

## ABSTRACTS OF CURRENT LITERATURE

**Positron Emission Tomography and Computed Tomography Assessments of the Aging Human Brain.** M. J. deLeon, A. E. George, S. H. Ferris, D. R. Christman, J. S. Fowler, C. I. Gentes, J. Brodie, B. Reisberg, A. P. Wolf; New York University Medical Center, New York, and Brookhaven National Laboratory, Upton, New York. *J Comp Assist Tomogr* 8:88-94, 1984

The authors examined the brains of normal young and old subjects with transmission computerized tomography (TCT) and positron emission tomography (PET) to estimate structural and metabolic changes. They describe the correlation between structure and function for normal aging and compare these results with correlations previously observed with Alzheimer's disease. By TCT there was significant age-related ventricular and cortical sulcal dilatation. The cortical changes were closely related to the age of the patients. On the other hand, positron emission tomography, following the i.v. administration of fluorine-18 deoxyglucose failed to demonstrate any regional changes in the brain glucose metabolic rates. The authors suggest that although the normal aging brain undergoes structural atrophic changes, there does not appear to be concomitant regional metabolic changes. The structural and metabolic measurements were subjected to correlations and no significant relationships were found. There appeared to be indications from this study that cortical changes may be more pronounced than ventricular changes in normal aging because of the strong relationship between age and the prominence of the cortical sulci. They also observed that in studies of pathological aging, i.e., Alzheimer's disease, the ventricular changes are more closely associated with clinical measurements of severity than are the cortical sulcal measurements. Therefore, the regional distribution of structural brain changes may differ between normal and pathological aging. They concluded that from their results that there appeared to be no significant specific metabolic changes associated with aging. Thus, the absence of a change in brain metabolism associated with normal aging contrasts sharply with a marked metabolic deficit that has been reported with senile dementia of the Alzheimer type. The authors speculated on a point of interest. After statistically correcting the metabolic rates for the remaining functional tissue in normal aging by adjusting the whole slice metabolic rate at CM plus 40 mm for the estimate of ventricular size at the same slice level, the resultant tissue metabolic rates showed a tendency to increase with age. This tendency was observed similarly at the CM plus 70 mm slice level, and thus there may exist a range of structural changes for which the brain is able to maintain normal cognitive functioning by a compensatory increase in its metabolic output.

**Diagnosis of Brain Death in Children by Radionuclide Cerebral Imaging.** J. A. Schwartz, J. Baxter, D. R. Brill; Geisinger Medical Center, Danville, PA. *Pediatrics* 73:14-19, 1984

Nine patients, aged 13 mo to 13 yr, with clinically suspected brain death were studied by radionuclide cerebral flow imaging and four-vessel contrast cerebral arteriography. The admitting diagnoses of the nine patients were: head trauma, four; anoxia, two; meningitis, one; brain abscess, one; and Reye's syndrome, one. The following clinical criteria for brain death were applied: (a) unresponsivity and unreactivity; (b) absent cephalic reflexes; and (c) apnea. For the radionuclide cerebral flow study, a tourniquet was applied around the patient's forehead, and 16 serial 1.5-sec images

were obtained with a portable gamma camera after a bolus Tc-99m i.v. injection. Static images were then obtained at 5 min. That the radionuclide study of these nine patients demonstrated absent cerebral blood flow was confirmed by four-vessel contrast arteriography. There was complete agreement in all cases. The radionuclide studies of two patients showed sagittal activity on the 5-min images, despite no direct visualization of absent cerebral blood flow. The likely source of this activity was extradural perforating arteries from the external carotid circulation. The authors concluded that failure to detect cerebral blood flow by noninvasive radionuclide cerebral flow study in children is a valid demonstration of absence of cerebral circulation for the purpose of determining brain death.

**Radionuclide Cerebral Perfusion Scintigraphy in Determination of Brain Death in Children.** B. H. Holzman, R. G. Curles, G. N. Sfakianakis, C. Ajmonemarsan, J. E. Montes; Univ. of Miami School Med., Miami, FL. *Neurology* 33:1027-1031, 1983

The criteria for the diagnosis of brain death have been validated by studies in adults, but few of the studies have included significant numbers of children. In addition, EEG activity may persist in children meeting other criteria for brain death, and the use of barbiturates and hypothermia in the therapy of comatose children may complicate the diagnosis. Radionuclide cerebral perfusion scintigraphy (RCPS) offers a rapid, accurate means of assessing relative cerebral perfusion in children, and it is not affected by barbiturates or hypothermia. To determine the usefulness of RCPS in determining brain death in children, 31 RCPS studies were obtained in 18 patients, age range 6 mo-13 yr (mean 4.5 yr), who had intracranial pressure greater than arterial pressure for 30 min, or no evidence of cortical or brainstem function. Rapid sequential dynamic images were obtained at 3-sec intervals for 1 min following a bolus i.v. injection of Tc-99m labeled glucoheptonate (400  $\mu$ Ci per kg body weight), and static images (500K) were obtained 10-20 min later. Studies were considered positive if no intracranial activity was seen in either the dynamic or static images. Eight true-positive studies were obtained; two other patients with equivocal RCPS (faint activity in the sagittal sinus on the delayed images only) also met the modified Harvard criteria for brain death within the same time interval,  $2.5 \pm 1.3$  d (mean  $\pm$  s.d.). There were no false positives, but one false-negative study was obtained. In the patients with intracranial pressure greater than arterial pressure, six had positive RCPS and 14 had negative (normal) studies. It appears from this series that elevated intracranial pressure alone does not account for absence of intracranial perfusion in the RCPS.

**Clinical Value of Phase and Amplitude Images and Left Ventricle Time-Activity Curves in Assessing Patients with Acute Myocardial Infarction.** R. Picozzi, G. L. Tarolo, A. Ricci, B. Palagi, G. Zatta, R. Baroffio; University of Milano, Milano, Italy. *Eur J Nucl Med* 9:6-11, 1984

First-pass ventriculography and gated-equilibrium radionuclide examinations were compared in 49 patients with acute myocardial infarction (AMI). Twenty-one of the patients were reexamined 3 mo after the onset of the AMI. A high correlation coefficient of 0.91 was found when the left ventricle ejection fraction values of both methods were compared. The gated equilibrium studies

demonstrated a greater number of regional wall motion abnormalities than the first-pass technique. The most sensitive global function parameter was the left ventricular peak filling rate. Regional dyskinesia was observed in ten of 29 patients with anterior AMI and in four of 27 patients with inferior AMI. A significant correlation was demonstrated between MB-CPK serum levels and the left ventricular ejection fraction only in patients with anterior AMI. An improvement or complete recovery of the wall motion abnormalities was observed in approximately 40% of the patients 3 mo after AMI.

**Radionuclide Imaging Correlatives of Heart Rate Impairment during Maximal Exercise Testing.** H. K. Hammond, T. L. Kelly, V. Froelicher; Univ. Hosp. San Diego, San Diego, CA. *J Am Coll Cardiol* 2:826-833, 1983

Patients with "chronotropic incompetence," the failure to achieve a normal heart rate response to maximal dynamic exercise, have been thought to have an increased incidence of "coronary events." To evaluate factors within this group of patients that may influence the prognosis, data were obtained on 156 men (aged 35-65 yr). All patients had exercise studies (treadmill or supine bicycle), which were symptom- or sign-limited following a modified Blake-Ware protocol. Rest and exercise-gated radionuclide ventriculograms, using Tc-99m labeled red blood cells, and rest and exercise Tl-201 scintigraphy were performed. Maximal oxygen consumption was measured separately using electronic equipment for gas analysis and weather balloons. Patients whose maximal heart rates were less than or equal to one standard error of the estimate below the regression line of maximal heart rate compared with age, on both of the exercise studies, were classified as chronotropically incompetent. Within this group, exercise-induced angina was more common than in the group with normal heart rate response, whereas coronary artery bypass surgery was more common in the latter. Patients with chronotropic incompetence tended to have a lower mean maximal systolic blood pressure with exercise and had a statistically lower mean maximal oxygen consumption. Chronotropically incompetent patients without angina had abnormal mean end-diastolic volumes and ejection fractions in the radionuclide studies; more myocardial scar was seen in these patients and in the surgical bypass group. It appears that patients with chronotropic incompetence and angina have better myocardial reserve and hence a better prognosis than those without angina.

**Effect of Ventricular Pacing on Left Ventricular Function Assessed by Radionuclide Angiography.** C. A. Boucher, G. M. Pohost, R. D. Okada, F. H. Levine, H. W. Strauss, J. W. Hawthorne; Massachusetts Gen. Hosp., Boston, MA. *Am Heart J* 106:1105-1111, 1983

To assess the beneficial consequences of ventricular pacing, multigated blood-pool study was used to evaluate left ventricular contraction on and off ventricular pacing in 35 patients. Twenty patients with permanent pacemaker studies, and seven patients with heart failure had no change between sinus rhythm and ventricular pacing in the decrease of the left ventricular ejection fraction (LVEF) (0.18 compared with 0.18). Among 13 patients without heart failure, there was similarly no significant change in LVEF (0.62 compared with 0.59) between sinus rhythm and ventricular pacing. Eight of 20 patients also underwent supine bicycle exercise, and rest and exercise LVEF values were not significantly different at a similar heart rate and workload when on and off pacing were compared. During pacing, however, there appeared to be abnormal regional motion in septal, apical, and inferior walls. Also noted was dissynchrony—early right ventricular and anterobasal and posterobasal LV motion with subsequent contraction of the apex. All seven patients with heart failure and one of 13 patients without heart failure had symptomatic im-

provement after conversion to atrioventricular pacing. Fifteen other patients were studied early (within 24 hr) after cardiac surgery. Temporary ventricular epicardial pacing produced a significant increase in right and left atrial pressure and a significant reduction in stroke volume, end-diastolic volume, and end-systolic volume but no significant change in LVEF. Conversion from sinus rhythm to ventricular pacing produces a deterioration in cardiac performance and severe regional LV wall motion abnormalities, but no significant change in LVEF. The authors concluded that LVEF is not useful for measuring the hemodynamic changes induced by ventricular pacing, but when reduced, LVEF may help to identify the patient who may require restoration of a normal atrioventricular contraction sequence.

**Perfusion Lung Scans vs. Pulmonary Angiography in Evaluation of Suspected Primary Pulmonary Hypertension.** A. J. Fishman, K. M. Moser, P. F. Fedullo; San Diego, CA. *Chest* 84:679-684, 1983

To assess the value of pulmonary perfusion scintigraphy in differentiating these patients from those with potentially operable, chronic (large vessel), thromboembolic pulmonary hypertension, 15 patients (six men, nine women, aged from 13 to 66 yr) were retrospectively studied. In addition to having pulmonary perfusion studies available, the patients selected the following criteria: (a) right heart catheterization had documented the presence of pulmonary hypertension (mean over 30 mm Hg or greater at rest) in absence of intracardiac shunt and in absence of an elevated pulmonary capillary wedge pressure; (b) none had co-existing pulmonary parenchymal disease; and (c) a pulmonary angiogram or lung biopsy had been performed. None of the 15 patients with pulmonary hypertension demonstrated a segmental or large perfusion defect suggesting large-vessel thromboembolic pulmonary hypertension. There were three pulmonary perfusion patterns: (a) normal perfusion (two patients); (b) mild patchiness (five patients); (c) patchiness (six patients). One of the patients with mild patchiness had subsegmental defect, LUL. The authors concluded that pulmonary perfusion scintigraphy provides a simple means for initially differentiating between patients with correctable, large vessel thromboembolic pulmonary hypertension and those with small vessel, obliterative pulmonary hypertension.

**Usefulness of Left Ventricular Wall Thickness-to-Diameter Ratio in Thallium-201 Scintigraphy.** B. Manno, A.-H. Hakki, S. A. Kane, A. S. Iskandrian; Likoff Cardiovascular Institute, Hahnemann University and Hospital, Philadelphia, PA. *Cathet Cardiovasc Diag* 9: 483-491, 1983

The relation of the left ventricular wall (LV) thickness to cavity dimension determined by means of echocardiography or contrast angiography provides important diagnostic and prognostic information in patients with cardiac disorders. The thickness-to-cavity dimension ratio has not been evaluated by thallium-201 scintigraphy. Fifty patients (39 men, 11 women, aged 40-86 yr) with symptomatic coronary artery disease underwent resting Tl-201 imaging and radionuclide ventriculography. The thickness (T) of LV and the transverse diameter (D) of the LV cavity were measured in LAO projection. The LV ejection fraction (EF), end-diastolic volume (EDV), and end-systolic volume (ESV) were correlated with T/D ratio. In 18 patients with T/D ratio less than 0.70, LVEF was lower than in the 16 patients with T/D ratio greater than or equal to 1.0 ( $22 \pm 2\%$  compared with  $49 \pm 3\%$ ). Similarly, in those patients with T/D ratio less than 0.70, the EDV and ESV were higher than in the remaining patients with higher T/D ratios. All 18 patients with T/D ratio less than 0.70 had LVEF less than 40%; 14 of 15 patients with T/D ratio greater than or equal to 1.0 had LVEF greater than 40%. The remaining 16

patients with T/D ratio 0.7–0.99 had intermediate LVEF and volumes. The inverse correlation between T/D ratio and LV volume and between LVEF, and EDV and ESV supports the contention that change in LV volume affects T/D ratio. It is concluded that the T/D ratio obtained from resting TI-201 study provides additional information regarding normal or abnormal systolic LV function in patients with coronary artery disease.

**The Accuracy and Limitations of Intravenous Digital Subtraction Angiography in the Evaluation of Atherosclerotic Cerebrovascular Disease: Angiographic and Surgical Correlation.** F. Earnest IV, W. Houser, G. S. Forbes, D. B. Kispert, W. N. Folger, T. M. Sundt, Jr.; Mayo Clinic, Rochester, MN. *Mayo Clin Proc* 58:735–746, 1983

In 78 patients who were suspected of having cerebrovascular disease, intravenous digital subtraction angiography followed by conventional selective carotid angiography were reviewed. The results of these two procedures were then correlated with the surgical findings in 53 patients. Of the 78 patients imaged by digital subtraction angiography after i.v. administration of contrast media, 33% of the studies were considered excellent, 42% good, and 25% incomplete. In a comparison of stenotic lesions, DSA and conventional angiography showed essentially equal results in 73% of the cases, DSA was better in 7%, and conventional angiography was better in 20%. Although i.v. DSA examinations were found to be of acceptable quality and accurately depicted atherosclerotic lesions in the cervical carotid arteries, this diagnostic procedure was deficient for the detection of intracranial vascular disease.

**Identification of Abscesses and Thrombi by Imaging of In-111 Labeled Blood Cells.** M. K. Dewanjee, S. Chowdhury, D. Jenkins, M. L. Brown, and H. W. Wahner. Mayo Clinic, Rochester, MN. *Mayo Clin Proc* 59:49–50, 1984

From 43 to 86 mm of a patient's blood, the platelets and leukocytes were separated from the erythrocytes and labeled with In-111 and then reinjected. The labeling complex was accomplished by incubating a lipid-soluble complex of In-111 tropolone. The unbound In-111 was separated by washing the cells with ACD-plasma medium, and then the labeled autologous cell preparations were administered i.v. within 3 to 4 hr after collection of the blood. The relative efficiency of leukocyte and platelet labeling was determined by Ficoll-hypaque discontinuous double-density gradient centrifugation. The granulocytes were labeled with an efficiency approximately 20 times that of the platelets. Nineteen percent of the injected In-111 was associated with granulocytes in their preparations. The authors found that when imaging abscesses with labeled granulocytes, the radioactivity ratio of abscess to muscle varied from 50 to 500/1. In their experience the quality of images obtained from In-111 granulocyte images was satisfactory.

**Intra-renal Localised Reno-renal Collaterals in the Dog after Tying of the Main Renal Artery.** G. Rosenbusch, J. Vincent, W. van Douveren, S. Skotnicki, T.H.M. Arts; University of Nijmegen, Nijmegen, The Netherlands. *Fortschr Röntgenstr* 140:15–20, 1984

The development of reno-renal collaterals was investigated in six dogs. The animals underwent selective angiography of the renal arteries, then one main stem of the renal artery was ligated, and successive, selective angiographic examinations were performed spanning a time interval of 45 to 61 days after surgery. Two dogs died shortly after the operation. Intrarenal collaterals were recognized in all animals, and the authors were able to demonstrate small collaterals soon after the occlusion of the artery. For 8 wk following surgery the number and diameter of the collateral vessels increased. The authors conclude that the intrarenal arteries in dogs might be functional but that anatomic end arteries are not.

**Radionuclide Enemas for Localization of Gastrointestinal Bleeding Sites.** A. J. Cohen, M. McCalley, P. Braunstein; University of California-Irvine, Orange, CA. *Gastrointest Radiol* 8:349–351, 1983

This case report describes an 82-yr-old woman presenting with a 2-yr history of lower gastrointestinal (GI) bleeding whose site had not been identified by colonoscopy, upper GI series, barium enema, or angiography. A right hemicolectomy was performed for presumed colonic angiodysplasia; postoperatively the bleeding was intermittent. Then, by i.v. injection the patient received 20 mCi Tc-99m labeled erythrocytes (tagged by the combined in vivo/in vitro technique) followed immediately by an i.v. injection of 1.0 mg glucagon to reduce GI motility. On gamma camera imaging, anterior scintigrams at 5-min intervals showed two foci of bleeding in the right upper quadrant at 35 min postinjection. A 3-hr static scintigram showed diffuse activity lying within a band extending superomedially across the right abdomen. Because the previous surgery had distorted the anatomy, it could not be accurately determined if bleeding sites were in small bowel, large bowel, or surgical anastomosis. At that point, a barium enema would have interfered with future diagnostic or therapeutic angiographic intervention, so a radionuclide enema was performed to reveal the anatomic site of bleeding better. The enema was prepared by mixing 5 mCi Tc-99m DTPA in a bag containing 2 l of normal saline, which was then infused into the rectum through a rectal balloon catheter. To avoid laboratory contamination, the patient was placed in an inflatable plastic disposable barium enema ring to catch any enema leakage. Anterior scintigrams showed a decrease in caliber of lumen and an increase in number of convolutions when activity passed the mid-abdomen, demonstrating that bleeding sites were in the terminal ileum lying in the right upper quadrant. The surgeons were advised to resect the terminal ileum in addition to the area of the colo-ileal anastomosis, the clinically suspected bleeding site. After a repeat negative angiogram, the reaction was performed, and pathologic examination showed multiple areas of submucosal hemorrhage in the terminal ileum and transverse colon adjacent to the anastomosis. No angiodysplasia was identified. Bleeding had not recurred at 8 mo follow-up. These authors endorse the use of sequential Tc-99m-erythrocytes i.v. and Tc-99m DTPA radionuclide enema for localization of intestinal bleeding sites.

**A Comparison between Whole Body Scans Made at Two Hours and Three Hours after Intravenous Injection of Tc-99m HDP as to Image Quality and Lesion Detectability.** E. K. J. Pauwels, J. Blom, J. C. N. M. Aarts; University Hospital, Leiden, The Netherlands. *Clin Nucl Med* 9:75–78, 1984

The purpose of this investigation was to study the difference between the image quality and lesion detection rate in bone images obtained with Tc-99m HDP at 2 and 3 hr following i.v. administration of the radiotracer. The studies were performed in the whole-body mode of imaging. Whole-body bone images were obtained in 35 patients and evaluated as to the quality and number of osseous lesions that could be detected at the studies of 2 hr and 3 hr. Of the 35 patients, lesions were observed in the bones of 22. These lesions were composed of 59 degenerative abnormalities and 36 malignant focal lesions. All 95 lesions were quite visible on both the 2- and 3-hr image studies; only one malignant and one degenerative lesion of these 95 sites were better seen at the 3-hr study, which corresponds to a 95% confidence interval. From the cosmetic standpoint, the bone images were scored equally at 2- and 3-hr studies, and in six patients the score was higher for the 3-hr study. The authors concluded that the image quality at 2 hr following injection of the tracer was generally quite good even though the soft tissue uptake might be slightly higher than at subsequent studies. The high-quality images were obtained in patients of all ages.

**A Radioimmunoassay Using a Monoclonal Antibody to Monitor the Course of Epithelial Ovarian Cancer.** R. C. Bast, Jr., T. L. Klug, E. St. John, E. Jenison, J. M. Niloff, H. Lazarus, R. S. Berkowitz, T. Leavitt, C. T. Griffith, L. Parker, V. R. Zurawski, Jr., R. C. Knapp; Brigham & Women's Hosp., Boston MA. *N Engl J Med* 309:883-887, 1983

A clinically useful antigenic marker, CA 125, has been defined in the serum of patients with epithelial ovarian carcinomas, and an immunoradiometric assay has been developed for its detection. The assay procedure utilizes polystyrene beads coated with the monoclonal antibody OC 125 incubated with serum and I-125 labeled OC-125 in a competitive-binding system. The interassay coefficient of variation is 15%, hence a 50% change in antigen level in serum is considered statistically significant. The mean normal values (U/ml  $\pm$  s.d.)  $8.0 \pm 9.4$  U in males and  $9.9 \pm 8.0$  U in females, with only 1% of 888 normal subjects showing values  $>35$ U, and only 0.2% had levels  $>65$ U. In 101 patients with epithelial ovarian carcinoma, 82% had values  $>35$ U, with 74%  $>65$ U. Only 29% of 200 samples from nongynecological cancer patients exceeded values of 35U. CA 125 levels in serum were correlated with the clinical course in 38 patients with epithelial ovarian carcinoma (duration 2-60 mo). Using the criteria of doubling or halving representing a significant change, the CA 125 levels correlated with the clinical course in 93% of the determinations ( $p < 0.0001$ ). Based on the experience in this group of patients, an elevated CA 125 level indicates a lack of durable complete response to therapy, and a rising CA 125 level is associated with disease progression (17 cases.) Carcinoembryonic antigen levels determined concurrently correlated with the clinical course in only 26% of cases ( $p = 0.61$ ).

**Gamma Scintigraphy Using Tc-99m Labeled Antibody to Human Chorionic Gonadotropin.** R. T. Morrison, D. M. Lyster, L. N. Alcorn, B. A. Rhodes, K. Breslow, S. W. Burchiel; Vancouver General Hospital, Vancouver, Canada; Summa Medical Corporation, and University of New Mexico, Albuquerque, NM. *Clin Nucl Med* 9:20-24, 1984

The authors presented the case of a 27-yr-old woman with an invasive trophoblastic hydatidiform mole that had metastasized to the lung. She was studied on two occasions with separate preparations, one a sheep polyclonal anti-hCG F(ab')<sub>2</sub> and with a murine monoclonal anti-hCG F(ab')<sub>2</sub>, beta subunit specific, both labeled with Tc-99m. A hydatidiform mole had been removed by curettage on two occasions, one month and two months before examination. About 10 days before the nuclear medicine study, her plasma hCG titer was 5536 mIU/ml. X-ray computerized tomography revealed a 4 cm mass between the uterus and the rectosigmoid colon. She received chemotherapy and her hCG level dropped to 66 mIU/ml. The fragment of the technetium-labeled polyclonal antibody was administered, and at 4 hr following injection a region of increased activity was observed in the pelvis. A month later her hCG titer had risen to 1040 mIU/ml and chest tomography revealed a nodule in the left lower lobe. She received another series of chemotherapy, and imaging with the polyclonal fragment to hCG revealed that the mass in the pelvis was larger; however, the nodule in the lung was not visualized. The polyclonal fragment study was again repeated and the abnormalities in the pelvis and lung were identified with the assistance of a subtraction technique. About three weeks later the titer became negative but rose again shortly thereafter to 8 mIU/ml; however, the chest radiograph was normal. A repeat study with Tc-99m labeled monoclonal fragment to hCG revealed the defect in the uterus but no lesions in the lung. The authors observed that at no time were the nodules in the lung detectable without using the blood pool subtraction technique. The problem appeared to be that the lesions were located close to the blood pool of the heart. They also observed

that there was no correlation between the hCG levels and the pulmonary lesions observed.

**Upon the Retention of <sup>77</sup>Bromine-Bromphenolblue and <sup>67</sup>Gallium-Citrate in Mammary Tumors—Comparative Investigations in Animals.** R. Senekowitsch, H. Kriegel, S. Möllenstädt; Institute of Radiation and Environment Research, D-8042 Neuherberg, West Germany. *NucCompact* 14:332-334, 1983

[<sup>77</sup>Br]bromphenolblue (Br-77 BPB) was compared with gallium-67 citrate in tumor-bearing mice. The animals were injected with 20  $\mu$ Ci Br-77 BPB and were killed at 3, 6, 12, 24, and 48 hr later. The Br-77 BPB activity was measured in the blood, kidney, muscle, breast tissue, and breast-tumor tissue. The same procedure was performed using Ga-67 citrate. The blood disappearance rate of Br-77 BPB was significantly higher compared with Ga-67 citrate. The tumor-to-blood ratio was 5.5:1 6 hr after Br-77 BPB was administered, whereas a ratio of 6:2 was noted until 48 hr after the administration of Ga-67 citrate. When the tumor-to-breast tissue ratios were compared, Br-77 BPB was also superior to Ga-67 citrate. The authors conclude, therefore, that Br-77 BPB might be a promising radiotracer for tumor imaging in patients.

**Reproducibility of Standard Preparation in Digoxin Radioimmunoassay in Plasma and Serum.** L. Molin, B. Bergdahl, G. Dahlstrom, E. Leander. Linköping Univ. Hosp., Linköping, Sweden. *Ther Drug Monitor* 5:355-357, 1983

These authors quantified errors that occurred when digoxin standards were prepared for radioimmunoassay (RIA). Five stock solutions (SS), each containing  $100.0 \pm 1.4$  (mean  $\pm$  s.d.) mg/l of World Health Organization digoxin in ethanol:water (80:20, vol/vol) were studied. Each SS was diluted in two steps with ethanol:water (5:95) to yield either 100, 200, or 400 ng/ml. From each dilution, 100  $\mu$ l were added to duplicate samples (10.0 ml each) of pooled heparinized plasma and of pooled serum from five healthy subjects yielding concentrations of 1.0, 2.0, and 4.0 ng/ml. Portions (1 ml) were taken from the 10.1 ml samples and frozen. Thawed samples were then compared in a balanced, incomplete block design comprising ten runs of a commercially available RIA for digoxin. Four standard curves were generated in each run. All assays were completed within three days, and counts per minute (CPM) data were corrected for radioactive decay of I-125. Estimates of different variance components (from CPM) in an analysis of variance were then derived. Estimated variance associated with preparation of SS dilutions indicated an error of 1.3%. Estimated variance associated with addition of diluted digoxin solutions to either plasma or serum indicated an error of 1.2%. Estimated variance associated with mixing SS dilutions with plasma or serum, portioning, and storage procedures was zero, indicating 0% error. Estimated variance due to the RIA procedure itself indicated an error of 3.7%. Plasma gave, on average, lower CPM values than did serum; however, the difference was significant ( $p < 0.01$ ) only for the 4 ng/ml concentration. A CPM value corresponding to 4.0 ng/ml on the mean serum curve would give 3.8 ng/ml if read from the mean plasma curve. In contrast, a value corresponding to 4.0 ng/ml on the mean plasma curve would give 4.2 ng/ml if read from the mean serum curve. That indicates a 5% under- or overestimation of concentration at a nominally high concentration of digoxin. These authors conclude that (a) errors inherent in preparing digoxin standards are rather small, and (b) differences in standard curves occurring when plasma and serum serve as matrices for digoxin standards suggest that RIA standard curve matrix and patient's sample be the same.

**Low-Level Internal Radionuclide Contamination: Use of a Gamma Camera for Detection.** H. Nishiyama, S. J. Lukes, E. L. Saenger;

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The Joint Commission on Accreditation of Hospitals (JCAH) requires each hospital to have a plan for handling radiation emergencies. An important element in the plan must be the capability of assessing the level of internal contamination of accident victims. Because most medical centers do not have special instrumentation that can be used for that purpose, e.g., whole-body counters, an evaluation of the use of gamma cameras is presented in this article. Four commonly available, uncollimated cameras were used to determine the minimum detectable activity (MDA) and to obtain calibration factors. Eleven radionuclides with energies ranging from 35 keV to 1332 keV were used to represent the range of energies that might be encountered in an accident. Calibration factors and MDAs were obtained in air and in the presence of scatter. These values were compared with measurements in dogs, which had known amounts of activities to determine the configuration best suited for quantitative measurements. A flood source containing a known amount of activity in air corresponded most closely to the animal measurements. It was noted that the MDAs differed significantly from camera to camera and were greatly affected by background levels of radiation. It was not possible to distinguish radionuclides with similar energies (e.g., Ba-133 and I-131). For activity levels below 5 nCi, it was impossible to detect a radionuclide by the display system (analog or MCA). Identification required activities above 10 nCi. Cameras without analog or MCA spectrum displays, i.e., those with ratemeters, have greater difficulty in distinguishing background from low-level activities. In general, gamma cameras can be properly calibrated to measure relatively low levels of contamination to meet the JCAH requirement.

**High-Resolution Magnetic Resonance Imaging.** L. E. Crooks, J. Hoenninger, M. Arakawa, et al.; University of California, San Francisco, CA. *Radiology* 150:163-171, 1984

Magnetic resonance imaging is sensitive to hydrogen density,  $T_1$  and  $T_2$  relaxation times, and flow. Variations in data acquisition parameters can alter the images such that these fundamental parameters contribute in different ways to the signal received from the patient, thus affecting contrast. The selection of different data acquisition techniques can produce tradeoffs among signal-to-noise (S/N) ratio, imaging time, and spatial resolution, within a given signal acquisition technique. All of these variations must be evaluated in terms of clinical utility. If the ability of an instrument to provide information is expressed in terms of resolving power, which is proportional to  $[(S/N)^2 \text{ times (contrast)}^2]$ , a means is available to study how certain parameters can be optimized. Manipulation of variables can produce increases in both S/N and object contrast.

For example, in magnetic resonance (MR) of the head, increasing the repetition time to 2.0 sec produced images with higher S/N ratios and excellent sensitivity to demyelinating disease and brain water content. Long repetition times were also found to increase the contrast between the patent area of a vessel and the surrounding tissue and to improve resolution. An approach to high resolution, long repetition time images, is the use of multisection imaging. In multisection imaging one section of the object is excited whereas another elapses. Although the efficiency of such an approach is lower with inversion recovery, there is still some advantage to be gained.

**Nuclear Magnetic Resonance: In Vivo Proton Chemical Shift Imaging.** I. L. Pykett, B. R. Rosen; Massachusetts General Hospital, Boston, MA. *Radiology* 149:197-201, 1983

Along with the advances of proton magnetic resonance (MR) imaging, there has been an improvement in MR spectroscopy for the study of biological systems in vivo. The latter enables investigators to obtain high spectral resolution (i.e., chemical shift) information from small volumes within intact biological samples. P-31 and C-13 nuclei have been studied extensively using these techniques. Although most approaches to imaging chemical shifts have involved P-31, the authors chose to use the hydrogen nucleus because of its higher sensitivity and larger physiological concentration. This article presents the first in vivo MR images containing proton chemical shift information. Data were collected with a small bore, superconducting system. A 3D Fourier transform approach was used to encode spatial information in two dimensions and chemical shift in the third. A pulse sequence based on saturation recovery was used. Images of a cat and a human forearm show the type of proton chemical shift that can be obtained. Chemical shift resolution of 0.7 ppm was attained over the imaging plane with a volume element resolution of approximately 1.3 cubic mm. Magnetic susceptibility was also measured in experiments with a phantom. Chemical shifts and magnetic susceptibility should provide additional useful parameters in characterizing disease.

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