TABLE 1. MEAN % RADIOCHEMICAL PURITY

Radiopharmaceutical	1980	1981	t	P*
DTPA	97.58 ± 1.21 N = 13	91.10 ± 5.03 N = 11	4.5103	> 0.995
Gluco	96.82 ± 1.977 N = 5	91.69 ± 4.08 N = 5	2.5281	> 0.975
PIPIDA	98.27 ± 1.70 N = 18	97.14 ± 1.13 N = 18	2.3405	> 0.975
MDP	99.22 ± 0.608 N = 42	98.56 ± 1.92 N = 41	2.1219	> 0.975
MAA	99.42 ± 0.259 N = 31	99.30 ± 0.4 N = 34	1.2565	≈ 0.90
PYP	97.74 ± 1.68 N = 13	97.44 ± 1.10 N = 11	0.5066	> 0.60
Sulfur colloid	99.72 ± 0.44 N = 30	99.70 ± 0.31 N = 33	0.2837	> 0.60

* $\bar{X}_{80} \neq \bar{X}_{81}$.

differences between the mean values measured in the two years was calculated using Student's t-test for the difference of means. The probability that the means are different was then determined using tables of distribution of t values (*2*).

Table 1 reports the data comparing these radiochemical purity data. The greatest change is observed with Tc-99m DTPA, and is in agreement with the previous observation. There are also statistically significant changes in glucoheptonate, PIPIDA, and methylene diphosphonate, but these changes probably have minor, if any, clinical significance. The DTPA value, however, does raise serious concern because Tc-99m DTPA is used at times for quantitative assessment of renal function. With a poor-quality radiotracer, results of serial studies in a patient could be misleading.

Although these findings do not conclusively prove that the radiochemical purity of Tc-99m radiopharmaceuticals was decreasing between the 1980 and 1981 measurements (since an alternative explanation is that the difference could be caused by an uncontrolled analytical variable), they do raise the question, especially with Tc-99m DTPA.

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On Changes in Calculated Ejection Fraction by Reducing Maximum Diastolic Count

The interesting concise communication by Powers et al. (*1*) on multiple gated acquisition techniques shows empirically that a reduced calculated ejection fraction ensues when there is delay between the time the R wave is sensed and the time the gating signal occurs. However, since both numerator and denominator of the expression for obtaining the ejection fraction will be decreased, it is not intuitively clear that the ejection fraction will be reduced.

We now provide a theoretical proof. Let C_{ED} and C_{ES} be the correct ventricular counts at end-diastole (maximum count) and end-systole. The expression for the actual ejection fraction is

$$F_1 = (C_{ED} - C_{ES})/C_{ED}. \quad (1)$$

If there is delay in recording the maximum count at diastole, let the spurious end-diastolic count be $(C_{ED} - A)$; then the expression for this calculated ejection fraction is

$$F_2 = \frac{(C_{ED} - A) - C_{ES}}{C_{ED} - A}. \quad (2)$$

From (1) and (2) we get

$$C_{ED} - C_{ES} = F_1 C_{ED} \quad (3)$$

and

$$C_{ED} - A - C_{ES} = F_2 C_{ED} - F_2 A. \quad (4)$$

Substituting (3) into (4) and dividing through by C_{ED}, we obtain

$$F_1 - \frac{A}{C_{ED}} = F_2 - F_2 \frac{A}{C_{ED}}. \quad (5)$$

Rearranging and factoring out A/C_{ED}, we arrive at

$$F_1 - F_2 = \frac{A}{C_{ED}}(1 - F_2). \quad (6)$$

Since all quantities are positive numbers and, by definition of ejection fraction, F_2 is less than 1, $(1 - F_2)$ is a positive quantity. Therefore the right-hand side of (6) is also a *positive* quantity. This necessitates

$$F_1 > F_2 \text{ or } F_2 < F_1, \qquad \text{Q.E.D.}$$

The situation represented by Eq. (2) is different from that encountered when background B is subtracted in calculating the ejection fraction. In the latter case, the expression will be

$$F_3 = \frac{(C_{ED} - B) - (C_{ES} - B)}{C_{ED} - B}, \quad (7)$$

which becomes

$$F_3 = \frac{C_{ED} - C_{ES}}{C_{ED} - B}. \quad (8)$$

As compared with Eq. (1), obviously $F_3 > F_1$ because for the same numerator the denominator in (8) is smaller than in (1)—a restatement of the well-known observation that the larger the background subtraction the higher the calculated ejection fraction. But when the maximum count in the left ventricle is artifactually diminished by reducing the maximum diastolic count as in Eq. (2), the calculated ejection fraction will be lower.

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Free Thyroxine Measurements in Euthyroid Patients with Low or High T_3 Uptakes

Previously we have reported (1) the problems encountered with free thyroxine radioimmunoassay (FT_4-RIA) in the serum of clinically euthyroid patients who had either a relatively high or a low tri-iodothyronine (T_3) uptake value. Recently a patient was referred to us for evaluation of possible hyperthyroidism. This tentative diagnosis was based on test results obtained from a reference lab. The FT_4 was 2.6 ng/dl (normal range 0.8-2.3) and the thyroxine-binding globulin RIA was 32 μg/ml (normal 12-30). The free-thyroxine index (FTI) had not been ordered by the referring physician.

In our laboratory the FTI was 2.3 (normal 1.4-4.0), the total T_4 was 9.3 μg/dl (normal 5.5-11.5), and the T_3 uptake was 25% (normal 25-35%). The baseline thyroid-stimulating hormone (TSH) was 2.9 μIU/ml (normal < 8). Twenty minutes after 100 mcg TRH (protirelin) intravenously the serum TSH increased to 11.8 (normal rise: 2-20 μIU). Microsomal and thyroglobulin antibodies were negative. The thyroid gland felt normal on palpation. There was no evidence of thyroid disease.

Once again we urge caution in the routine clinical use of the FT_4-RIA in patients with relatively high or low T_3 uptakes. In such instances the FTI may be a more reliable measurement.

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Adverse Reactions to Radiopharmaceuticals

In 1980, a summary of adverse reactions reported by members of the Society of Nuclear Medicine was tabulated for the years 1976 through 1979 (1). The data summarized and reported in 1980

TABLE 1. COMPARISON OF THE TOTAL ADMINISTERED DOSES OF RADIOPHARMACEUTICAL FOR 1978 AND 1979

Radiopharmaceutical	Doses administered 1978	1979
Tc-99m SC	1,584,000	1,352,000
$^{99m}TcO_4^-$	1,392,000	1,648,000
Tc-99m MDP	800,000	1,104,000
Tc-99m PPi	384,000	264,000
Tc-99m HEDP	120,000	80,000
Tc-99m MAA	752,000	586,000
Tc-99m HAM	368,000	111,000
Tc-99m DTPA	488,000	482,000
Xenon-133	408,000	302,000
Tc-99m glucoheptonate	248,000	392,000
Ga-67 citrate	168,000	178,000
Tl-201 Cl	128,000	152,000
Orthoiodohippurate (I-131)	88,000	23,000
I-131 rose bengal	18,400	1,200
In-111 DTPA	2,400	6,400

TABLE 2. INCIDENCE OF ADVERSE REACTIONS TO RADIOPHARMACEUTICALS

Radiopharmaceutical	1979 Incidence	Range*
Tc-99m MAA	0.3	0.68–3.4
Tc-99m HAM	5.4	10.8–54.0
Tc-99m SC	0.69	1.3–6.9
Tc-99m DTPA	0.62	1.2–6.2
Tc-99m MDP	0.54	1.08–5.4
Tc-99m glucoheptonate	0.25	0.51–2.5
Tc-99m PPi	0.37	0.75–3.7

* Estimated range = 2N/no. of admin. to 10N/no. of admin., where N is the reported number of adverse reactions.

TABLE 3. COMPARISON OF THE INCIDENCE OF ADVERSE REACTIONS FOR 1978 AND 1979

Radiopharmaceutical	Incidence of adverse reactions 1978 (per 100,000)	1979 (per 100,000)
Tc-99m MAA	0.26	0.3
Tc-99m HAM	4.36	5.4
Tc-99m SC	0.82	0.69
Tc-99m DTPA (Sn)	—	0.62
Tc-99m MDP	0.12	0.54
Tc-99m glucoheptonate	0.81	0.25
Tc-99m PPi	0.52	0.37
$Na^{131}I$	0.71	—
Tc-99m HEDP	0.82	—
Tc-99m HSA	8.83	—
Tc-99m DTPA (Fe)	5.1	—