Gel scintillation counting of I^{131} in plasma at high efficiencies

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SYNOPSIS A method is described for assaying low concentrations of I^{131} in plasma by detecting the beta radiation in a gel scintillator. Higher detection efficiencies are obtained compared with measurements of the gamma radiation from this radioisotope using a well-type crystal of sodium iodide.

Determination of the concentration of protein-bound I^{131} in plasma in association with I^{131} neck uptakes provides a useful method for investigating patients with abnormal thyroid function (Wayne, 1960). Forty-eight hours after an oral dose of 20 to 50 microcuries I^{131} , 10 to 12 ml. blood is removed from the patient, centrifuged, and the plasma passed through an anion exchange resin to remove any residual inorganic radio-iodine. The amount of protein-bound I^{131} (P.B. I^{131}) present in the eluate is small and consequently the counting periods for a required statistical accuracy are long.

Horwitz, Kereiakes, Saenger, and Selkirk (1963) have investigated the liquid scintillation counting of plasma containing I^{131} and reported a technique for assaying the beta particles emitted by this isotope in 1 to 3 ml. volumes absorbed and dried on filter paper strips. A similar method using filter paper discs has been described by Polesky and Seligson (1965). This article outlines a simpler liquid scintillation counting method which yields greater detection efficiencies and is compared with the more usual measurement by gamma detection in a well-type scintillation counter.

MATERIALS

A liquid scintillator solution was prepared by dissolving 7 g. 2,5 diphenyloxazole (P.P.O.), 0.3 g. 1,4-bis-2-(4-methyl-5-phenyloxazolyl)-benzene (Dimethyl P.O.P.O.P.), and 100 g. naphthalene in dioxane to a final volume of 1 litre, and to this solution 50 g. Cab-o-Sil was added to yield a gel scintillator.

A Tri-Carb liquid scintillation spectrometer¹ equipped with an automatic external standard (A.E.S.) was used to assay the radioactive plasma in the gel scintillator

while a well-type scintillation counter² containing a sodium iodide crystal was used to measure the samples by gamma detection.

METHOD

The efficiency, defined as the percentage of the disintegrations which were detected, was measured for different plasma volumes in the gel scintillator by adding 0.1 microcurie I^{131} , in 0.1 ml. water, to 140 ml. of the gel. Sequentially, 1.0, 1.4, 1.8, 2.2, 2.6, 3.0, 3.4, and 3.8 ml. of non-radioactive plasma were added to eight counting vials each containing 15 ml. of the radioiodine gel scintillator. On adding the plasma to the gel a white cloudy precipitate formed but was uniformly suspended by gently shaking the counting vials, care being taken to ensure that none of the gel touched the cap of the vials.

One channel of the liquid scintillation spectrometer was adjusted to give the optimum $\frac{R_s^2}{R_b}$ figure of merit (Loevinger and Berman, 1951) for the vial containing 1.0 ml. plasma where R_s is the sample count and R_b the background count, and a second channel adjusted to record over 60,000 counts per minute above the sample count when the external standard was applied to this vial. The well-type scintillation counter was adjusted to give the optimum $\frac{R_s^2}{R_b}$ value for I^{131} using a channel centred on the photopeak arising from the 0.36 Mev. gamma ray emitted by this isotope.

RESULTS

The figure shows the variation in efficiency with external standard counts due to the addition of plasma to the gel scintillator and can be used for quench correction for unknown plasma samples (Schrodt, Gibbs, and Cavanaugh, 1965). The curve was obtained after the samples had cooled to the

¹Packard Instrument Company, Inc. Downers Grove, Ill., U.S.A., type 3324.

²Ekco Electronics Ltd, Southend-on-Sea, England, type N664.

FIG. 1. The detection efficiency for ^{131}I in the gel scintillator for different plasma volumes and A.E.S. counts per min.

plasma volumes containing P.B. ^{131}I at a concentration of $20\ \mu\text{C.}^{131}\text{I}$ per ml., representing 0.1% of a dose of $20\ \mu\text{C.}$ per litre of plasma, is shown in the Table. The associated percentage errors in the selected counting periods were derived from the nonogram by Loevinger and Berman, where r is the ratio of the sample plus background counts to the background counts.

In order to express the concentration of P.B. ^{131}I as a percentage of the dose it is necessary to make a dilution in water of an aliquot of the dose solution. At the temperature of the counting cabinet aqueous solutions added to the dioxane gel tend to freeze but this effect can be overcome by adding only 0.1 to 0.5 ml. of the dose dilution and making up the volume to that of the samples with non-radioactive plasma.

CONCLUSION

The results show that the method of determining P.B. ^{131}I in a dioxane based gel scintillator is superior to that of gamma detection in a well-type sodium iodide crystal since it yields the smallest statistical

TABLE

COMPARISON OF THE EFFICIENCY OF DETECTION AND ERRORS ASSOCIATED WITH THE ASSAY OF ^{131}I IN PLASMA AT A CONCENTRATION OF $20\ \mu\text{C./ML.}$ USING THE WELL-TYPE SCINTILLATION COUNTER AND THE GEL SCINTILLATOR

Sample Volume (ml.)	Well-type Scintillation Counter				Gel Scintillator			
	Efficiency (%)	r	Percentage Error		Efficiency (%)	r	Percentage Error	
			50 min.	20 min.			50 min.	20 min.
1.0	26	1.17	16.0	26.0	85.3	2.28	3.9	5.2
2.0	25	1.32	8.4	13.5	77.4	3.21	2.7	4.1
2.5	24.5	1.49	6.0	9.1	72.1	3.56	2.4	3.8
3.0	24.0	1.52	5.8	8.8	67.4	3.87	2.2	3.6
4.0	22.8	1.66	4.8	7.9	—	—	—	—
5.0	21.1	1.72	4.1	7.0	—	—	—	—
Rb	Background counts		3,450	1,360	Background counts		1,531	612

temperature of the counting cabinet of the liquid scintillation counter, -2°C. , and the efficiencies ranged from 85.3 to 49.5% for volumes 1.0 to 3.8 ml. Similar curves were obtained up to seven days later, appropriate corrections being made for radioactive decay. The light yellow plasma gel scintillator suspension tends to turn to a deeper shade when exposed to excessive light for a few hours, increasing the degree of colour quenching, but is self compensating to some degree since the quench curve obtained initially has been found to be applicable up to volumes of 3.0 ml.

The efficiency for detecting ^{131}I in the well-type scintillation counter ranged from 26 to 21.1% for plasma volumes of 1.0 to 5.0 ml.

A summary of the results obtained from assaying

error in a given period of time due to the high detection efficiency, low background count, and smaller volume of plasma required. The method can be used for assaying ^{131}I in inorganic form in plasma and is technically simpler than that of Horwitz *et al.* (1963) who quoted efficiencies of 52.5 to 48% over the range 1.0 to 3.0 ml. since less time is required to prepare the samples for counting.

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