SAM-TR-68-46

DETERMINING PLASMA VOLUME, BLOOD VOLUME, AND RED CELL MASS WITH ^{125}I

DONALD F. LOGSDON, JR., Captain, USAF, BSC
JAMES F. GREEN, Master Sergeant, USAF

USAF School of Aerospace Medicine
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas

May 1968

ABSTRACT

A standard method was used for determining plasma volume with radioiodinated human serum albumin (RISA) labeled with ^{125}I. A typical plasma volume value found with this method is 37 ml./kg., within the normal range of 27.6 to 52.0 $\pm$ 6.1 ml./kg. By use of indirect measurements, the total blood volume and red cell volume can also be determined. Values for these were: total blood volume, 67 ml./kg.; and red cell volume, 30 ml./kg.

DETERMINING PLASMA VOLUME, BLOOD VOLUME, AND RED CELL MASS WITH ^{125}I

I. INTRODUCTION

As part of a study of erythrokinetics, a procedure was standardized for measuring ^{125}I plasma volume. This report describes a procedure based on the methods of King and Mitchell (1) and Abbott Laboratories (2), which gives accurate and reproducible results. Indirect methods were used for determining the ^{125}I total blood volume and red cell mass.

II. MATERIALS AND METHODS

Iodine-125

The solution in sterile saline is radioiodinated human serum albumin (RISA) labeled with ^{125}I. The concentration of activity in the solution is 10 μc./ml. ^{125}I is a gamma emitter with a principal photopeak of 35.4 kev. The physical half-life of ^{125}I is 60 days. The activity used per determination is 10 μc., of which 5 μc. is used for the standard and 5 μc. is used for the injection dose.

Gamma spectrometer

The instrument used to measure the iodine-125 activity is a Packard (series 5000) Auto-Gamma spectrometer system. The element which measures radioactivity consists of a well-type NaI scintillation crystal, with dimensions of 3 by 3 inches. The well photomultiplier multiplies incident photon energies to the 11th dynode; that is, the incident energy is raised to the 11th power. The spectrometer has been calibrated for full-scale energy of 1 Mev at a gain setting of 40%. In addition, it has been calibrated for settings of 0.5 Mev, gain equals 80%; 2 Mev, gain equals 20%; and 4 Mev, gain equals 10%.

Instrument settings

The coarse gain setting was 80% with a fine gain setting of 7.0 (maximum count rate). This will measure gamma energies of 0 to 0.5 Mev. The discriminators were set to provide a window of 10 to 40 kev, to include the ^{125}I peak of 35.4 kev. The actual potentiometer settings were bottom level 20, upper level 80. The background is automatically subtracted. All samples were counted to 10,000 counts.

Dosimetry

The total body dose due to one injection of 5 μc. is 6 mrem. Since the weekly maximum exposure limit is 100 mrem, this is well below the limit of radiation exposure.

Plasma volume

The day before the plasma volume determination, the patient is given 10 drops of Lugol's solution (iodine, potassium iodide, and water) orally. This is necessary to insure blockage of the thyroid. About 1 ml. of RISA-^{125}I, containing 10 μc., is mixed with 1 ml. of human serum albumin. This is then raised to a volume of 6.5 ml. with sterile isotonic saline. After mixing, 3 ml. of the suspension are drawn up into a sterile 5-ml. syringe for the injection dose. A second 5-ml. syringe, identical to the first, is used to draw up another 3-ml. sample, which is used to prepare the standard. The 3-ml. plasma sample for the standard is diluted to 1 liter with isotonic saline plus 0.5 ml. human serum albumin.

The injection dose is administered to the patient. After 30 minutes, 7 ml. of whole blood are drawn in heparin. From this, two hematocrit tubes are filled and the hematocrit determined. The 7 ml. of whole blood are centrifuged for 15 minutes at 3,000 r.p.m. and the plasma separated from the cells. Then 3 ml. of the plasma are withdrawn and the ^{125}I activity determined. At the same time, the activity of the standard is also determined. The ratio of the standard activity to the plasma activity, multiplied by the dilution factor (1,000), will give the plasma volume (PV).

The total blood volume and red cell mass can be determined using the PV and the hematocrit.

III. RESULTS

Normal values for plasma volume, total blood volume, and red cell volume are: plasma volume, 27.6 to 52.0 ± 6.1 ml./kg.; total blood volume, 51.0 to 81.2 ± 7.3 ml./kg.; and red cell volume, 20.4 to 31.2 ± 2.7 ml./kg. (3). Typical values for ^{125}I blood parameters are: plasma volume, 37 ml./kg.; total blood volume, 67 ml./kg.; and red cell volume, 30 ml./kg.

IV. DISCUSSION

Although there are several ways to determine plasma volumes with radioisotopes, the best way is by directly labeling the plasma with the isotope. Indirect methods for obtaining plasma volume, such as by labeling the red cells, are inherently less accurate, because the red cells are not uniformly distributed. Plasma volume can be obtained using ^{59}Fe labeled plasma, but the total body radiation dose is much higher. RISA-^{125}I is a direct plasma method, which gives a minimal total body radiation dose. Values obtained by this method are well within accepted limits for normal individuals (3).

There are two basic methods for determining ^{125}I plasma volume. The first method is the one reported in this paper, in which the blood sample is collected 30 minutes after isotope injection. The second method is to draw samples at 15, 30, and 45 minutes and extrapolate the activity value at these times back to zero time. This zero-time value is used to calculate the plasma volume. We have evaluated this technic and have found that the plasma ^{125}I clears at a very slow rate. This means that the zero-time activity is almost identical to the 30-minute activity, and the value for plasma volume is practically unchanged using the zero-time activity. We have decided in favor of the first method because only one blood sample is needed. In comparing plasma volumes in the same individual or group of individuals, either method will work; however, it is advisable always to measure the plasma volume in the same way, to eliminate even this small error.

REFERENCES

1. King, E. R., and T. G. Mitchell. A manual for nuclear medicine. Springfield, Ill.: Charles C Thomas, 1961.

2. RISA-I-131, radio-iodinated serum albumin (human). Abbott radio-pharmaceuticals pamphlet, 1966.

3. Wasserman, L. R., T. F. Voh, and I. A. Rashkoff. Blood volume determination: Comparison of T-1824 and P-32 labeled red cell methods. J. Lab. Clin. Med. 37:342 (1951).

Unclassified
Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
USAF School of Aerospace Medicine
Aerospace Medical Division (AFSC)
Brooks Air Force Base, Texas

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE

DETERMINING PLASMA VOLUME, BLOOD VOLUME, AND RED CELL MASS WITH ^{125}I

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Jan. - Feb. 1968

5. AUTHOR(S) *(First name, middle initial, last name)*
Donald F. Logsdon, Jr., Captain, USAF, BSC
James F. Green, Master Sergeant, USAF

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
May 1968	2	3

8a. CONTRACT OR GRANT NO	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO.	SAM-TR-68-46
c. Task No. 775506	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10. DISTRIBUTION STATEMENT

This document has been approved for public release and sale; its distribution is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	USAF School of Aerospace Medicine Aerospace Medical Division (AFSC) Brooks Air Force Base, Texas

13. ABSTRACT

A standard method was used for determining plasma volume with radioiodinated human serum albumin (RISA) labeled with ^{125}I. A typical plasma volume value found with this method is 37 ml./kg., within the normal range of 27.6 to 52.0 $\pm$ 6.1 ml./kg. By use of indirect measurements, the total blood volume and red cell volume can also be determined. Values for these were: total blood volume, 67 ml./kg.; and red cell volume, 30 ml./kg.

DD FORM 1 NOV 68 1473

Unclassified
Security Classification