BROOKHAVEN NATIONAL LABORATORY

MEMORANDUM

Upton, L. I., New York

DATE: June 15, 1959

REPOSITORY Records Holding Area Bldg 194
COLLECTION Protocals - Clinical
BOX No. 4
FOLDER Human Protocols 1950 - 1963

TO: Committee for the Use of Isotopes in Humans.

FROM: L. K. Dahl, M.D., and W. M. Gordon, Jr., M.D.

SUBJECT: Use of Na^{22} as a tracer in hospitalized patients; H-54

Request is made for authorization for the use of Na^{22} in tracer quantities in selected hospitalized patients. For the most part, these patients will be over 45 years of age, and should the isotope be considered for administration to individuals of younger age, it would be only in persons known to have diseases which will result in a sharply limited life span.

This isotope will be used in conjunction with long term studies and research on hypertension where the shorter-lived Na^{24} cannot be used without prohibitive radiation dosage being given.

It is proposed to administer the isotope orally and intravenously; for some studies the whole-body counter will be used, and for others urine, stool, blood, and possibly other tissues will be collected.

While Na^{22} has a physical half-life of 2.6 years, the biological half-life has been shown to depend on the sodium intake and sodium balance of the individual (1); the excretion of Na^{22} can be hastened readily by a high intake of sodium (2), a fact confirmed in our own laboratory on rats (3). Estimates

1176379

of the biological half-life of Na^{22} in humans, range from 10 - 26 days (4,5) but our own evidence from rats with Na^{22} (3) and humans using Na^{24} suggests that on a low sodium diet (100 mgm/day) the biological half-life would be longer, and on a high sodium diet (4 - 8 gm/day, i.e. 10 - 20 gm as NaCl) it would be much shorter than these stated ranges. In any event, in the adult individual, excluding pregnancy and situations where mineralization of bone is occurring, there is no evidence of permanent retention of Na^{22} (5). In view of our capacity to vary the biological half-life of this isotope at will, no problems are anticipated in the use of Na^{22} at the dose levels proposed.

In general two ranges of dosage level are planned for our studies. For the most part doses of 0.5 to 3 μc will be used for the whole body counter work; occasionally it is possible that 25 - 70 μc may be administered for studies not involving the whole body counter. Since the addition of increments of NaCl to the diets of our rats has decreased the biological half-life of Na^{22} to about one day, it is anticipated that the larger amounts of Na^{22} in humans can be eliminated as rapidly by similar means. In any event, however, the patient will not be allowed to receive a cumulative dose that will average over 0.3 rad per week or 5.0 rad per year. Calculations for various biological half-lives, using different doses in a 70 Kg. individual have been made as follows: (4, 6, 7, 8, 9):

Na^{22} Characteristics (References (10,11)

	Half Life	Radiation	Maximum Energy, MEV
$_{11}Na^{22}$	2.60 year	$\beta 1^+$ ($\sim$ 100%)	0.542
		$\beta 2^+$ (< 0.1%)	$\sim$ 1.8
		γ (after β_1^+)	

DECAY SCHEME

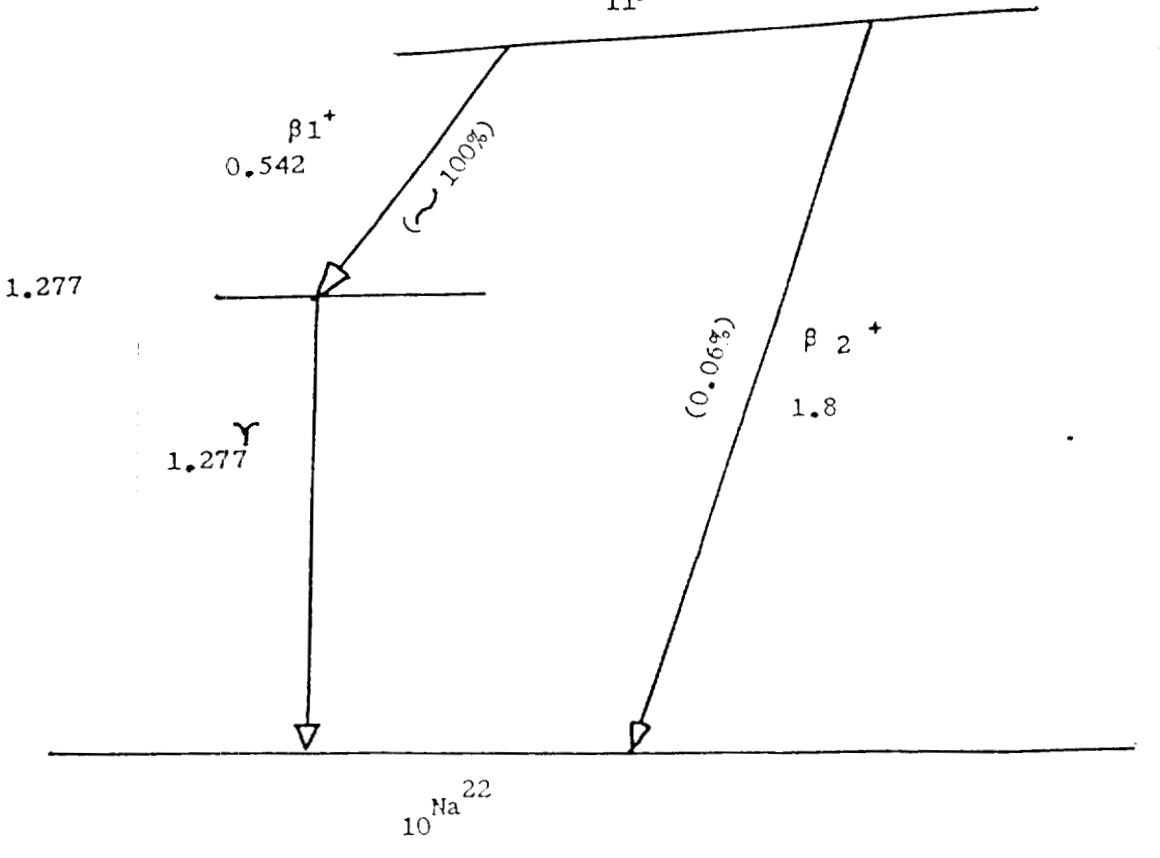

DIAGRAM No. 1

Dose	Biological Half Life	Total Absorbed Dose in Rads
70 μc	10 days	1.19
70 μc	20 days	2.38
70 μc	30 days	3.57
70 μc	40 days	4.76
70 μc	50 days	5.95
70 μc	60 days	7.14
70 μc	2.6 years	113
50 μc	10 days	0.85
50 μc	20 days	1.70
50 μc	30 days	2.55
50 μc	40 days	3.40
50 μc	50 days	4.25
50 μc	60 days	5.10
50 μc	2.6 years	81
25 μc	10 days	0.43
25 μc	20 days	0.85
25 μc	30 days	1.27
25 μc	40 days	1.70
25 μc	50 days	2.12

Dose	Biological Half Life	Total Absorved Dose in Rads
25 µc	60 days	2.55
25 µc	2.6 years=	41
10 µc	10 days	0.17
10 µc	20 days	0.51
10 µc	30 days	0.51
10 µc	40 days	0.68
10 µc	50 days	0.85
10 µc	2.6 years	16.2
3 µc	10 days	0.05
3 µc	20 days	0.10
3 µc	30 days	0.15
3 µc	40 days	0.20
3 µc	50 days	0.26
3 µc	60 days	0.31
3 µc	2.6 years	4.9
1 µc	10 days	0.02
1 µc	20 days	0.04
1 µc	30 days	0.05
1 µc	40 days	0.07

Dose	Biological Half Life	Total Absorbed Dose in Rads
1 μc	30 days	0.09
1 μc	60 days	0.11
1 μc	2.6 years	1.62

For a person, given an initial concentration of 1 μc Na^{22}/kg body weight, the absorbed radiation dose received at a point at the center of the trunk, when the isotope can be assumed uniformly distributed over the whole body, can be calculated as (references 3, 7, 8, 9):

	β-dose rate (millirad/hr)	λ - dose rate (millirad/hr)	Combined dose rate (millirad/hr)
Na^{22} 1 μc/kg	0.40	3.05	3.45

It is requested therefore, that permission be given to administer Na^{22} to selected individuals in amounts and under conditions as noted in the foregoing.

Request approved.

Elmer E. Stickley, Ph.D.

Walton W. Shreeve, M.D., Ph.D.

Donald C. Borg, M.D.

Gerald F. McGinniss, M.D.

James S. Robertson, M.D., Ph.D.
Ex-officio

Lee E. Farr, M.D. Ex-officio

REFERENCES

1. Martin, M. Mencer and Walker, G. Studies with Na^{22} - an Assessment of Sodium Balance and Distribution. Metabolism, 6: 466, September 1957.

2. Martin, M. Mencer, Walker, G. and Chapman, M. Sodium Balance Studied with ^{22}Na and an External Counter for Measuring Whole-Body Radioactivity. The Lancet , March 30, 1957, pp.653-656.

3. Dahl, L.K., and Gordon, W.H., Jr. Biological Half-life of Na^{22} in Rats. Unpublished data of experiments done at Brookhaven National Laboratory.

4. Veall, N. and Vetter, H. Radioisotope Techniques in Clinical Research and Diagnosis, Butterworth & Co. (Publishers) Ltd. (1958).

5. Veall, N., Fisher, H.J., Brown, J.C.M., Bradley, J.E.S., An Improved Method for Clinical Studies of Total Exchangeable Sdoium, Lancet, i: 419, (1955).

6. Bertinchamps, A.J., and Cotzias, G.C. Dosimetry of Radioisotopes. Science, 128: No. 3330, 988-990, Oct. 24, 1958.

7. Marinelli, L.D., et al. Rev. Mod. Phys. 19: 25, 1947.

8. Hine, G.J., & Brownell, G.L. (Eds). (1956) Radiation Dosimetry, New York, Academic Press.

References (Continued)

9. Mayneord, W. V., and Sinclair, W.K. The Dosimetry of Artificial Radioactive Isotopes. Advances in Biological and Medical Physics, 3: (1953), New York, Academic Press.

10. Hollander, J.M. et al. Rev. Mod. Phys. 25: 469, 1953.

11. National Bureau of Standards. Circ. 499, with Supp. 1, 2, & 3.