REFERENCES

1. WENDT RE, MURPHY PH, CLARK JW, et al: Interpretation of multigated fourier functional images. *J Nucl Med* 23: 715-724, 1982
2. HAMILTON GW, WILLIAMS DL, CALDWELL JM: Frame-rate requirements for recording time-activity curves by radionuclide angiocardiography." In *Nuclear Cardiology: Selected Computer Aspects*. Sorenson, JA, Ed. The Society of Nuclear Medicine, New York, 1978, pp 75-83
3. Probability, Random Variables, and Stochastic Processes. Papoulis, A. New York, McGraw-Hill, 1965, pp. 390-490

Dependence of Distribution of Short-Lived Tracers on Decay. A Noncompartmental Approach

In the paper by Modell and Graham (*1*) it was shown that the single-compartment, well-mixed model is a not good predictor of Kr-81m behavior in the lung. The authors tried to explain the differences between the experimental data and theoretical curves generated from a single-compartment, well-mixed model by the inhomogeneity of Kr-81m distribution and its dependence on factors such as combinations of tidal volume and frequency and inspiratory time, but dependence of Kr-81m distribution on decay was not discussed. To assess the dependence of Kr-81m distribution on decay only, one can simplify the problem by considering a system of fixed volume V, where the input concentration is denoted by $I_{in}(t)$, the output concentration by $I_{out}(t)$, the amount of tracer in the system by I(t), constant flow by F, and decay constant by λ. Then

$$I(t) = F \cdot \int_0^t H(t-t')I_{in}(t') \exp[-\lambda(t-t')]dt' \quad (1)$$

$$I_{out}(t) = \int_0^t h(t-t')I_{in}(t') \exp[-\lambda(t-t')]dt' \quad (2)$$

$$(I_{in}(t) = 0 \text{ for } t < 0)$$

Where H(t) is the impulse response function and h(t) is the spectrum of transit times. Equations (1) and (2) may be reduced to the well-known equation

$$\frac{dI(t)}{dt} = F[I_{in}(t) - I_{out}(t)] - \lambda I(t). \quad (3)$$

This, assuming thorough mixing, i.e.:

$$V = \frac{I(t)}{I_{out}(t)}, \quad (4)$$

has been used as a starting point for almost all studies with short-lived tracers. In the case of constant infusion (I_{in} is constant) and the steady state defined by $\dot{I}(t) = 0$, one can combine Eqs. (3) and (4) to write:

$$I = \frac{F}{\frac{F}{V} + \lambda} I_{in}. \quad (5)$$

That is the result for a well-mixed, single-compartment model, as pointed out by Fazio and Jones (*2*). Using a noncompartmental approach [Eqs. (1) and (2)], the ratio between I(t) and $I_{out}(t)$ should be found to obtain a corrected version of Eq. (5),

$$I = \frac{F}{A + \lambda} I_{in}, \quad (6)$$

where,

$$A = \frac{\int_0^\infty e^{-\lambda t}h(t)dt}{\int_0^\infty e^{-\lambda t}H(t)dt}. \quad (7)$$

For long-lived radionuclides ($\lambda = 0$), A^{-1} reduces to

$$A^{-1} = \bar{t} = \frac{V}{F}, \quad (8)$$

where $\bar{t}$ is the mean transit time. In that case Eqs. (4) and (8) are the same, showing that the assumption of thorough mixing is strictly appropriate only in the steady state and with negligible decay. That is, only in such a case is the volume of the system is equal to the volume of distribution of the tracers, which is defined by Eq. (4). For short-lived emitters such as Kr-81m, A may be approximated by $\exp(-\lambda t)$ and the contribution of A may be negligible if λ is large. Hence from Eq. (6) we obtain the approximate relation:

$$I \sim \frac{F}{\lambda} I_{in}, \quad (9)$$

indicating a more nearly linear relationship between the amount of tracer (or concentration at fixed volume) in the organ and the flow for a short-lived tracer than the single-compartment, well-mixed model does.

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REFERENCES

1. MODELL HI, GRAHAM MM: Limitations of Kr-81m for quantitation of ventilation scans. *J Nucl Med* 23:301-305, 1982
2. FAZIO F, JONES T: Assessment of regional ventilation by continuous inhalation of radioactive krypton-81m. *Br Med J* 3:673-676, 1975

Reply

The noncompartmental analysis by Knešaurek represents an alternative mathematical approach to explain our observation that Kr-81m activity compared with ventilation is more nearly linear than is predicted using a well-mixed, single-compartment model. The major differences are in the impulse response function and the spectrum of transit times that are introduced in Knešaurek's Equations (1) and (2). The most reasonable impulse response function for Kr-81m activity in the lung is a simple step function. This would reduce to 1.0 for $t > 0$ and thus would essentially cancel out of Eq. (1). The spectrum of transit times, however, is likely to be a broad function correlating with the general inhomogeneity of ventilation, which, we felt, explained the discrepancy between our data and the single-compartment analysis. This may represent a starting point for a better quantitative approach to the analyses of ventilation inhomogeneity.

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Abnormal Perfusion Scan Due to Intrathoracic Stomach and Colon

There have been previous reports in the literature of perfusion lung scan defects caused by intrathoracic stomach (*1*) and