 10% FFAP on Chromosorb W-AW.

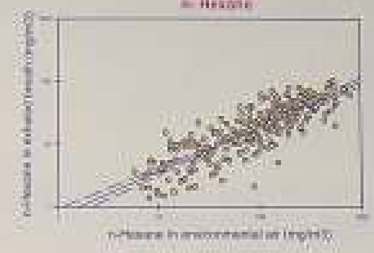

Figure 3

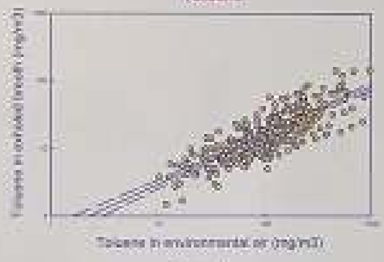

Figure 4

Figure 5

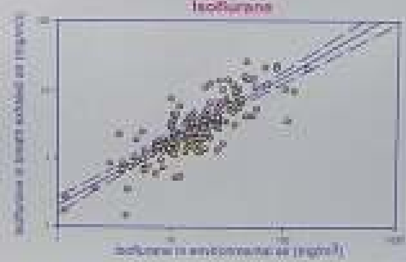

Figure 6

TABLE II

Results of analyses in environmental air and exhaled breath and parameters of the regression equation logY = a+b logX

	CONCENTRATION (mg/m³)			REGRESSION PARAMETERS			
	n	ENVIRONMENTAL AIR	EXHALED BREATH	a	b	r	p
n-Hexane	234	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Toluene	205	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Styrene	50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Isoflurane	178	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE I

Experimental conditions for biological and environmental sampling

	BIOLOGICAL			ENVIRONMENTAL		
	SAMPLING VOLUME	SORBENT	DESORPTION	DIFFUSIVE SAMPLER	DESORPTION	[illegible]
n-Hexane	1 litre	Activated Charcoal	CS_2	SM-3000	CS_2	3
Toluene	1 litre	Activated Charcoal	CS_2	SM-3000	CS_2	3
Styrene	1 litre	Tenax	Thermal	SM-3000	CS_2	[illegible]
Isoflurane	1 litre	Chromosorb 106	Thermal	ATD-50	Thermal	[illegible]

RESULTS AND DISCUSSION

Figures 3 to 6 show the correlation found between environmental and biological results. We have studied 234 subjects exposed to n-hexane, 205 to toluene, 50 to styrene and 178 to isoflurane.The parameters of the regression equation are shown in table II. From the good correlations between exhalatory concentrations and personal air samples, the concentration in ambient air can be predicted from the exhaled air concentration and vice versa. Thus, Threshold Limit Values in ambient air have their equivalent concentration in the exhaled air.

In conclusion our results show that the proposed method may be useful for the biological monitoring of environmental exposures to volatile organic compounds.

REFERENCES

1. J.F. Periago, A. Luna, A. Morente, A. Zambudio. Design and evaluation of exh. breath sampler for biological monitoring of organic solvents. J.Appl. Toxicol. 12 [illegible] 1992.
2. J.F. Periago, A. Morente, [illegible], A. Luna. Correlation between concentrations of n-hexane and toluene in exhaled breath and environmental air in an occupationally exposed population. J.Appl. Toxicol. 14, [illegible] 1994.
3. J.F. Periago, C. Prado, [illegible], J.A. Tortosa. Application of thermal desorption to the biological monitoring of organic compounds. J. Chromatogr. A [illegible] 1997.
4. Analytical Method for [illegible] in ambient air: diffusive sampler/solvent desorption method [illegible].
5. C. Prado, J.A. Tortosa, [illegible], A. Luna, J.F. Periago. Biological monitoring of occupational exposure to isoflurane by measurement of isoflurane in exhaled breath. J.Appl. Toxicol. 17 [illegible] 1997.