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The Good, the Quick, and the Inexpensive

In this age of increasing costs of medical instrumentation and procedures, sight is very often lost of the lesser things that can be done within a nuclear medicine department to improve the quality of studies. All too often it is felt that large expenditures for instrumentation will solve all problems. There are many studies, to be sure, that do require sophisticated devices. Nevertheless, there are other expedients to improve study quality within nuclear medicine, either using existing data-processing facilities or without data processing of any sort.

An excellent example of the use of the existing facilities is described in an article in this *Journal* issue under the title "Improvement in Visualization of Hepatic Lesions with Upright Views." The people who have used this technique report an improvement in the quality of their liver scans. Their approach raises the obvious question as to what else can be done in a nuclear medicine department without the expenditure of large amounts of money (say, over $5,000) to improve study quality. Although a complete review of all facets of a nuclear medicine department is not possible in a limited space, a few major considerations can be discussed.

Referring back to the current article on the liver, other expedients for the improvement of liver scans exist. A number of years ago, the group at the University of Chicago developed a rather simple analog device for motion correction (*1*), and it has recently become commercially available. The original studies with this device indicated that only a small increase in the detectability of lesions could be expected, and indeed such has been the case. In our laboratory, only a handful of cases have been uncovered where the original lesion was not seen on a standard scan but was later identified on a motion-corrected study. What has been more surprising, however, has been the degree of confidence that has developed in calling equivocal lesions. Some that would have been borderline without motion correction are called with a greater degree of confidence on the motion-corrected study. Although these findings have not been documented with ROC curves, they do represent a clinical observation.

Indeed, a much less expensive means of motion correction for the liver exists: simply have the patient hold his breath at either inspiration, mid-inspiration, or expiration. (Prevention is better than cure!) Generally, given a cooperative patient and a modern camera, images containing 100,000-200,000 counts can be obtained by suitable breath holding. While it may be unusual to do a complete liver image by this technique, repeating equivocal views should further improve lesion visibility. This technique is also useful to establish whether a filling defect in the liver is intra- or extrahepatic. The use of views at inspiration and expiration will demonstrate whether the defect moves with the liver (*2*).

Perhaps the most easily accomplished changes that result in improved study quality lie in the area of film selection. There are now a number of films available for image display. Previously we were restricted to one type or at most a limited choice of films. There is now a good deal of evidence to suggest that films with wider gray scales may make lesion detection easier. Optimum counts to be collected with different types of film have also been worked out such that the optimum image counts for the type of film in use can be approached (*3*).

The cost of film conversion is not high—indeed, there may be some ultimate saving, depending on the type of film currently in use. Although many individuals feel that the purchase of a multi-thousand dollar, multiformat device is necessary to switch film, such is certainly not the case. While multiformat devices provide a significant advantage in a high-volume department where film

changing is cumbersome, in those departments of lower volume, a simple substitution of a different oscilloscope camera, capable of handling the type of film desired, may be all that is necessary.

In the realm of instrument modification, most of us realize the significant advantages offered by multiple, rather than single, energy windows for nuclides such as gallium-67, indium-111, and thallium-201. Indeed, most rectilinear scanners and many scintillation cameras can be equipped with additional pulse-height analyzers at a cost under $5,000. The effect of going to multiple pulse-height analysis from a wide-window or integral scanning system is to reduce significantly the off-target scatter accepted by a window, and therefore to subsequently improve the image (*4*). The resulting improvement in image quality and lesion detection is certainly worth the small investment.

As more and more institutions become wholly or predominantly dependent on scintillation-camera imaging, many of the old and good rules that have governed the use of rectilinear scanners fall by the wayside. Although quality control for scintillation cameras is often discussed, one questions whether it is widely applied. Certainly very few institutions apply any quality control to their moving-table camera systems, and it has been our experience that significant system malfunctions are required before the observer notices them. The simple scanning of standard phantoms on a moving-table system will often disclose resolution losses and misalignment between the different passes.

Those of us who were trained in nuclear medicine in the age when the rectilinear scanner was predominantly employed will remember the emphasis placed on information density. In spite of the fact that at least two camera manufacturers currently offer information-density options as part of their package, the clinical use of such devices is woefully neglected. In our laboratory, we have been pleasantly surprised with the improvement in image quality when information-density policies were adopted instead of the full-field count. This has been particularly true in the case of gamma-camera brain scans where the traditional problems of how much facial activity is in the image can be totally obviated by the use of an information-density approach.

These systems may be adapted to moving-table camera systems as well. Although the manufacturer's direct interfacing is abandoned, significant improvement in image quality is obtained by the creation of information-density tables for the moving-table system (*5*). The intrusion of kidneys or of abnormal areas of increased skeletal activity is totally eliminated by the use of information-density scanning. Highly reproducible scans are obtained time after time, with maximum film density turning out as desired by the observer. Again, the cost of this type of modification to the camera, especially if made at the time of purchase, is well under $5,000.

A number of camera manufacturers currently offer automated uniformity correction systems as part of their camera packages. Although we do not propose to comment on the desirability of uniformity correction, certainly people who feel it necessary can now have it without the purchase of free-standing data-processing units.

Perhaps last but not least, one of the major aids toward good gamma-camera performance is the practical availability of an appropriate selection of collimators. Although the purchase of a medium-resolution, medium-sensitivity collimator may seem like a good compromise permitting use of one collimator for all applications, this is generally not the case. Especially in the cameras with 15-in. field of view, multiple collimators are desirable. There are situations, such as in dynamic studies, where image quality is dependent more on statistics than on the intrinsic resolution of the collimator system. Conversely there are static studies in which the resolution of the collimator has predominant weight in the detectability of lesions.

The introduction of converging collimators—and their applications to brain, cardiac, and other special imaging studies—further increases the desirability of having several collimators available. For these reasons, as well as those related to nuclide energy, the use of the appropriate collimator for a study is as important as the planning of the number of views and positions to be used.

No less important to the practice of good nuclear medicine are those procedures to be performed in the in-vitro laboratory. Here again, relatively minor expenditures—or no expenditures at all—may result in significant improvement in the quality of output information.

The small touch of the proper collection of the patient's samples—especially with reference to the handling of samples of CEA and renin—can result in a huge improvement in the reproducibility and reliability of laboratory data.

The investment in pH meters, pipette calibrations, and small automated pipetting devices, vastly increases the reliability of most RIA procedures.

The quality control of well counters, generally a sadly neglected area, is essential. Significant shifts in the energy resolution of the detector systems within these counters often goes undetected until gross errors occur.

In short, there are many things within each nuclear medicine laboratory that, with the expenditure of little or not funds at all, can result in improved diagnostic quality of both in-vivo and in-vitro studies. A walk through your own laboratory on any given day will suggest a number of minor changes that can be made to increase the effectiveness of the procedures employed.

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