1980
YEAR BOOK OF
NUCLEAR MEDICINE

QUINN

The YEAR BOOK of

Nuclear Medicine

1980

Editor

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Introduction

The first volume of the YEAR BOOK OF NUCLEAR MEDICINE was published in 1966, and the publishers gave me the privilege of being the Editor. This is my 15th year as its Editor. It now seems right that the helmsman be changed; this will give us new leadership as our speciality gets buffeted about on increasingly unfriendly seas that want to fragment us into nuclear subspecialities and drown us in the morass of overregulation.

As I leave, I wish to thank all of you who have helped to keep this volume alive and well. The criticisms by early reviewers sometimes stung but were never unkind.

It has been a great pleasure for me to have worked these many years with a keen publishing team. Thanks to all, and good health to you and yours. *Ut in omnibus glorificetur Deus.*

JAMES LELAND QUINN, III, M.D.

Radiation Physics and Instrumentation

Relationship of Nuclear Medicine to Other Diagnostic Studies is discussed by C. Douglas Maynard[1] (Bowman Gray School of Medicine, Winston-Salem, N. C.). In many institutions nuclear medicine is a division of the Radiology Department. This is particularly true with regard to imaging procedures and is widely observed in nonteaching hospitals. Both imaging and in vitro studies sometimes are part of the Pathology Department, but more often the in vitro studies are incorporated into the clinical laboratories as part of the Pathology Department. Often it is necessary to perform tests in a particular sequence to avoid unnecessary procedures. Multiple independent units within an institution tend to promote duplication of personnel. Each unit vies for space and equipment. The problem of self-referral also arises. The complexities of educational programs have increased greatly with the development of the new technologies. Some of the most difficult problems anticipated in the coming years are in the area of clinical research, including identification of the point at which a given technique moves from the realm of clinical research to that of a clinically practical procedure.

One approach would be directed at organ systems that in some way adequately amalgamates all tests into one administrative unit. Perhaps ultimately all diagnostic procedures within an institution could be administered under a single unit, the Division of Diagnostic Studies, composed of a number of smaller divisions arranged to fit the functional needs of the particular institution. The success of nuclear medicine is directly related to its functioning as an integral part of the larger diagnostic area.

► [Sometimes I feel like the future has already passed me by. Perhaps I

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(1) Semin. Nucl. Med. 9:4–7, January, 1979.

should shorten my "time constant" to be able to react while the ball is still over the plate.] ◄

Comparative Sensitivity of CT Scans, Radiographs and Radionuclide Bone Scans in Detecting Metastatic Calvarial Lesions. About 50% demineralization is necessary before lytic calvarial lesions can be visualized by skull radiography, and lesions less than 1.5 cm in diameter often are missed. Nuclide bone scans, in contrast, depend on increased osteoblastic activity. Daniel K. Kido, Robert Gould, Farshid Taati, Andrew Duncan and James Schnur[2] (Harvard Med. School) evaluated the sensitivity of computed tomographic (CT) scans for demonstrating metastatic calvarial lesions in patients suspected of having intracranial metastatic deposits. One hundred patients with histologically diagnosed extracerebral neoplasms who were suspected clinically of having cerebral metastasis were examined with an EMI-Mark 1 head scanner. Radionuclide bone scans were made with the use of ^{99m}Tc-methylene diphosphonate. Skull radiographs also were reviewed.

Thirty-two patients had metastatic calvarial deposits demonstrated by at least two of the three techniques used. The most common metastatic tumors were breast cancer and lung cancer. Lytic, blastic and mixed calvarial lesions were detected by CT scanning; lytic lesions were the most common type and were often solitary. Some calvarial lesions had a soft tissue component that was viewed only at a wide window width and a low window level. Multiple lytic lesions were infrequent but were easily diagnosed. Blastic calvarial lesions were infrequent; most involved a relatively large segment of calvarium. Skull radiographs were falsely negative in 35% of cases. Bone scans detected 3 lesions that CT scans did not demonstrate, whereas CT showed 2 lesions not seen on bone scans. Patients with calvarial metastasis had demonstrable intracranial lesions on CT study in 34% of cases.

The sensitivity of CT in detecting metastatic calvarial lesions has not been appreciated fully. It is more accurate than skull radiography in detecting metastatic deposits, but care is needed in specifying an etiology. The use of CT

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(2) Radiology 128:371–375, August, 1978.

should reduce the need for radiographic skull series and brain scans.

► [The numbers are interesting. It is too bad, however, that the authors did not include at least one representative study in their figures.] ◄

New Transverse Section Brain Imager for Single-Gamma Emitters. Peter H. Jarritt, Peter J. Ell, Melvin J. Myers, Nicholas J. G. Brown and Judith M. Deacon[3] (London) have compared the results obtained with a new emission transverse-section tomographic scanner with images of the same patient obtained with conventional gamma camera and x-ray CT methods. The Cleon-710 Imager was the object of study. Resolution at the center of the field is 9 mm for this tomoscanner, compared with 18 mm for the earlier tomoscanner and 11 mm for the rotating camera. The sensitivities are 36K, 15.4K and 1.9K, respectively, in terms of cps/Ci-ml. The crystal areas are 3,096, 619 and 490 sq cm. No false positive results were found when 40 brain scans were analyzed in conjunction with x-ray transmission tomography. All but 1 of 15 lesions seen by the CT x-ray scanner were detected by the emission tomographic scanner and 12 by standard gamma-camera imaging. One false negative result, a cyst, was obtained by the transmission x-ray scanner but not by the emission scanner.

A section image permits separation of a feature of interest within an organ from neighboring structures. The high sensitivity of detection of mass lesions in the brain at a low radiation dose underlines the potential screening role of the emission approach. The radiation dose is one twentieth of that delivered by scanning with x-ray transmission techniques. Much of the success of emission tomography will depend on the development of new radiopharmaceuticals and short-lived emitters. Scanning systems may offer a more artifact-free reconstructed image because of the inherently more uniform method of data acquisition used. Whichever system is used, it must be capable of sectioning an organ to give a map of quantitative tracer concentration with high resolution and accuracy. The removal of superimposed information allows the measurement of aspects of function not possible in the past.

► [Time will tell what the value of this new transverse section brain im-

(3) J. Nucl. Med. 20:319–327, April, 1979.

ages will be, but the pictures and the retrievable data are impressive. You should check back in about 10 years.] ◄

Emission Computerized Tomography: New Diagnostic Imaging Technique was evaluated by P. J. Ell, P. H. Jarritt, J. Deacon, N. J. G. Brown and E. S. Williams[4] (Middlesex Hosp., London). Emission computerized axial tomography (ECAT) is a new noninvasive imaging technique, which was first applied to the brain and now to the body. Radiation emitted from the organ and recorded by scintillation detectors is used for image processing, rather than absorption coefficients as in transmission computerized tomography (EMI type of imaging). A Cleon-710 transverse-section brain imager comprising twelve detectors was used. Up to eight slices can be scanned automatically. Over 80 patients were initially studied with ^{99m}Tc-labeled nuclides.

No false positive results were obtained in a series of 40 brain scans. All but 1 of 15 lesions diagnosed on the EMI scanner were seen on emission scanning, and 12 were also detected by conventional gamma-camera imaging. One cyst was missed by ECAT. Forty patients having routine bone scanning with bone-seeking ^{99m}Tc-labeled phosphate nuclides also underwent ECAT. Uptake values in the skull in 20 patients with suspected metabolic bone disease were 2–10 times above the calculated normal range.

The early results of ECAT are very promising. The method appears to be sensitive in detecting mass lesions in the brain at one twentieth of the radiation dose resulting from conventional EMI brain scanning. The technique therefore has potential for screening. Emission tomography can be described as in vivo autoradiography. Percentage of uptake per volume of tissue is easy to calculate, and the accurate calculation of flow indices in terms of ml/minute/gm of tissue can be foreseen. The results obtained for uptake of bone-seeking nuclides show the clinical potential of this approach.

► [This is the earlier report from the same group of investigators who wrote the preceding article.] ◄

Validation of Tomographic Measurement of Cerebral Blood Volume with ^{11}C-Labeled Carboxyhemoglobin. M. E. Phelps, S. C. Huang, E. J. Hoffman and D. E.

(4) Lancet 2:608–610, Sept. 16, 1978.

Kuhl[5] (Univ. of California, Los Angeles) performed in vitro studies in dogs and rhesus monkeys to compare regional cerebral blood volume (CBV) measurements made with the use of ^{11}CO-red blood cells and ^{51}Cr-labeled red blood cells. Studies also were done in human beings after a single-breath inhalation of ^{11}CO gas to determine the accuracy and reproducibility of the in vivo tomographic measurement of CBV. Red blood cells were labeled in vivo with ^{11}CO by administering an admixture of ^{11}CO and oxygen gases. Clinical studies were done in 5 men, aged 22–27, given 10–15 mCi ^{11}CO. Tomographic studies were done with a positron transaxial tomograph.

Studies in 4 dogs and 2 monkeys yielded an average ratio of CBV values by the ^{11}C and ^{51}Cr techniques of 1.02 $\pm$ 0.03 in 92 samples. The ratio of CBV in gray matter to that in white matter was 2.8 $\pm$ 0.4. In vivo studies gave coefficients of variation of $\pm$2.8% and $\pm$4.8% for cross-sectional CBV and regional (4 sq cm) CBV over an 80-minute period. The average human CBV was 4.2 $\pm$ 0.4 cc blood per 100 gm tissue. Clear tomographic delineation of the distribution of CBV was achieved with emission CT.

Administration of ^{11}CO by single-breath inhalation is a reliable and accurate means of measuring CBV by emission computed tomography. This scanning technique provides a "live" measurement of this parameter of cerebral hemodynamics. Sequential tomograms of CBV allow measurement of the response of this variable to induced or naturally occurring changes in brain hemodynamics.

► [. . . yes.] ◄

Radionuclide Computed Tomography of the Body Using Routine Radiopharmaceuticals.—*I. System characterization.* Paul H. Murphy, Wayne L. Thompson, Mark L. Moore and John A. Burdine[6] (Houston) describe the imaging capabilities of a single-photon emission computed tomography (ECT) system consisting of two opposed large-field-of-view scintillation cameras. In all studies, conventional parallel-hole collimators, are used in addition to one-dimensional converging or fan-beam collimators. Eleven count profiles along slices 1.25 or 2.5 cm thick are collected

(5) J. Nucl. Med. 20:328–334, April, 1979.
(6) Ibid., pp. 102–107, February, 1979.