The Medical Research Center 725131 —

Brookhaven National Laboratory BROOKHAVEN NATIONAL LABORATORY

Upton, L. I., New York MEMORANDUM

DATE: January 3, 1962

TO: Committee for the Use of Isotopes in Human Subjects

FROM: L.K. Dahl, M.D., L.C. Lax, M.D., and E. Schackow, M.D.

SUBJECT: Supplemental request to Project No. H-28 (request for permission to use K^{42}): request for permission to use K^{43} in tracer amounts.

Request is hereby made for permission to use K^{43} in tracer amounts in selected hospitalized patients.

The isotope will be used to study potassium metabolism whenever it is necessary to use a potassium isotope with longer physical half-life and somewhat different radiation characteristics from those of K^{42}. It will not replace, but will supplement, K^{42}.

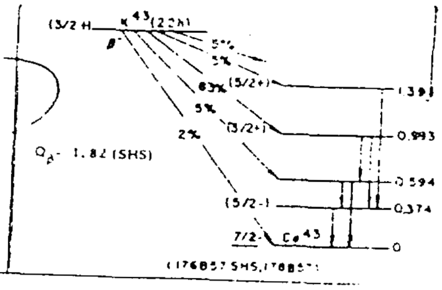
In keeping with classical biological theory, it is assumed here that the isotope K^{43} is physiologically interchangeable with the naturally occurring isotopes K^{39} and K^{40}. Furthermore, in view of the high specific activity of the K^{43} which is available, no consideration need be given to any pharmacological problems relative to potassium administration.

Physical properties of K^{43}:

This isotope has a physical half-life of 22.2 hours and emits both beta and gamma radiation according to the following decay scheme (1):

β⁻ 0.[illegible] ([illegible]%), 0.46 (5%), 0.83 (83%), 1.22 (5%), 1.34 (2%) spect (65L54);
0.24, 0.81 spect, abs (11C49);

γ 0.220 ([illegible]), 0.371 (↑100), 0.388 (↑14), 0.394 (↑16), 0.[illegible] (↑23), 0.614 (↑91),
1.01 (↑4) spect, scint spect, β-γ, γ-γ coinc (176B57),
0.219 (↑1.5), 0.374 (↑100), 0.393 (↑19), 0.619 (↑150, $e_K/\gamma \sim 2 \times 10^{-4}$),
1.02 (↑6) (0.374 γ coinc with 0.219 γ, 0.619 γ, and 1.02 γ) spect, spect
conv, scint spect, γ-γ coinc (65L54, 128B57a),
others (122N55, 28N57, 65L57c);
see also gammas of Sc^{43}



K^{43} is produced at BNL by bombardment of natural, non-enriched argon with cyclotron produced alpha particles (α, p reaction). It has an approximate specific activity of 1 curie/gm. K.

<u>Administration of K^{43}</u>:

K^{43} will be administered orally or parenterally as may be necessary. Prior to use, each shipment will be suitably calibrated and the amount of isotope required will be removed. Suitable sterilization will be done when parenteral routes of administration are used and the precautions appropriate to such procedures will be followed.

It is anticipated that between 2 and 10 μc of K^{43} will be administered to the average patient at any one time. If repetitive doses are administered, the maximal radiation doses received will be well within the tolerance limits proposed by both the International Committee on Radiological Protection (2) and the National Committee on Radiological Protection (3), respectively.

Radiation Dose from K^{43}:

The maximal radiation dose delivered to an individual has been calculated on the assumption that none of the K^{43} was excreted, i.e. an infinite biological half-life was assumed.

Calculations are based on a 70 kg man, 160 cm tall, receiving a dose of 10 μc K^{43}.

Formulae for these calculations are generally accepted, as in Quimby, et al (4) and Hine and Brownell (5).

Radiation from beta radiation:

$D\beta = 73.8\ C\ \bar{E}\beta\ T_{1/2}$ rads

where $D\beta$ = dose due to β radiation in rads

$\bar{E}\beta$ = average β ray energy per disintegration

= 0.29 Mev for K^{43}

C = conc. of isotope in body tissues assuming uniform distribution

$= \frac{10}{70{,}000}$ μc/gm

$T_{1/2}$ = half-life in days = 0.925 days

$\therefore D\beta$ = 0.0029 rads for 10 μc K^{43}

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Radiation from gamma radiation:

$$D\gamma = 0.0346\ \Gamma C\ T_{1/2}\ \bar{g}$$

where $D\gamma$ = dose due to γ radiation in rads

Γ = dose rate in roentgens per hour at 1 cm distance in air from 1 mc

= 5.8 for K^{43}

C = as for D β calculation

$T_{1/2}$ = as for D β calculation

$\bar{g}$ = an average geometrical factor for a γ ray emitter uniformly distributed in the total body = 129 for a 70 kg man 160 cm long.

$\therefore D\gamma = 0.0034$ rads

and Total cumulative dose =

$$D\beta + \gamma = 0.0029 + 0.0034 = 0.0063 \text{ rads for } 10\ \mu c\ K^{43}$$

Thus about 46% of the radiation is from β radiation and 54% from gamma radiation.

If it is further assumed that none of the K^{43} is in extracellular fluid but is confined to an intracellular locus, the amount of β radiation would be increased by about 20 per cent.

But in any event, the total amount of whole body radiation is very small.

Bibliography

1. Strominger, D., Hollander, J.M., and Seaborg, G.T. The Table of Isotopes, Reviews of Modern Physics, 30 (No. 2) Part 2, p. 619, (April) 1958.

2. Report on Permissible Dose for Internal Radiation, by I C R P Committee II: 1959, Health Physics, 3: 3-4, 11-27, 41, 1960.

3. Recommendations of the National Committee on Radiation Protection: Maximal Permissible Body Burdens and Maximal Permissible Concentrations of Radionuclides in Air and Water for Occupation Exposure, Washington, D.C., National Bureau of Standards Handbook 69, U. S. Gov't. Printing Office, 1959, p. 24.

4. Quimby, E.H., Feitelberg, S., and Silver, S. Radioisotopes in Clinical Practice, Lea and Febiger, Philadelphia, 1958, Ch. 8.

5. Hine, H. J., and Brownell, G. L. Radiation Dosimetry, Academic Press, New York, 1956.