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STUDIES ON THE ABSORPTION AND EXCRETION OF ARSENIC IN TEST ANIMALS

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STUDIES ON THE ABSORPTION AND EXCRETION OF ARSENIC IN TEST ANIMALS

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BADANIA NAD WCHŁANIANIEM I WYDALANIEM ZWIĄZKÓW ARSENU U ZWIERZĄT DOŚWIADCZALNYCH

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The partition of arseneus compounds in cats between blood, lymph and urine has been studied by the isotopic method. The rate of poison absorption from the intestinal tract and poison excretion with urine have also been investigated. It was found that arsenic is evenly distributed between blood and lymph, but its concentration in urine is about 100 times larger. The rate of arsenic absorption is very high - the absorption time is of the order of minutes and the absorption is shortly followed by the appearance of arsenic in urine. (author)

Stosując metodę izotopową badano u kotów podział związków arsenu między krew, chłonkę i mocz. Śledzono również szybkość wchłaniania trucizny z przewodu pokarmowego oraz jej wydalanie z moczu. Stwierdzono równomierny podział arsenu między krew i chłonkę, natomiast w moczu znaleziono stężenie ok. 100-krotnie wyższe. Szybkość wchłaniania arsenu jest bardzo duża - jest to kwestia minut, wkrótce potem pojawia się arsen w znacznych ilościach w moczu.

Применяя изотопный метод было исследовано распределение соединений мышьяка между кровью, лимфой и мочой котов. Одновременно наблюдалась скорость поглощения яда из желудочно-кишечного тракта, а также его выделения с мочой. Было обнаружено равномерное распределение мышьяка между лимфой и кровью, зато его концентрация в моче оказалась в около 100 раз больше. Скорость поглощения была очень большая /продолжительность процесса - несколько минут/ и сразу потом появлялся он в большом количестве в моче.

Studies on the rate of absorption of toxical inorganic compounds from the intestinal tract into blood and lymph and of excretion with urine are continued on cats. Previous studies [1,2] revealed that the rates of absorbing Hg(II) and Tl compounds are very high and the distribution coefficients for the systems lymph/blood, lymph/urine and urine/blood differ significantly for mercury and thallium. The experimental data indicate that kidneys play the main role in eliminating thallium compounds from the animal's organism.

The purpose of our research was to measure the rate of absorption of arsenic compounds in a cat's organism and to study the way of removing them from the organism. The ^{74}As isotope /in its chloride form/ was used as a marker. To achieve a sharp toxic effect, the marker was mixed with an inactive arsenous compound immediately before being administered to the animal.

Materials and procedure

The radionuclide used in the investigations was ^{74}As produced in the cyclotron U-120 in the Institute of Nuclear Physic in Cracow, according to the reaction

$$Ge\ /d,n/\ ^{74}As$$

Short-lived side-products ^{71}As, ^{72}As and ^{76}As also arise in the process. The energy of incident deuterons was 12,3 MeV at the current intensity of 10 uA. The radiation characteristics for ^{74}As is:

E = 596 keV /61%/; 635 keV /16%/ plus beta radiation / $^{+}$, $^{-}$,K/.

The half-life time is $T_{1/2}$ = 17,9 days.

The irradiated germanium /GeO_2/ target was dissolved in aqua regia, evaporated almost to dryness and then adsorbed from 7 M hydrochloric acid on the ion-exchange column filled with DOWEX 1 x 8 synthetic resin. Under such conditions the radionuclide ^{74}As is not adsorbed in the column, in contrast to the impurities of the target material. The radionuclide ^{74}As was repeatedly evaporated almost to dryness and then transformed into the radiodrug form using sterile 0.01 M HCl.

The tests were carried out on domestic cats of mixed race. The average weight of the animals was about 3 kg. The solution of easily absorbable $NaAsO_2$ was introduced into the cat's stomach /in the amount of 3 mg As/kg body weight/ with a syringe through the abdominal tunicles. The non-traced compound was introduced to induce a sharp toxic effect.

The activity of the marker /^{74}As/ administered to the animals at the same time was about 50 uCi /4 x 10^6 pulses/100 s/.

The experiments were performed on three groups of animals:

I - those whose lymph was collected during the whole experiment from the drained thoracal duct;

II - those subject to intense peritoneal dialysis, the dialising liquid being changed 12 times during 8 hours;

III - a reference group in which no lymph collection or peritoneal dialysis was performed after introducing arsenic into the animal's organism.

The radioactivity was measured using PT 72 a counters with NaJ/Tl/ scintillation probe for gamma radiation of 596 keV /discrimination/. Double 0.1 ml samples of blood, lymph and urine taken from the animals of each group were measured in 10 runs of 100 s each and the average activity was calculated.

Results

The activity of ^{74}As in blood is plotted in Fig.1 for the three tested groups. During first 30 min after the poison has been administered the activity rises very quickly, so that is achieves the highert values of the whole 8 hour experiment. The activity is easily detectable already 5 min after the poison has been given /the data are not plotted/. In general, the activity of ^{74}As in blood remains constant,

but in the group of animals submitted to dialysis. In this group the activity of ^{74}As drops significantly /p 0.02/ starting from the fourth hour. This is due to the diffusion of ^{74}As into dialysing solution during intense depoisoning.

The activity of ^{74}As in lymph collected from drained thoracal duct /first group of animals/ increases from the first to the fourth hours of the experiment and then drops to the starting value /Fig.2/.

The activity of arsenic in urine for the three groups tested is plotted in Fig.3. Very often the poison can be detected in urine already after 15 min after being injected.

The plot represents the average results of measurements taken from the first to the eighthhour of the experiment. In the group whose lymphatic thoracal duct has been drained the activity of urine, initially low, increases continuously up to the 7th hour. In the other two groups, the initial activity of urine was very high and decreased constantly throughout the experiment. An apparently different behaviour of arsenic in the group with lymph draining can be explained as resulting from perturbations in the action of kidneys after surgical operation. Worth noting is the fact that the plots of urine activity for the group of cats submitted to dialysis and for the reference group are clearly parallel.

Partition coefficient

The partition coefficient of ^{74}As between blood, lymph and urine for the group of cats submitted to lymph

draining are collected in Table I. The data are the total numbers for the whole time of the experiment, i.e. from the 1-st to the 8-th hour. It should be noted, however, that they were varying in time only to a minor extent. As follows from the blood/lymph partition coefficient which is close to 1, the rates of arsenic diffusion to blood and to lymph are very similar. On the other hand, the arsenic concentration in by the factor of 100 larger than in blood and lymph indicates that cat's organism disposes of the poison primarily via a kidney.

The urine/blood partition coefficients behave in a similar way for all the three experimental groups /Table II/. They are very large, their values oscillating around 100. The largest partition coefficient /120/ was detected in the reference group where the depoisoning action of kidneys was not perturbed by other factors.

Summary

1. For a cat the rate of the absorption of compounds from the intestinal tract to lymph and blood is very large.
2. The lymph/blood partition coefficient is for ^{74}As constant and amounts to about 1.0 during the 8 hours of the experiment.
3. Arsenic excretion with urine is very quick and intense. It starts already 15 minutes after the poison has been administered, and the kidney concentrates poison about 100 times with respect to blood.

4. As the amount of the lymph collected by draining a few milliliters/hour and the arsenic concentration in lymph are small, the draining of the thoracal duct or the external draining out the lymph with the object of depoisoning the animal's organism, do not seem justified.

Table I

Values of As-74 partition coefficients between lymph, blood and urine in the group of cats whose lymph was collected by draining the thoracal duct. The mean values are calculated for all measurements during the total time of the experiment.

Coefficient	Mean $\bar{x}$	Standard deviation s	Mean error of the mean S.D.
Lymph / Blood	1,05	0,78	0,075
Urine / Lymph	105,6	93,1	9,04
Urine / Blood	92,5	64,9	6,27

Table II

Urine/blood partition coefficients in various experimental groups

Group	Mean $\bar{x}$	Standard deviation s	Mean error of the mean S. D.
Draining	92,5	64,9	6,27
Dialysis	104,3	101,2	9,92
Reference	130,3	103,9	12,69

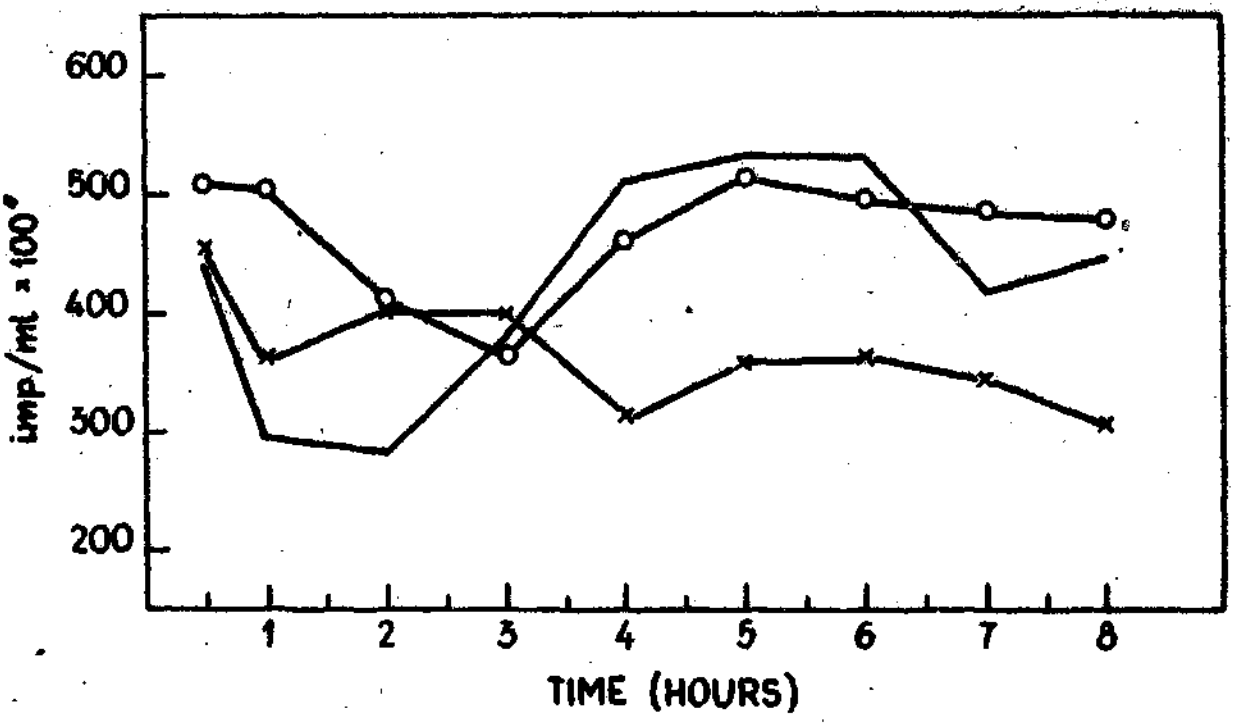

Fig. 1. Mean values of As-74 activity in blood in the group of animals whose lymph was collected by draining the thoracal duct ------- , subject to dialysis ---x---x--- , reference group ---o---o--- .

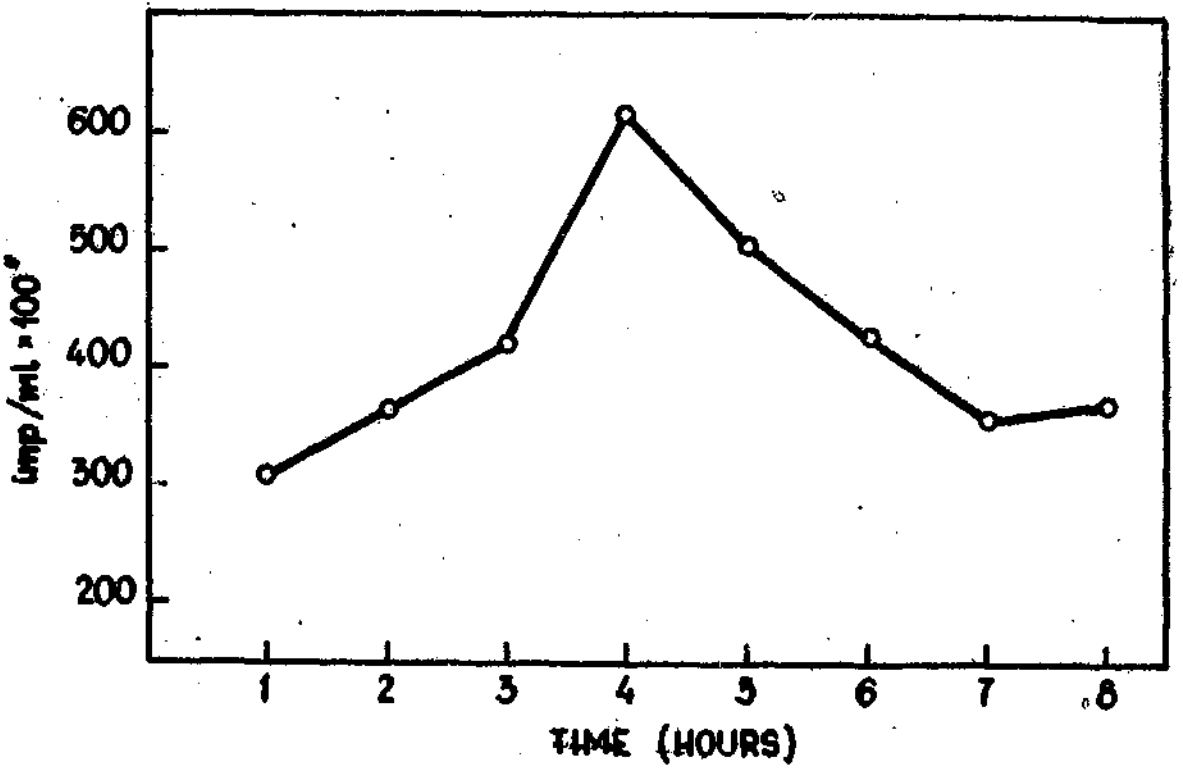

Fig. 2. Mean values of As-74 activity in lymph

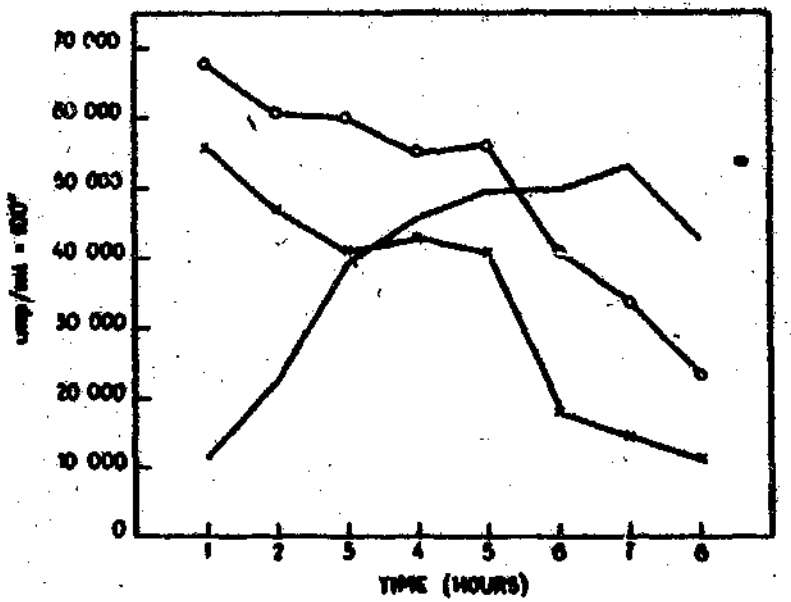

Fig. 3. Mean As-74 activities in urine in the group of animals whose lymph was collected by draining the thoracal duct ——— ,
subject to dialysis ---x---x--- ,
reference group ---o---o--- .

Literature

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