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Standardization of I^{131} Solutions by Direct Comparison of Gamma Activities* (18079)

WILLIAM A. REILLY, DINA I. BAYER AND JACK M. SIEGEL (Introduced by B. B. Wells)

From the Department of Pediatrics, Radioisotope Laboratory, University of Arkansas School of Medicine, Little Rock, Ark.

Since no generally accepted procedure has been published for the standardization of I^{131} solutions for clinical use, it seems advisable to report a simple method in use in our laboratories. This procedure, which involves direct comparison of gamma-ray intensities of unknown and standard radioiodine solutions, is free from many uncertainties involved in the preparation and measurement of solid I^{131} samples, namely, (1) the danger of loss of activity by volatilization of iodine, (2) the uncertainties in geometry resulting from poor reproducibility in depositing the solid material, (3) the approximate nature of the corrections applied for absorption of beta particles in sample, air and counter window, and (4) the uncertainty of the primary geometry standardization (*e.g.* with RaD, E, F standard). These uncertainties are still present in the Bureau of Standards value for their iodine standard.

The standard I^{131} solution employed in the procedure described here can be obtained periodically from the Bureau of Standards.† They consist of approximately 3 ml of an aqueous solution, containing a known concentration of I^{131} usually in the order of 0.1 rutherfords (rd) per ml. An accurately measured volume of this solution is transferred to a 5 ml glass ampoule and the volume made up to 3 ml and the ampoule sealed in a Bunsen flame. A 3.0 ml sample of the unknown solution containing between 0.1 and 3 rd per ml is prepared in the same manner using an identical ampoule.‡ The gamma activities of the 2 samples are then compared by counting at the greatest practical distance from a standard Geiger-Mueller (G-M) counter, such that the counting rate of the weaker sample is greater than 100 counts per minute (c/m). To eliminate entirely the beta particles from I^{131}, the tube window should be covered with about 200 mg/cm^2 of aluminum.

Standard and unknown are counted in precisely identical positions with respect to the tube, each for a period which yields a total of greater than 10,000 counts whenever practical, so that the statistical error of the counts is negligible.

The arrangement of G-M tube and sample employed in this laboratory are shown in Fig. 1. The use of a rather large distance between sample and tube minimizes geometry fluctuations. The counting rate should not fall below about 100 c/m above background, however, in order that reliable counting data are obtained. Preparation of duplicate un-

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† U. S. Department of Commerce, Bureau of Standards, Radioactivity Section, Washington, D. C.

‡ Obtained from E. Macklett and Son, 220 East 23rd Street, New York City.

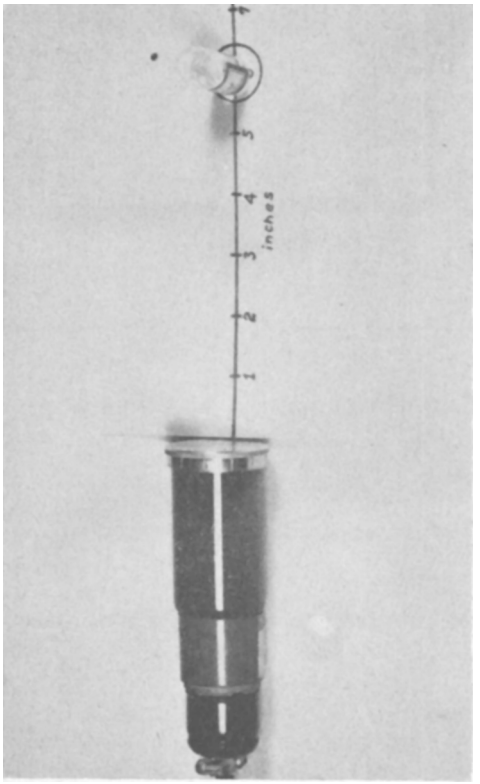

FIG. 1.

known samples, to minimize sampling errors, is advised.

Correction for decay of the 8 day I^{131} in the standard solution (since standardization) must be applied in calculating the strength of the unknown. A sample measurement is described below:

A solution of about 2 millicuries (mc) of I^{131} from Oak Ridge was diluted to 10 ml, yielding a concentration of about 7.4 rd/ml (1 mc = 37 rd). A sample of 1.0 ml of the unknown was placed in a 5 ml ampoule, 2.0 ml of water was added, and the ampoule sealed. A standard I^{131} solution 9 days old was on hand; in the 9 day period, the activity of this standard had decayed from 0.1 to 0.046 rd/ml. The 2 samples were then compared as described above at a distance of 6 inches from the window of a Tracerlab TGC-2 tube, attached to a Nuclear Instrument Company, Model 165, scaling circuit. The counting rates so obtained are employed to calculate the activity of the unknown (X) from the simple proportion:

$$X = \frac{(\text{activity of standard in rd})\ (\text{c/m unknown})}{(\text{c/m standard})}$$

Application of the proper correction factor for dilution then yields a value for the actual activity of the unknown solution in rd/ml. Example: The standard had decayed for 9 days when used to standardize the unknown. As calculated above the standard then contained 0.046 rd/ml or 0.138 rd in 3 ml. This corresponds to 0.00373 mc ($\frac{0.138\ \text{rd}}{37\ \text{rd/mc}}$ = 0.00373 mc) or 3.73 μc. The standard gave 100 c/m at 6 inches with a background of 25 c/m. This minus background was 75 c/m. The unknown gave 3512 c/m at 6 inches. This minus background was 3487 c/m.

$$X = \frac{.00373\ \text{mc} \times 3487\ \text{c/m}}{75\ \text{c/m}} = 0.1734\ \text{mc}$$

This value represents the I^{131} content of 1 ml of the original solution or 1/10 of the shipment from Oak Ridge. Thus the entire shipment contained 1.734 mc of I^{131}.

The actual variability encountered in making repeated determinations on the same solution, *i.e.*, the statistical fluctuations of the method is presented in Table I. The tests were made more severe by comparing samples of different strengths (a 30-fold range of intensities) with a single I^{131} standard. An evaluation of the accuracy of the method was attempted by comparing the values so obtained with an independent standardization of the solution against a RaD beta standard.

A 50 ml stock solution of radioiodine, containing approximately 10 rd of I^{131}, was prepared. Samples of this solution were made up in duplicate according to the above procedure. The gamma activities of these samples were compared with a standard consisting of 2.00 ml of the calibrated I^{131} solution provided by the National Bureau of Standards. At the time of its use the standard contained 0.0522 rd of I^{131} as calculated from the data supplied with the standard solution. The low activity of the standard made it necessary to conduct the measurements at a distance of only 2 inches from

TABLE I. Statistical Variability in the Standardization of I^{131}.

ml of I^{131} sol. taken*	Activity in c/m minus background	Activity in rutherfords	Total activity of I^{131} soln. in rd.†	Deviation from mean
.1	41 ± 2	.0187	9.35 ± .47	—.25
.1	40 ± 2	.0184	9.20 ± .46	—.40
.5	197 ± 5	.0906	9.06 ± .23	—.54
.5	207 ± 5	.0954	9.54 ± .23	—.06
1.0	402 ± 5	.185	9.25 ± .12	—.35
1.0	402 ± 5	.193	9.65 ± .11	+.05
2.0	863 ± 12	.398	9.95 ± .14	+.35
2.0	869 ± 12	.400	10.00 ± .14	+.40
3.0	1306 ± 15	.601	10.00 ± .12	+.40
3.0	1300 ± 15	.598	9.96 ± .11	+.36
Standard (2.0)	113 ± 3	.0522‡		
		Mean	9.60 ± .11§	
Standardized against RaD beta standard†			7.93 ± .16	
			7.80 ± .20	
		Mean	7.87	

* Make up to a total volume of 3.0 ml with distilled water.
† Stand. dev. based on counting error only.
‡ Calculated from data supplied by the National Bureau of Standards.
§ Stand. dev. of the mean for 10 samples.

the Geiger-Mueller tube. Even at this close distance geometry errors were less than 2% as shown by repeated counts on the same sample following repositioning of the ampoule.

It is seen from Table I that for low intensity samples the counting precision appeared to be the limiting source of error while for higher intensity samples other factors such as measurement of volume become more predominant. The agreement between the mean values obtained by the 2 methods of standardization was considered to be satisfactory, in view of the fact that small differences in the geometries and absorption coefficients of the I^{131} beta sample and RaD standard were in the direction to give a low result.

Summary. A rapid and convenient method for the standardization of I^{131} solutions is described. A statistical evaluation of the method showed that the standard deviation of the mean for 10 samples was approximately 1%.

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Maintenance of Pregnancy in Hypophysectomized Rats with Placental Implants.* (18080)

STUART C. AVERILL, ESTEN W. RAY, AND WILLIAM R. LYONS

From the Division of Anatomy and the Institute of Experimental Biology, University of California, Berkeley, Calif.

Using the placentoma reaction Astwood and Greep(1) demonstrated that the rat placenta contains a luteotrophic substance capable of stimulating the corpora lutea to secrete pro-

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1. Astwood, E. B. and Greep, R. O., PROC. SOC. EXP. BIOL. AND MED., 1938, v38, 713.