EDITORIAL

Imaging—Future Perspectives

In the 1950s continuous-flow automated analysis of clinical chemistries ushered in a new and basically different approach to diagnosis in medicine. This single advance heralded an unprecedented period in the development and utilization of technology in medical laboratories. Also in the 1950s rapid technological development in imaging was initiated when contrast angiography was applied to multiple organ systems. The 1960s witnessed the explosive development of nuclear medicine, and the 1970s are stamped by the dramatic impact of transmission computerized tomography and ultrasound. Now in the decade of the 80s there is again the promise of new, exciting, and beneficial imaging modes, namely, digital subtraction angiography (DSA) and nuclear magnetic resonance (NMR). With the development and acceptance of these modes, one principle is prevalent, i.e., they are "noninvasive." The ability to demonstrate pathology without resorting to diagnostic methods that usually require hospitalization and are associated with some degree of morbidity or mortality has been a major stimulus to the research, development, and marketing of the necessary instrumentation. As each new modality of imaging has gained acceptance for routine use, previous diagnostic modalities have been modified in techniques, applications, and usefulness that contribute most beneficially. To plan intelligently the future direction of technology with respect to space requirements, instrumentation, personnel, and research, it is mandatory that we prognosticate the various aspects of the contributions and impact of newer imaging modes.

In the 1980s digital subtraction angiography and nuclear magnetic resonance will add to our diagnostic acumen. What will be their impact? What previous procedures will become obsolete? The answers to these questions may be speculative; however, certain factors are relatively obvious. In the immediate future, digital subtraction angiography will contribute impressively to diagnoses that can be made from data obtained in blood-pool and larger vessel imaging. This technique will have a significant effect on the diagnosis of pathology of the neck vessels, vascular abnormalities of the brain (aneurysms, arteriovenous malformations, and highly vascular tumors), major pulmonary, renal, and intestinal vessels, and the differential diagnoses of chest masses based on their vascular patterns.

Recent studies have shown that for carotid artery lesions the sensitivity and specificity achieved by DSA is greater than 97% when compared with selective carotid arteriography. In the detection of pulmonary emboli, visualization of the right ventricle, pulmonary outflow tract, main pulmonary arteries, and possibly first and second order vessels has been accomplished. In the abdomen, visualization of aortic aneurysms, of the main renal arteries for the evaluation of hypertension, and the studies of revascularization following surgery have been excellent. Future renal applications may include quantitation of the functional compartments of the kidney. Localized peripheral studies for the evaluation of surgical by-pass procedures in the aorto-iliac-femoral area are gaining clinical usage. DSA combined with ECG gating provides the ability to determine cardiac ejection fractions, output data, and the assessment of wall motion. A significant application is the identification of coronary bypass grafts. Future advances may include conversion of digital data to timed physiologic studies including arterial flow, compartmental anatomy, and appearance times and clearance times. As with all new procedures there are associated problems. In digital subtraction angiography, exact registry is required—i.e., no patient motion can be accepted; all vascular pathways are visualized, thus the information sought may be obscured by multiple vessels; and patient sensitivity to iodinated contrast media remains a problem. In studies to date, at least 70% are acceptable for diagnostic purposes. Equipment for digital subtraction angiography is presently available, and if an excellent angiographic radiology suite exists, then the equipment required can be added at a relatively modest cost. It appears likely that most medical centers and larger hospitals and undoubtedly many smaller community hospitals will have installed this equipment within a few years. Thus, this newer, excellent diagnostic modality, already in limited use, must be considered in future planning.

Nuclear magnetic resonance holds great promise for both the near and more distant future. Although its potential as a diagnostic imaging mode is not as well defined at this time as is that of digital subtraction angiography, again the principle involved and the results available document its usefulness. In the realm of application within the near future, sampling techniques of NMR could be applied to study ischemic vascular disease of the extremities and the response to surgery, as well as cerebral response to therapy. An early possibility is the measurement of the change in T_1 before and after injection of a paramagnetic relative to a metallic ion, such as manganese, as a potential for measuring blood flow. Another procedure that has been proven is T_1 and T_2 proton NMR signal that reflects the state of water (amount) that varies with the pathology of tissue. Other applications of nuclear magnetic resonance, such as measurement of diffusion in blood flow from the proton signal and determination of the chemical state of calcium and phosphorous in bone, require further development, but in all probability will eventually become realities as diagnostic procedures. The unique feature of NMR is that it provides information on the chemistry of tissues. NMR researchers believe that proton images can be obtained that are comparable to those of transmission computerized tomography.

We in nuclear medicine should carefully assess the potential of these newer imaging modes of the 80s and plan our responsibilities and objectives accordingly. Since the advent of transmission computerized tomography and of ultrasound in the 70s, we should have as our goals the development of radiotracers that define dynamic processes, supported and augmented by improved image displays of these processes by means of tomography and computer processing. There are many areas of investigation that will prove valuable for routine clinical application. Tracers for the various metabolic cerebral pathways in disease and therapy could be defined by emission tomography. Similar types of tracers for the evaluation of myocardial, hepatic, and renal diseases can be developed. Possibly the most promising area of the application of radiotracers for the diagnosis of disease and the measurement of the progress of therapy is the application of immunological principles. The development of radiolabeled antibodies to tumor-associated antigens and tumor products has been proven to be a very viable approach to the in vivo diagnosis and therapy of cancer. Extension of these methodologies to bacterial, mycotic, and parasitic diseases; autoimmune diseases; degenerative diseases; etc., is obvious. The possibilities of the application of radiotracers are essentially unlimited. Organization of our efforts and pragmatic assessments of our goals will extend the rewards of nuclear medicine to greater and even now unanticipated improvements in medical care.

FRANK H. DELAND
EDITOR