AN INTERRELATIONSHIP BETWEEN INFORMATION DENSITY AND RATEMETER STATISTICS

I am writing in reference to the recent "Letter to the Editor" by R. Sear and P. M. Dean, "Unidirectional Versus Bidirectional Scanning" and the reply by G. H. Simmons and J. G. Kereiakes of General Hospital, Cincinnati, Ohio (*J Nucl Med* 12: 768–769, 1971). The following represents my interpretation of an interrelationship between information density and ratemeter statistics which may shed some light on the problem.

Information density or count density (counts/cm²) has become accepted as a valid criterion for indicating the statistical validity of radionuclide imaging. When a rectilinear scanner is involved, another statistical parameter is apparent, that is, the ratemeter.

For one parameter to be valid, they must both be valid. One can derive a relationship between these two statistical situations if one is willing to accept the following relationship:

$$\sigma_R \leq \sigma_{CD}, \tag{1}$$

where σ_R = 1 s.d. in % as a function of counting rate,

σ_{CD} = 1 s.d. in % as a function of counts observed per cm².

This implies that the ratemeter statistics must always be better than or at least equal to the count-density statistics.

Through certain algebraic manipulations an intrarelationship may be established. Count density is given by

$$CD = \frac{R}{S \times L}, \tag{2}$$

where R is the counting rate, S the scan speed, and L the line spacing. The validity of count density may be determined from

$$\sigma_{CD} = \frac{100}{(CD)^{1/2}}, \tag{3}$$

whereas ratemeter statistics may be determined from

$$\sigma_R = \frac{\left(100\,\frac{R}{2tr}\right)^{1/2}}{R}, \tag{4}$$

where R is the counting rate and tr the time constant.

Squaring both sides and simplifying,

$$\sigma_{CD}^2 \times CD = 10{,}000. \tag{5}$$

$$\sigma_R^2 \times R = \frac{5{,}000}{tr}. \tag{6}$$

We may substitute for R the value CD × S × L from Eq. (2):

$$\sigma_R^2 \times CD \times S \times L = \frac{5{,}000}{tr}. \tag{7}$$

Returning to our basic assumption (Eq. 1), but requiring that $\sigma_R = \sigma_{CD}$, we may substitute σ_{CD} for σ_R from Eq. 7:

$$\sigma_{CD}^2 \times CD \times S \times L = \frac{5{,}000}{tr}. \tag{8}$$

We see from Eq. 5 that the quantity $\sigma_{CD}^2 \times CD$ is a constant, i.e., 10,000. Then

$$10{,}000 \times S \times L = \frac{5{,}000}{tr}, \tag{9}$$

and

$$S \times L = \frac{1}{2tr}. \tag{10}$$

Since 0.3-cm line spacing has become more or less standard, we can treat L as a constant. Then

$$S = \frac{1}{0.6tr}. \tag{11}$$

We now have an equation with two variables, which is a function of CD providing of course S is determined as a function of CD.

Obviously, we could meet our original criterion by using the longest time constant available. We then have the problem of scalloping. By accepting a number such as 3 mm for the maximum scalloping allowed, we can establish limits on the above equation for the maximum speed allowed for a given time constant. The formula itself will establish the minimum speed for a given time constant.

Using this system the table given on the next page was prepared for one model of the Picker Magnascanner. The values must be established for each instrument depending on the time constants available.

Scan speed range	Time constant
2–7	1.0
8–24	0.25
25–75	0.08
76–200	0.03
201–600	0.01

These data tend to confirm the contention of Simmons and Kereiakes. To be statistically valid, both the count density and the ratemeter must be operating under statistically valid conditions.

Two further complicating factors are the effect of the voltmeter (to the light source) response which is a function of both the ratemeter and the contrast enhancement, and the fact that the count density is normally calculated over the hot spot of the organ to be scanned. This, of course, can vary considerably, particularly as one approaches the periphery. Further investigation of these two factors, particularly the former, would prove quite interesting.

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HOT HEPATIC LESIONS ON LIVER SCANS

In their Case Report of a radiocolloid-concentrating lesion on liver scan, Coel, et al (*1*) request reports of similar cases since their patient never had a tissue diagnosis.

I would like to refer the authors to a report by Volpe and Johnston (*2*) of a similar case of a hot radiocolloid-concentrating lesion in a patient who had histologically proven breast carcinoma. On the basis of the scan, a diagnosis of hepatic hemangioma was entertained. This diagnosis was confirmed at laparotomy when the lesion was resected. There was no metastatic cancer in the liver.

Thus it would appear that one should hesitate before assuming a hot lesion on liver scan to be a metastatic focus—even in a patient with a known primary tumor. Even more important, on the basis of this one histologically documented case of such a lesion, one should probably consider percutaneous needle biopsy contraindicated as a means of establishing the diagnosis.

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REFERENCES

1. COEL M, HALPERN S, ALAZRAKI N, et al: Intrahepatic lesion presenting as an area of increased radiocolloid uptake on a liver scan. *J Nucl Med* 13: 221–222, 1972

2. VOLPE JA, JOHNSTON GS: Hot hepatic hemangioma: A unique radiocolloid-concentrating liver scan lesion. *J Surg Oncology* 2: 373–377, 1970

AUTHORS' REPLY

The authors wish to thank Dr. Lull for bringing to our attention the work of Dr. Volpe and Dr. Johnston. It would appear from this work that there is a good chance that the lesion in our patient's liver was indeed a hemangioma. Since hemangiomas involving the liver are not rare phenomena, one wonders why more of them are not visualized as hot. The authors agree with Dr. Lull that an area of increased uptake on a liver scan should not be interpreted as a metastatic focus.

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