RADIOACTIVITY OF HUMAN ORGANS¹⁾

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The radioactivity of organs would have often to be measured at autopsy in the near future as the utilization of atomic energy advances. On such occasions, it is necessary to compare the values then obtained with the standard or so-called normal values of radioactivity of human organs. But, there are no data available that should become the basis of comparison.

The radioactivity of various organs was measured on the autopsy cases of sudden death by such causes as acute heart diseases, intracranial haemorrhage and acute poisoning.

Since there is a certain amount of potassium in the human body and potassium contains the natural radioactive potassium at the rate of 0.01-0.012%, it was also studied that whether the activity shown by G-M counter is contributed to the natural radioactive potassium. In order to determine the potassium content, some samples of the same materials was sent to Mr. Ohtsu of Kanto Communication Hospital (See the next report).

MATERIALS AND METHODS

Materials: Livers, lungs, hearts, spleens, kidneys and brains of the autopsy cases⁵⁾ of sudden death during July 1954 and January 1955 were used. The number of organs obtained was diversified from 21 to 13 depending upon organs. The autopsy cases here dealt with include 8 cases of acute heart diseases, 5 of acute poisoning (not including those by potassium compounds), 3 of acute intracranial diseases and of asphyxia respectively and 2 of other causes. The age of the deceased extends from 12 to 77 years of age, and 12 cases of them are within the range between 21 and 50 years of age.

Methods for measurement of radioactivity: All utensils used were treated with "Desicote". The weight of organs was measured, cut into pieces, then dried at 100°C for 3-4 days, and carbonized for about 4 hours by heat adding with 5-10 cc of fuming nitric acid, and then reduced to ashes at 500°C for about 10 hours and weighed. The

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⁵⁾The organs were offered by the courtesy of the Tokyo-to Medical Examiner's Office.

Table 1. Radioactivity

Autopsy number	Age & sex	Cause of death	Spleen
11021	16 ♂	Death of sleeping draught (Bromvaleryl-urea)	—
11022	19 ♂	Death of sleeping draught (Barbiturate)	6.8±1.1
11065	22 ♂	Acute heart failure	5.5±1.0
11068	48 ♂	Death of drowning	7.3±1.3
11451	27 ♂	Death of sleeping draught (Barbiturate)	6.3±1.1
11453	42 ♂	Hemorrhage in pons	5.9±0.7
11454	68 ♂	Acute heart failure	6.7±0.6
11546	58 ♂	Heart rupture	—
11549	49 ♂	Acute heart failure	4.4±0.5
11614	29 ♂	Acute heart failure	5.4±0.5
11615	14 ♀	Death of strangulation	11.4±3.1
11616	12 ♂	Death of strangulation	6.4±0.5
11935	24 ♂	Asphyxia (by aspiration of vomited mass)	5.6±0.6
11937	77 ♀	Acute heart failure	7.3±1.3
12087	46 ♂	Acute heart failure	5.5±0.7
12089	46 ♂	Bleeding to death	6.2±0.5
12090	31 ♀	Death of sleeping draught (Bromvaleryl-urea)	6.3±0.5
12167	45 ♂	Subdural hemorrhage	3.6±1.4
12169	72 ♀	Yellow phosphor poisoning	7.2±1.1
12179	56 ♂	Heart failure	4.5±0.9
12181	48 ♂	Cerebral compression	5.0±0.6
Mean			6.2±1.4

total amount or part of the ashes was taken in the stainless steel dishes, dried up with infra-red lamp after the addition of distilled water for uniform distribution of the ashes in the dishes. Ash thickness of samples was 34 ± 17 mg/cm². Then radioactivity of ashes was measured by a G-M tube with a 2.9 mg/cm² mica window manufactured by the Scientific Research Institute and "Autoscaler SC-1b" by the Tracerlab Co. The samples were placed on the first shelf (distance: 1 cm) of a sample holder, and 1024 counts were taken for each sample. In no case self-absorption was corrected.

RESULTS AND DISCUSSION

The weight of organs used was 23.6 ± 7.9 g and the amounts of ashes obtained from spleens, brains, livers, kidneys, hearts and lungs were $1.01 \pm 0.20\%$, $1.32 \pm 0.14\%$, $1.04 \pm 0.18\%$, $0.91 \pm 0.16\%$, $0.95 \pm 0.23\%$, and $0.88 \pm 0.21\%$ of wet weights respectively. The actual values of radioactivity (cpm) per 10 g wet weight by each organ as well as the cause of death were presented in Table 1.

The measurement was also performed on 21 samples of the sternum, in which the weight of organ was 10.2 ± 3.9 g, the ash obtained was $13.78 \pm 3.81\%$ of wet weight and the radioactivity per 10 g wet weight was 3.3 ± 3.4 cpm. But,

of human organs

Radioactivity per 10 g of organs (cpm)				
Brain	Liver	Kidney	Heart	Lung
—	6.6±0.8	—	—	1.5±0.7
8.0±0.8	3.3±0.9	5.2±0.9	—	1.2±1.2
—	—	5.0±0.9	—	6.0±1.3
—	—	—	—	1.0±0.5
—	3.0±0.5	3.4±0.6	4.1±1.2	4.2±1.1
—	6.8±0.9	4.1±1.3	5.1±0.8	—
7.4±0.6	5.6±0.7	3.9±0.7	4.7±0.7	5.5±0.8
—	4.9±0.5	5.8±1.0	—	—
4.4±0.6	4.7±0.5	4.5±1.0	—	4.5±0.8
—	8.7±0.6	3.4±0.3	6.2±0.6	—
7.8±0.9	4.9±0.6	8.9±0.7	3.8±0.7	1.4±0.6
—	—	3.0±0.4	4.5±0.5	—
4.1±0.4	3.0±0.4	2.8±0.6	5.3±1.0	4.0±0.7
6.4±0.6	3.6±0.4	4.6±0.6	—	3.6±0.6
3.3±0.7	3.3±0.8	2.3±0.9	2.6±0.8	—
5.1±0.6	5.5±0.5	3.9±0.7	5.7±0.9	1.6±1.6
6.0±0.5	7.1±1.0	1.9±0.6	5.8±0.8	2.1±0.7
8.1±1.0	4.0±0.6	4.1±0.6	4.1±0.6	3.0±1.0
5.2±0.5	3.7±0.8	2.8±0.7	5.7±1.0	2.5±1.5
4.5±0.5	5.3±1.1	3.6±1.0	8.0±0.9	2.1±0.4
5.9±0.5	6.8±0.6	4.0±0.5	3.4±0.6	2.5±0.5
5.9±1.4	5.0±1.7	4.1±1.4	4.9±1.4	2.9±1.5

Table 2. The comparison between actual values of radioactivity in organs and the values calculated from potassium content in them

Organ	Actual value of radioactivity		Presumptive value of radioactivity due to potassium content	
	Number of cases	cpm/10 g of wet weight	Number of cases	cpm/10 g of wet weight
Spleen	19	6.2 ± 1.4	12	5.0
Brain	13	5.9 ± 1.4	12	6.0
Liver	18	5.0 ± 1.7	10	4.4
Heart	14	4.9 ± 1.4	10	5.0
Kidney	19	4.1 ± 1.4	12	3.3
Lung	16	2.9 ± 1.5	10	3.1

perhaps owing to the high content of calcium, some samples showed the radioactivity under background and some gave large error of measurement, so that the value was not included in Table 1.

Fig. 1. Radioactivity of K-compounds (Isotope Lab., NIH)

The right column of Table 2 is the presumptive values of radioactivity due to the potassium contained in the organs. These values were obtained by the use of Fig. 1 indicating the relationship between the amount of potassium and radioactivity, which was compiled from the results by the same apparatus on four known inorganic K-compounds.

On the other hand, the radioactivity of K^{40} per 1 mg is 2×10^4 disintegrations per minute, computing from the half life of it (1.2×10^9 year). The weight of ashes in the organs is roughly 1% of wet weight as described above, the potassium content of the ashes is about 15% as shown in the following report by Ohtsu, so K^{40} in an organ of 10 g wet weight is 1.5×10^{-3} mg or so. If the efficiency of the counter is 10%, the activity in 10 g of an organ should be several counts per minute. Thus the value is also coincided with the mean value in Table 2.

CONCLUSION

The radioactivity of various organs on about twenty cases of sudden death, was measured which may show the standard or so-called normal values in Japanese towards the second half of the year 1954.

Practically the radioactivity of organs reported in the above are considered to be attributed to the natural radioactive potassium in them.

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