keV radiation. Their improved efficiency is particularly apparent in the case of the small detectors required in the circular geometry. BGO detectors are now commercially available and are used in several x-ray CT systems (AS & E, Ohio Nuclear, and Picker). Both the investigators cited are now planning the construction of such devices. Thompson and coworkers (*14*) at Montreal have abandoned their NaI circular-ring tomograph and have constructed and are using a BGO circular-ring system.

An advantage of the circular tomograph in a *stationary* mode is that when activity is moving around during the imaging time, the final image represents a linear superposition (i.e., smooth blurring) of the various redistributions that took place without the "sharp" motion artifacts that are characteristic of CT devices. However, the redundant sampling of the ECAT (*1*) also accomplishes this to a major degree. The redundant sampling of the ECAT has also been shown to provide unique protection against detector instability and motion artifacts, and improves signal-to-noise ratios in the image (*1*).

If a circular tomograph uses detectors that are either stationary or shift half the distance between detectors, a very short imaging time is mechanically possible. It has yet to be proven that the 10-sec scan mode of the ECAT poses any limit in mechanical scan times that exceeds the limits imposed by statistical requirements.

We would like to reiterate that our comments (*1*) were not against a general design concept of a multiplanar ECT system. A *properly* designed ECT system will ultimately be limited in resolution and contrast by its detection efficiency. As opposed to x-ray CT, which irradiates mainly the plane under study, all the potential planes in ECT are being irradiated whether they are imaged or not. It seems only logical, therefore, to try to use this information. The problem is not easily solved, however, and different design options must be carefully analyzed, and tradeoffs made, to optimize the overall system performance within realistic design constraints, considering the problems particular to CT and the types of studies for which the system will be used.

When one examines the parameter of efficiency he must consider: a) the total system efficiency; b) the efficiency per plane (or image); and c) efficiency for the organ under study. The system efficiency tells how efficient the system is when activity covers the entire field of view. The per-plane efficiency gives the efficiency per image. The last factor tells how much of the system efficiency will be used to image the organ of interest. Present multiplane imaging systems employ only 40-70% of the *system efficiency* for heart and brain studies, since the remainder of the planes are outside the organ of interest. A single-plane system, on the other hand, inherently has a design objective of maximizing the efficiency both per image and for the target organ. In addition, multiple-plane systems must be carefully designed to avoid gaps between planes [the multiplane system of Muehllenhner et al. (*4*) has continuous or redundant planes], or to provide appropriate spacing (by moving the patient) to allow interplane images to be recorded in a contiguous fashion, or with some appropriate overlap, to optimize axial sampling (i.e., to minimize partial-volume effects). Along with efficiency values, one should provide that portion caused by scatter and random coincidences, since these events provide counts but little or no information. The resolution at the stated efficiency should also be given.

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Optimization of Analog-Circuit Motion Correction for Liver Scintigraphy

Baimel and Bronskill (*1*) have presented an interesting mathematical proposal, though whether it will significantly improve the accuracy of reading liver scintigrams in clinical practice is another matter. Their sweeping conclusion that *all* cameras should be provided with analog motion correction is a little premature, particularly when their paper does not contain even a solitary pair of liver scintigrams—with and without their motion correction. This is in spite of their studying 52 patients and the claim that in seven cases (13%) the clinical interpretation was changed. Moreover, they do not state whether any of the 52 scintigram reports were confirmed by either operative or autopsy findings. Also, it appears from their text (p.1064) that the clinical evaluation was made by a single nuclear medicine

clinician. Surely, before making their positive recommendation for *all* cameras, some attempt should have been made to enable the results to be assessed by a panel rather than by a single clinician only.

Furthermore, their "liver phantom of average size (17 cm × 17 cm)" (no scintigrams of which were shown) in which "the focal lesion was simulated using various thicknesses of aluminum discs, 2 cm in diameter" is probably not very realistic clinically, unlike that used by the United Kingdom DHSS (*2*). A liver of average shape is difficult to define, as can be seen from the literature (*3, 4*), and a better policy might have been to adapt the DHSS phantom so that three or four of the most commonly occurring normal variants of liver shape had been available.

Baimel and Bronskill also concluded that since 256 of 1973 (13%) Ontario Cancer Institute liver studies had been read as equivocal or suspicious during 1975–76, motion correction could be of *considerable* benefit in that institute. Without a detailed followup analysis on as many of the 1975–76 patients as possible, and a resulting assessment of false-positive, false-negative, and equivocal reports, no such strongly worded statement should be made.

Finally, since the liver is a large organ of variable thickness, I am not fully convinced that the displacement of its periphery is the same as that of the center of activity within the liver. If the motion is more complicated than that assumed by Baimel and Bronskill, motion correction will in turn become more complicated—although, we hope, not to the extent that an increase in false positives will occur! Perhaps, therefore, while we are investigating new mathematical tools we should find it rewarding and informative also to assess in detail our present diagnostic efficiency in liver scintigraphy. For example, are we really seeing a 2-cm tumor when we think we are? Such an exercise, involving good prospective record keeping of patient data, including any subsequent followup for eventual correlation studies, could in itself lead to a reduction in the number of equivocal scintigram reports—even without any liver-motion correction. This suggestion also has the advantage that only a minimum of mathematics is required!

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Reply

Our article (*1*) described a general mathematical model for analog motion-correction circuits. The validity of this model was verified by experimental measurements and a simple detection test that simulated clinical liver scintigrams. The purpose of our article, as clearly stated in the title, was to provide a general technique for optimizing the performance of analog-circuit motion correction.

I draw Dr. Mould's attention to the work of Turner et al. (*2*), which was published before our article. They not only showed liver scintigrams with and without motion correction, but they also analyzed liver scintigrams for 102 patients in which the true state of the liver was established. Their results with five observers were expressed as receiver operating characteristic curves and their conclusion was that "analogue motion correction is an effective, inexpensive method for improving hepatic scintigraphy with a scintillation camera." With this background information available, I do not find at all "premature" our conclusion that analog motion correction be provided in all scintillation cameras used for liver scintigraphy.

Our liver phantom was constructed to duplicate the film-density distribution measured from a liver scintigram of a patient with a normal liver. To that extent our phantom certainly was "clinically realistic." The DHSS phantom may well be a more common (and commercial) variant; its use in our experiments would not change our results or conclusions.

Because a large fraction (13%) of our 1975 and 1976 liver studies were interpreted as suspicious or equivocal, we considered as worthy of comment the indication that motion correction is most likely to clarify the interpretation of suspicious or equivocal. We were merely pointing to a large fraction of our liver scintigraphy studies in which we believed motion correction *could* be of benefit. The adjective "considerable" was apparently too strong for Dr. Mould. Although about 10% of our liver images are still obtained with a rectilinear scanner, we have observed, since implementing analog motion correction, a decrease in the fraction of total liver images interpreted as suspicious or equivocal from 13% to 10.5% (206 out of 1967) in 1977 and to 7.5% (139 out of 1863) in 1978. I consider this benefit worth considering (i.e., "considerable").

Dr. Mould's final paragraph restates the basic assumption of analog motion correction: that only translatory motion of the organ occurs. I, too, am not convinced that the motion of the periphery of the organ is the same as the motion of the center of activity. The fact remains that, within this limitation, properly executed analog motion correction is a simple, effective, and inexpensive technique for improving spatial resolution in liver scintigraphy.

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Reticuloendothelial Distribution of a Colloid-Like Material in 6β-[^{131}I]-Iodomethyl-19-Norcholesterol (NP-59)

We have recently observed a previously unreported occurrence involving the apparently reticuloendothelial distribution of a colloid-like impurity in the adrenal imaging agent 6β-[^{131}I]-iodomethyl-19-norcholesterol (NP-59). The radiodiagnostic agent* was obtained as 6β-[^{131}I]-iodomethyl-19-norcholesterol in 1.5% polysorbate (Tween 80) and 6.6% absolute ethanol, in a final specific concentration of 2.33 mCi/ml at the time of calibration. Sterility and limulus lysate pyrogenicity testing, performed in our department, proved negative. A radiochemical purity check with ITLC-silica gel media and normal saline