Response of erythrocyte pyrimidine 5'-nucleotidase (P5N) activity in workers exposed to lead

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Erythrocyte pyrimidine 5'-nucleotidase (P5N) is an enzyme that catalyses the hydrolytic dephosphorylation of pyrimidine 5'-ribose monophosphate:uridine and cytidine 5'-monophosphates (UMP and CMP). Its presence in the soluble fraction of human erythrocytes was first reported by Valentine *et al* in 1974, indicating that a severe deficiency of erythrocyte P5N is associated with hereditary haemolytic anaemia characterised by a pronounced increase in erythrocyte basophilic stippling.¹

Recently, several investigators have reported that erythrocyte P5N activity is appreciably inhibited by lead, and the log of its activity has a good negative correlation with blood lead in lead workers ($r = -0.79$ to -0.80).^{2,3}

To confirm these findings we have performed the erythrocyte P5N test in lead workers and compared the data obtained with other biological indices of lead exposure: blood lead (PbB), erythrocyte δ -aminolaevulinic acid dehydratase (ALAD), erythrocyte protoporphyrin (PROTO), urinary δ -aminolaevulinic acid (ALA), and urinary coproporphyrin (COPRO).

Heparinised venous blood and spot urine were

obtained from 77 lead workers who were employed in factories producing lead pipe and lead plate and in a polyvinyl chloride factory. Erythrocyte P5N activity was measured by high performance liquid chromatography (HPLC).⁴ The concentration of PbB was determined by flameless atomic absorption spectrophotometry, erythrocyte ALAD activity by the method of Nikkanen *et al*,⁵ erythrocyte PROTO by the method of Piomelli,⁶ urinary ALA by the method of Tomokuni and Ogata,⁷ and urinary COPRO by a fluorometric method using HPLC.⁸

The concentration of PbB obtained from the lead workers ranged from 16 to 96 $\mu\text{g}/100$ ml. The workers were divided into two groups according to their blood lead concentrations: one group with PbB concentrations less than 40 $\mu\text{g}/100$ ml and the other with PbB concentrations greater than 40 $\mu\text{g}/100$ ml. The arithmetic mean and SD in each group was 28 ± 6 $\mu\text{g}/100$ ml ($n = 40$) and 58 ± 16 $\mu\text{g}/100$ ml ($n = 37$), respectively. In each group correlation coefficients between erythrocyte P5N and other biological indices were calculated.

As shown in table 1, a negative correlation was found between PbB and P5N activity and between PbB and ALAD activity in 40 lead workers with PbB < 40 $\mu\text{g}/100$ ml. In this group the correlation

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Table 1 Correlation matrix of biological indicators obtained from 40 lead workers with PbB < 40 $\mu\text{g}/100$ ml

	P5N	ALAD	PROTO	ALA	COPRO
PbB	-0.43**	-0.49**	0.21	0.17	0.26
P5N		0.30	-0.50**	-0.06	-0.07
ALAD			-0.37*	-0.17	-0.10
PROTO				0.19	-0.00
ALA					0.17

* $p < 0.05$; ** $p < 0.01$.

Table 2 Correlation matrix of biological indicators obtained from 37 lead workers with PbB ≥ 40 $\mu\text{g}/100$ ml

	P5N	ALAD	PROTO	ALA	COPRO
PbB	-0.78***	-0.51**	0.75***	0.70***	0.55***
P5N		0.59***	-0.74***	-0.49**	-0.56***
ALAD			-0.52**	-0.33*	-0.34*
PROTO				0.62***	0.68***
ALA					0.80***

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 3 Correlation matrix of biological indices obtained from 77 lead workers

	P5N	ALAD	PROTO	ALA	COPRO
PbB	-0.82**	-0.60**	0.72**	0.66**	0.61**
P5N		0.59**	-0.75**	-0.52**	-0.58**
ALAD			-0.55**	-0.35*	-0.37*
PROTO				0.63**	0.68**
ALA					0.82**

*p < 0.01; **p < 0.001.

coefficient for PbB v ALAD was greater than that for PbB v P5N.

Table 2 shows the correlation matrix of the biological indicators obtained from 37 lead workers with PbB ≥ 40 µg/100 ml. The concentration of PbB correlated significantly with all the indices examined. The intensity of correlation between PbB and other biological parameters increased in the order: ALAD < COPRO < ALA < PROTO < P5N. Although erythrocyte P5N activity correlated significantly with all the indicators tested, it had an especially high negative correlation with PbB and erythrocyte PROTO. From the results shown in tables 1 and 2, it is estimated that the erythrocyte P5N test is useful in monitoring exposure to lead at a comparatively high level.

The correlation coefficients for all the 77 lead workers are summarised in table 3. The correlation coefficient between erythrocyte P5N and other biological indicators increased in the order: ALA < COPRO < ALAD < PROTO < PbB. These data support the results described by Mohammed-Brahim *et al*² and Sakai and Ushio.³

In conclusion, the erythrocyte P5N test is a useful biological monitor for exposure to lead in a wide range, indicating that its activity is useful in predicting the disturbance in porphyrin metabolism induced by lead.

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