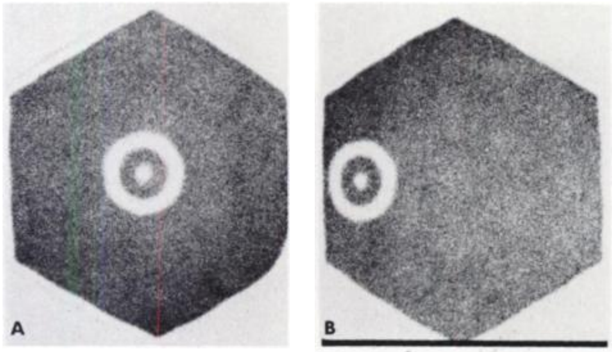

FIG. 1. Example of our most severe formatter nonlinearity. Co-57 field flood with 10-cm (outer diameter) disc. Single-image format and 1 million counts/image. Camera linearity was within specifications. (A) Disc in center has no distortion. (B) Disc in periphery has distortion in x-axis. When positioned in other peripheral areas, this distortion changed and in some places affected y-axis linearity.

evaluation of the performance of quality imaging in the clinical setting. It is essential when viewing an imaging system, however, not to look only at the detector. The image formatter is one of the critical elements in the total imaging system and when evaluation of the hardcopy device is excluded, any discussion of camera performance is deficient.

Recently we were reminded of this fact when at each of our institutions several of our vendors' image formatters, when carefully evaluated, showed a 7–25% distortion on the peripheral, yet useful, field of view (Fig. 1). A detector linearity of ±1% is quickly overshadowed by a formatter nonlinearity of 10%. As far as we could determine, most manufacturers have no specifications for formatter linearity. It is important that the industry recognize this shortcoming and establish strict manufacturing, sales, and maintenance specifications for all hardcopy devices. With this more encompassing information the nuclear medicine laboratories will have a method for the evaluation of imaging systems as a whole rather than for the detector alone.

MANUEL L. BROWN
WILLIAM L. DUNN
Mayo Clinic
Rochester, Minnesota

MICHAEL TUSCAN
University of Michigan Hospital
Ann Arbor, Michigan

Re: ECG Gating: Does It Adequately Monitor Ventricular Contraction?

In his editorial on ECG gating (*1*), P. H. Murphy complains that "... commercial systems today reject cycles following the one irregular beat." Which "is ordinarily accepted." The implication is obviously that the contraction that precedes the extra systole (ES) is abnormal. This would be the case, however, only if the heart itself knew that an ES would follow.

Actually, if the average cycle is 16Δ, and if the ES occurs at the time $n\Delta T < 16\Delta T$, all the data collected between 0 and $n\Delta T$ are those of an average but interrupted cycle. No data are obtained for that beat during the interval $n\Delta T$ to $16\Delta T$. The net result is an undersampling in the later intervals but not an error in the earlier intervals.

Correction can easily be made by recording the number of average cycles sampled in each interval and normalizing on this basis. No blurring should result. A clue to the apparent confusion is given by a paper in the same issue (*2*). In their computer simulation these authors assumed three RR intervals, each of them corresponding to a complete sinusoidal contraction. This model differs from reality by simulating the behavior of a heart adapting to an event that has not yet occurred. In truth, the heart does not know that an ES will follow.

MICHAEL GORIS
Stanford University
School of Medicine
Stanford, California

REFERENCES

1. MURPHY PH: ECG Gating: Does it adequately monitor ventricular contraction? *J Nucl Med* 21: 399–401, 1980
2. BRASH HM, WRAITH PK, HANNAN WJ, et al: The influence of ectopic heart beats in gated ventricular blood-pool studies. *J Nucl Med* 21: 391–393, 1980

Reply

The comments by Dr. Goris on my teaching editorial on ECG gating are interesting and most appreciated. He proposes a mechanism for partial compensation of the errors contributed by the collection of irregular cycle lengths in the composite ventricular volume curve. As discussed in my paper, there are several mechanisms for correcting data obtained from nonuniform cycle lengths, but usually they require list-mode acquisition and subsequent data framing. Most nuclear medicine computer systems do not include mechanisms for correction of irregular cycle lengths in their cardiac protocols. Dr. Goris states that I "complain" that commercial systems today reject cycles following the initiating irregular cycle (which is accepted). This is the case, and even if the contraction phases of this cycle are normal, the addition of this data to the composite cycle distorts the curve shape and causes inaccuracies in the calculation of the ejection fraction. In the paper by Brash, et al. that Dr. Goris references these errors are emphasized (*1*). In fact, Brash et al. state several times that the ectopic beats and the postectopic accentuated beat must be excluded from the analysis in order to avoid errors in the shape of the volume curve and the value of the ejection fraction. Dr. Goris suggests that "correction can easily be made by recording the number of average cycles sampled in each interval and normalizing on this basis." This position assumes that the ventricular contraction up to the beginning of the extra systole is completely normal with respect to its time distribution, and it also assumes that there is never an initiating irregular cycle that is longer than the the selected R-to-R range. In the context of R-wave gating irregular beats relate to the time interval of the R-to-R interval and not to the characteristics of the muscular contraction itself. The computer measures only the R-to-R interval, and therefore rejection or acceptance of a beat is based only on this time measurement. It appears that the concept proposed by Dr. Goris that "the heart does not know when an extra systole will follow" is true, and his correction scheme would be valid in the most common circumstances of irregular cycle lengths, i.e., premature ventricular contraction, but not as a universal solution to the problem.

PAUL H. MURPHY
Baylor College of Medicine
St. Luke's Episcopal-Texas Children's Hospital
Houston, Texas

REFERENCE

1. BRASH HM, WRAITH PK, HANNAN WJ, et al: The influence of ectopic heart beats in gated ventricular blood-pool studies. *J Nucl Med* 21: 391–393, 1980