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Absorption, Distribution and Excretion of HG^{203} in Mice

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The toxicity of mercury has been known since the first century B.C., when Pliny for the first time reported a peculiar disease among the slaves working in the mercury mines (cf. MAGOS 1975). The marked toxicity of inorganic mercury coupled with its ever-increasing use in everyday life is drawing the attention of more and more workers. As a food contaminant, exposure to inorganic mercury is quite widespread these days. Though the mercury in various food items occurs in traces only and further that only 7% of the total intake is absorbed (TASK GROUP ON METAL ACCUMULATION 1973), yet it poses serious health hazards owing to its prolonged retention in the human system, particularly in the kidney. However, not much is known about the distribution and retention of mercury in the various tissues following a single administration. The present report embodies integrated observations pertaining to Hg^{203} uptake and retention by various tissues of male mouse at different time intervals, varying from 12 to 72 hr.

MATERIAL AND METHODS

Sexually mature Swiss albino male mice, each weighing 25-30 g, were used for the present investigations. The isotope was procured from Isotope Division, Bhabha Atomic Research Centre, Trombay, Bombay as $Hg^{203}(NO_3)_2$ (specific activity 522 mCi/g Hg). The animals were divided into six groups and sacrificed at varied time intervals (12-72 hr) following single dose of $Hg^{203}(NO_3)_2$ (in saline) administered intraperitoneally at a dose rate of 20 µCi/100 g body weight. The 5 animals used for each set of experiments were kept singly in cages. The faeces were collected, dried and scanned for excreted Hg^{203}. The animals of each group were anaesthetized with nembutol (5 mg/100g body wt) prior to sacrificing. The blood was drawn directly from the heart of anaesthetized animals, whereafter the body cavity was opened, heart removed for instantaneous cessation of blood supply to the other organs and the various organs dissected out in the following order employing separate dissecting instruments for each organ: testes, seminal vesicles, epididymes, cere-

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brum, cerebellum, brain-stem, intestine, spleen, lungs liver and the kidneys.

For assaying radioactivity, the tissues were weighed carefully and transferred to counting tubes containing 1 ml of 60% KOH (w/v). Thereafter the counting tubes were heated to 90°C and maintained at that temperature for 10 min to allow complete digestion of the tissues. The tissue-digests so obtained were analyzed for Hg^{203} activity in a well-type NaI scintillation medical spectrometer. Five replicate counts for each of the samples were recorded with counting time set at 10 s. 0.1 ml of administered $Hg^{203}(NO_3)_2$ in each group was diluted with distilled water and 1 ml of this diluted solution was taken as standard. The standard was counted along with the tissue samples to calculate the percentage of isotope uptake.

RESULTS AND DISCUSSION

The distribution patterns of Hg^{203} (Table 1) in the various tissues of the mouse show that the uptake and retention of the isotope vary widely following a single dose administered intraperitoneally. The highest Hg^{203} uptake was recorded well before 24 hr in most of the tissues except kidney, brain stem, intestines and seminal vesicles where the peaks were attained as late as 24 hr post-treatment. Hg^{203} uptake in the blood was the highest (2.95%) at 12 hr, whereafter the fall was steep. As much as 94% of the peak activity was reduced till 72 hr post-administration. Although 99.5% of the mercury contained in the blood is bound to its cells (NORSETH and CLARKSON 1971), the present data indicate rather quick removal of mercury from the blood. The injected radiomercury was found to be relatively rapidly taken up by the kidneys where the highest Hg^{203} level (68%) was observed at 24 hr post-administration. There occurred only a 50% fall in the activity from 12-72 hr in this organ. Such an observation is consistent with the findings of many previous investigators (FRIBERG 1956, ULFVARSON 1962, ROBERT and FANG 1967, TROJANOWSKA 1968, JAKUBOWSKI et al. 1970). The prolonged retention in the kidneys is probably due to the formation of a complex between mercury and metallothionein and also the administration of the former induces an increased synthesis of the latter in the kidneys (PIOTROWSKI et al. 1974). Maximum uptake in liver is recorded at 12 hr followed by a decrease of 65% up to 72 hr. In liver, as in the kidneys, mercury forms a complex with metallothionein but does not induce an increased synthesis of the latter (PIOTROWSKI et al. 1974).

Hg^{203} uptake in the heart is 5% at 12 hr and a decrease of 95% from 12-72 hr is observed. The incorpora-

TABLE I

Hg^{203} Distribution in mice (20 μCi/100 g body weight)

% dose of standard Hg^{203} uptake

Organs	12 hours	24 hours	36 hours	48 hours	60 hours	72 hours
Blood(.1ml)	2.95*±0.048	1.75±0.03	1.06±0.015	0.59±0.008	0.23±0.004	0.18±0.005
Liver	10.03*±0.14	7.44±0.10	3.96±0.056	3.82±0.054	3.62±0.067	3.52±0.068
Kidney	52.14±0.74	67.96*±0.96	44.97±0.64	35.65±0.50	34.90±0.65	34.29±0.68
Lungs	8.78*±0.12	4.31±0.03	2.85±0.03	1.76±0.01	0.94±0.01	0.56±0.01
Heart	5.22*±0.07	1.26±0.01	0.85±0.01	0.49±0.007	0.46±0.008	0.26±0.006
Spleen	3.15*±0.05	1.89±0.03	0.93±0.01	0.82±0.01	0.64±0.01	0.57±0.01
Intestine	1.85±0.02	2.98*±0.04	1.04±0.01	0.79±0.01	0.78±0.01	0.74±0.02
Cerebrum	0.66*±0.009	0.29±0.004	0.29±0.004	0.27±0.004	0.21±0.004	0.20±0.005
Cerebellum	0.94*±0.01	0.36±0.005	0.31±0.004	0.30±0.004	0.28±0.005	0.28±0.006
Brain Stem	0.13±0.001	0.29*±0.004	0.27±0.003	0.25±0.004	0.21±0.004	0.21±0.005
Testis	0.74*±0.01	0.56±0.008	0.41±0.006	0.34±0.005	0.30±0.006	0.26±0.004
Epididymes	1.42*±0.02	1.36±0.02	1.32±0.01	0.66±0.09	0.42±0.08	0.37±0.006
Seminal Ves.	0.94±0.01	1.38*±0.03	1.12±0.002	0.49±0.007	0.46±0.008	0.26±0.005
Faeces	10.99*±0.15	5.63±0.08	3.52±0.05	2.87±0.04	1.42±0.02	1.35±0.04

The data shows values from four to five animals ± S.D.

* Indicates maximum uptake of Hg^{203} in each tissue.

tion of Hg^{203} in the lungs and spleen too is maximum at 12 hr (9% and 3% respectively), whereafter a sharp decrease in the level of mercury in lungs was observed from 12-24 hr. The intestine records a fall of 60% from 12 to 72 hr. Hg^{203} incorporation in epididymes, seminal vesicles and testes is rather poor. However, epididymes incorporate 2 times more radiomercury in the first 12 hr as compared to the testes. In seminal vesicles, maximum uptake is 2.4% at 24 hr post-treatment.

In the central nervous system, uptake of Hg^{203} is rather poor. The cerebellum records a higher uptake than the cerebrum. However, a decrease of 7% was observed in both the tissues from 12-72 hr. The low uptake of Hg^{203} has also been recorded by other authors (SWENSSON et al, 1959, ROBERT and FANG 1967). The blood-brain barrier fails to admit protein-bound mercury. However, whatever amount of mercury crosses the blood-brain barrier is then retained for extremely long periods.

The present study on faecal excretion of Hg^{203} shows an appreciable overall absorption of the isotope by the various tissues inasmuch as only 11% is excreted through the faeces 12 hr post-administration. The faecal activity falls further by 88% from 12-72 hr. These observations indicate that mercury acts as a very strong ligand and the complexes it forms have slow degradation/elimination rates.

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