

RADIOBIOLOGY

Whole-Body Turnover of Selenium in the Rat

SELENIUM has recently been shown to be an essential micronutrient for rats¹ and ruminants². These discoveries have directed attention to the lack of information concerning the metabolism of selenium in subtoxic amounts. The present communication gives results for whole-body turnover, or total excretion, of selenium by the rat over a prolonged period of time.

Hooded rats of the Long-Evans strain were used. They were maintained on a complete stock colony ration (*ad libitum*) and weighed approximately 150 gm. at the time of administration of radioactive selenium; 0.0011 mc. of selenium-75 in physiological saline was administered interperitoneally. The total selenium content of the dose was 0.14 mgm. and the selenium was present as sodium selenite. The total selenium-75 content of the rats was determined three times daily for the first two days, twice daily for one week and daily for a second week. For measurement, individual rats were placed in a ventilated stainless steel tube and confined to a length approximately equal to that of the rat's body. The rat was then suspended approximately 20 cm. above a scintillation counter for measurement of radiation. The counter used was a standard well-counter operated without the top lead shield. The entire top surface of the crystal was unshielded. The 0.269-MeV. gamma-ray of selenium-75 was counted, using a single-channel pulse-height analyser and scaler. For calibration, a vial containing an aliquot of the dose was substituted for the rat. The standard error of measurement was 2.3 per cent as determined from duplicate counts³. There was no difference in the error of measurement between two operators.

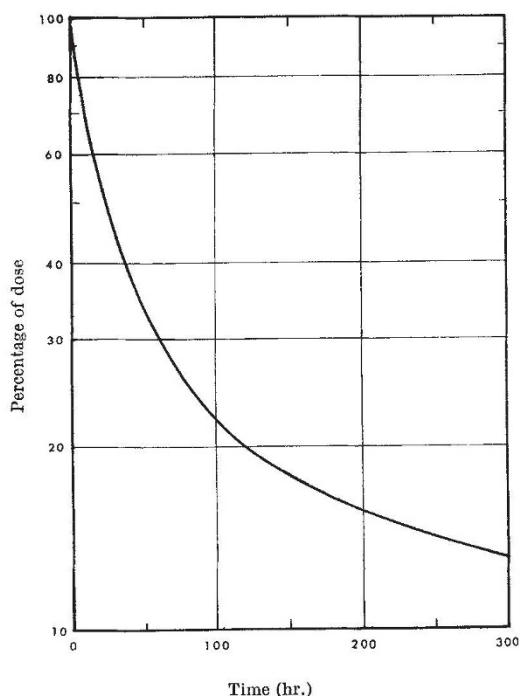


Fig. 1. Radioselenium turnover in the rat

Table 1. WHOLE-BODY TURNOVER OF SELENIUM IN THE RAT

| Rat No. | Rate constants (hr. ⁻¹): | |
|--------------------|--------------------------------------|--------|
| | K_1 | K_2 |
| 0 | 0.037 | 0.0025 |
| 1 | 0.037 | 0.0018 |
| 2 | 0.036 | 0.0021 |
| 3 | 0.037 | 0.0025 |
| 6 | 0.040 | 0.0023 |
| 7 | 0.036 | 0.0021 |
| 9 | 0.038 | 0.0021 |
| Mean | 0.037 | 0.0022 |
| Standard deviation | 0.001 | 0.0002 |
| $t_{1/2}$ (hr.) | 19 | 318 |

The results were analysed by considering the whole-body turnover to be describable by a set of consecutive first-order chemical reactions. The rate constants for the various segments of the turnover curve were computed, fitting the data by the method of least squares.

For the first 300 hr. after injection of selenium-75, the whole-body turnover may be described by two first-order processes of widely differing rate constants (K_1 and K_2). A graph presenting the average results is shown in Fig. 1. The initial slope of the curve is determined by K_1 and the final slope by K_2 . The individual rate constants are presented in Table 1.

Previously published work of selenium metabolism was for periods of less than 50 hr. and hence comparison is difficult. Also, other studies measured excretion, rather than retention, and often ignore one of the three routes of selenium excretion—urine, faeces and expired air. Harshfield⁴ found the 'total recoverable selenium' in the rat to be about 75 per cent of dose at 6 hr. after injection and about 65 per cent of dose at 12 hr. These results agree with the present work. Harshfield found, however, no decrease in 'total recoverable selenium' between 12 and 48 hr. post-injection as was found here (see Fig. 1). McConnell⁵ found the urine and faecal excretion of selenium-75 from the mouse to be about 45 per cent of dose in the first 24 hr. The present work indicates a total excretion of about 48 per cent of dose in an equivalent time. Heinrich and Kelsey⁶ reported the 'total recoverable selenium' in the mouse to be only 16.5 per cent of dose at 48 hr. after injection—considerably less than that found here for the rat.

The presence of two rate constants governing selenium turnover indicates that selenium is involved in the metabolism of the animal. Selenium is transferred from one (rapidly excreted) form to another (slowly excreted) form. Two choices are available: (1) the rate-limiting processes are the renal clearance of two chemically different forms of selenium; and (2) the rate-limiting process for the smaller rate constant is the rate of release of selenium from tissues in which it is fixed.

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³ Youden, W. J., "Statistical Methods for Chemists", 16 (Wiley, New York, 1951).

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