LETTERS TO THE EDITOR

Re: Determination of Left-Ventricular Volume from First-Pass Kinetics of Labeled Red Cells.

An analysis of the model proposed by Harpen et al. (*1*) to measure LV volume provides an opportunity to comment in disagreement with the authors and to offer a more explicit version of it.

First the disagreement: The activity of the bolus in the LV can be approximated by Eq. (1) in the paper, but Eq. (2) is not the integral (continuous) form of (1). Consequently in Eq. (1) the bolus activity in the LV is represented by the area under the sinusoid included between the envelopes D(t) and S(t). Equation (2) represents the whole area between D(t) and S(t), and thus provides a higher estimate of the LV bolus. This error is reflected in a peculiar conclusion that arises from Eq. (7): to the extent that as far as the activity in the LV bolus should be less than the total bolus activity, $2\alpha/(2-\alpha)$ must be less than one; then $\alpha \leq 2/3$. That is, the model provides an analytical restriction to the EF independent of clinical and physiological considerations.

Second, it is a simple exercise to demonstrate that if D(t) and S(t) are defined as in the paper, and they satisfy Eqs. (3) and (4), then the function:

$$I(t) = A_1 t^{(-at)} \sin(bt) + A_2 t^{(-at)}$$

represents the time-activity curve for a first-pass study. The first function on the right represents the modulated bolus activity in the LV, and the second one, the nonpulsating bolus activity (function B(t) in the paper). Using this expression, it follows that:

$$D(t) = A_1 t^{(-at)} + A_2 t^{(-at)}$$

$$S(t) = A_2 t^{(-at)} + A_1 t^{(-at)}$$

Also:

$$D(t) - S(t) = 2A_1 t^{(-at)}$$

$$\alpha = 2/[1 + (A_2, A_1)]$$

$$D(t) - S(t) = \frac{2\alpha}{2-\alpha} A_2 t^{(-at)}$$

$$= \frac{2\alpha}{2-\alpha} Bt$$

The empirical restrictions $A_2 > A_1$, implies only that $\alpha < 1$. If we apply the authors' restriction $\alpha \leq 2/3$, it follows then that $A_2 \leq 2A_1$, which cannot be justified from the model as a necessary condition on A_1, A_2.

F(t) could be a useful expression to model first-pass experiments, providing a model very appealing to intuition and the experimental conditions.

Finally, as a comment on the experimental results as discussed in this paper, I am convinced that contrast ventriculography is a too intricate method to evaluate, particularly, the extreme situations in Fig. 3. And, as is usual in this kind of correlation calculation, if you throw away the volumes less than 100 ml and higher than 300 ml, the straight-line correlation is no longer good.

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REFERENCES

1. HARPEN MD, DUBUISSON RL, HEAD GB, et al: Determination of left ventricular volume from first-pass kinetics of labeled red cells. *J Nucl Med* 24:98-103, 1983

Reply

We are puzzled at Dr. Vergara's criticisms of our manuscript (*1*). Equation (2) follows from Eq. (1) by the straightforward application of the definition of the definite integral. The integral in Eq. (2) is indeed the total area between curves D and S, it is also the activity ejected from the left ventricle when divided by the time per heart beat (ΔT).

There is no peculiar conclusion drawn from Eq. (7) if one correctly interprets total counts as the area under the bolus transit rather than the unattenuated count rate. The factor $2\alpha/(2-\alpha)$ is thus not required to be less than one, and consequently alpha is not required to be less than $\frac{2}{3}$.

It can be shown, however, that the accuracy of the method is improved in situations where the ejection fraction is low. This follows from the fact that the method assumes that the averaged left-ventricular activity is the average of diastolic and systolic activities rather than the true time-averaged activity, which can in many cases be obtained from the volume-time curve derived from gated blood-pool scans (*2*). The difference between these two averages is diminished when the volume-time curves possess symmetry, as the sinusoidal curve in the preceding letter, or when the ejection fraction is low.

As a final comment, I would like to mention that while contrast ventriculography is indeed an "intricate" procedure, other investigators have managed to obtain excellent correlations between it and radionuclide procedures for the determination of left-ventricular volumes. For example, in Massie et al. (*3*) r = 0.98, Bourguignon et al. (*4*) r = 0.96, Clements et al. (*5*) r = 0.98, Links et al. (*6*) r = 0.95, and Grenier et al. (*7*) r = 0.98.

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REFERENCES

1. HARPEN MD, DUBUISSON RL, HEAD GB, et al: Determination of left-ventricular volume from first-pass kinetics of labeled red cells. *J Nucl Med* 24:98-103, 1983
2. HUTTON BF, BAUTOVICH GJ, CORMACK J: Determination of absolute cardiac ventricular volume using radionuclide techniques. (Lett). *Phys Med Biol* 26:715-718, 1981
3. MASSIE BM, KRAMER BL, GERTZ EW, HENDERSON SG: Radionuclide measurement of left ventricular volume: comparison of geometric and counts-based methods. *Circulation* 65:725-730, 1982