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Subject Groups High and Low in Urinary Selenium Levels: Workers Exposed to Heavy Metals and Patients with Cancer and Epilepsy

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Selenium was first recognized for its toxicity ; its essential nature in animals was discovered and established later. That Se is essential to human nutrition has yet to be confirmed (VENUGOPAL & LUCKEY 1978). Recently the selenoenzyme glutathione peroxidase (GSH-Px) was isolated from human erythrocyte (AWASHI et al. 1975) and placenta (AWASHI & DAO 1978). In order to discover the role Se plays in human health and disease, THOMSON & ROBINSON (1980) emphasized a need for continuing studies of special needs of certain groups such as those exposed to heavy metals and those with certain disease and illness for example, cancer and cardiovascular disease. It is amongst these groups that Se deficiency or Se-responsive conditions may be found. Urinary Se excretion has been mainly used to assess the nutritional Se status. Recently estimation of urinary Se level in the form of its content per creatinine (abbreviated as CT) content using 24-hr or random urine samples was shown to be more precise in reducing dilution and variation effects than that per urinary volume using 24-hr urines (HOJO). The purpose of this study is to search the subject groups high or low in Se status by employing urinary Se content per CT content or per urine volume.

EXPERIMENTAL

Daily urine samples were collected from patients in hospital with cancer, epilepsy and hypertension, active factory workers exposed to heavy metals (manganese, chromium, cadmium and mercury), and control groups. All subjects took normal meals. Selenium concentration was determined by fluorimetric method with 2,3-diaminonaphthalene (WATKINSON 1966) and CT concentration by Folin-Wu method (BOSNES & TAUSSKY 1945). The comparison of means of urinary Se level between subject groups was made by Student's t test (SNEDECOR & COCHRAN 1967).

RESULTS AND DISCUSSION

Table 1 represents the range, average and coefficient of variation of the urinary Se level expressed by Se(ng/mL) and Se(ng/mg CT) and the correlation coeffici-

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TABLE 1. Urinary Selenium Levels

Group	Se(ng/mL)			Se(ng/mg creatinine)			R	N
	Mean±SD	Range	CV	Mean±SD	Range	CV		
CON	57.9±26.3	20-113	45.4	59.9±24.5	27-128	40.9	0.55**	21
CAN	26.0±14.0	10- 66	53.8	34.1±14.8	13- 66	43.4	0.50*	23
EPI	36.0±15.6	10- 75	43.3	45.2±17.6	19- 77	38.9	0.50*	21
HYP	44.5±21.9	29- 60	49.2	99.0± 1.4	98-100	1.4	1.0**	2
Mn	68.9±48.9	15-170	71.0	91.5±67.6	19-269	73.9	0.51*	22
Cr	106.9±45.4	56-198	42.5	146.3±85.7	40-283	58.6	0.07^{NS}	14
Cd	166.4±56.6	93-219	34.0	197.8±97.9	126-365	49.5	0.27^{NS}	5
Hg	288			172				1

SD : Standard deviation. CV : Coefficient of variation.
R : Correlation coefficient between Se(ng/mL) and creatinine(mg/mL).
N : Number of subjects. CON : Control. CAN : Cancer. EPI : Epilepsy.
HYP : Hypertension. ** : Highly significant ($p<0.01$).
* : Significant ($p<0.05$). NS : Not significant ($p>0.05$).

TABLE 2. Significance of difference in urinary Se(ng/mL) between subject groups.

Group (mean)	CAN (26)	EPI (36)	HYP (45)	CON (58)	Mn (69)	Cr (107)	Cd (166)	Hg (288)
CAN(26)	-	*	NS	**	**	**	**	**
EPI(36)	*	-	NS	**	**	**	**	**
HYP(45)	NS	NS	-	NS	NS	**	**	NS
CON(58)	**	**	NS	-	NS	**	**	**
Mn (69)	**	**	NS	NS	-	*	**	**
Cr(107)	**	**	**	**	*	-	*	**
Cd(166)	**	**	**	**	**	*	-	NS
Hg(288)	**	**	NS	**	**	**	NS	-

See Table 1 for symbols.

TABLE 3. Significance of difference in urinary Se(ng/mg creatinine) between subject groups.

Group (mean)	CAN (34)	EPI (45)	CON (60)	Mn (92)	HYP (99)	Cr (146)	Hg (172)	Cd (198)
CAN(34)	-	*	**	**	**	**	**	**
EPI(45)	*	-	*	**	**	**	**	**
CON(60)	**	*	-	NS	NS	**	**	**
Mn (92)	**	**	NS	-	NS	*	NS	**
HYP(99)	**	**	NS	NS	-	NS	*	NS
Cr(146)	**	**	**	*	NS	-	NS	NS
Hg(172)	**	**	**	NS	*	NS	-	NS
Cd(198)	**	**	**	**	NS	NS	NS	-

See Table 1 for symbols.

ent between Se and CT concentrations along with number of samples in each subject group. Average Se(ng/mL) apparently decreased in the order, Hg > Cd > Cr > Mn > control > hypertension > epilepsy > cancer groups. Mean Se(ng/mg CT) decreased in the order, Cd > Hg > Cr > hypertension > Mn > control > epilepsy > cancer groups.

The results of test for significance of difference in urinary Se(ng/mL) and Se(ng/mg CT) between subject groups are given in Tables 2 and 3, respectively. Cancer and epilepsy groups had significantly lower urinary Se level, and Cr, Cd and Hg groups had significantly higher Se level than control group.

Cancer group is significantly lower in urinary Se level than any other groups examined. This group had

correlation coefficients of -0.30 between age(years) and Se(ng/mL) and of -0.33 between age and Se(ng/mg CT). The corresponding values in control group were -0.13 and 0.08. These values were not found to be significant. The observation shows that Se levels are not influenced by aging. SHAMBERGER et al. (1973) found that patients with some kinds of cancer had significantly lower blood Se levels than controls. HOPKINS & TUDHOPE (1973) observed that patients with carcinoma were significantly lower in GSH-Px activity compared to normal subjects. It was indicated that a lack of dietary Se merely increases the susceptibility to cancer induction by viral or chemical agents, and tumors will not be developed without these carcinogens (SCHRAUZER 1980). The results of this study clearly show high relationship between low Se status and cancer. At present, any reasonable explanation cannot be given to this relationship.

Epilepsy subjects had significantly lower Se level than any other groups except cancer group. Differences between hypertension and other groups were frequently not significant because of small sample size.

Factory workers exposed to heavy metals were found to be significantly higher in both Se levels than other groups. This observation may be partly due to intake of Se occuring in substantial quantity in sulfide minerals and partly because ingested metals accelerate excretion of body Se as the metal selenides. Selenium is similar in chemical properties to sulfur and largely occurs as metal selenides in the sulfide minerals. The Se contents of sulfide ores of Hg and Zn frequently go up to over 20 % (NATIONAL RESEARCH COUNCIL 1976). The main Cd ore, greenockite (CdS), occurs as a coating on sphalerite (ZnS). The most common ore of Hg is cinnabar (α HgS) and other less important ores are metacinnabarite (β HgS) and livingstonite ($HgS \cdot 2Sb_2S_3$). Chromium occurs in nature mostly as chrome iron ore ($FeO \cdot Cr_2O_3$) and the sulfide mineral, daubreelite ($FeS \cdot Cr_2S_3$), is less important ore. Manganese can be obtained mostly as oxide ores such as pyrolusite (MnO_2) and rarely as sulfide ores such as hauserite (VENUGOPAL & LUCKEY 1978). These characteristic composition of metal ores is fully consistent with the Pearson's hard and soft acids theory (BASOLC & PEARSON 1967). The ions such as Hg^{2+} and Cd^{2+} belong to soft acid group and so the order of affinity for donor atoms is Se > S > O. Methylmercuric ion prefers selenohydryl to sulfhydryl and amino groups (SUGIURA et al. 1976). The ions such as Cr^{3+}, Cr^{6+} and Mn^{2+} belong to hard acid group and so the affinity for donor atoms decreases in the order, O > S > Se. These facts may explain the higher urinary Se level of workers exposed to Hg and Cd than those to Cr and Mn. The results for metal groups are of interest in connection with the reciprocal detoxifications between Se and various metals, such as

prevention of Cd-induced hypertension by Se (PERRY et al. 1974).

The frequencies of significant differences in urinary Se(ng/mg CT) between metal groups were lower than those in Se(ng/mL) since the coefficients of variation for Se(ng/mg CT) were greater than those for Se(ng/mL) and the correlation coefficients between Se(ng/mL) and CT(mg/mL) were statistically not significant in the cases of urine samples in heavy metal groups.

In order to know more profoundly the function of Se, the biologically active form such as selenoenzyme should be investigated.

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