

Non-Invasive Screening for Surgical Intracranial Lesions. P. D. Superviola and N. D. Greyson. *J Neurol Neurosurg Psychiatry* 38:52-56, 1975.

The purpose of this investigation was to determine if a given combination of noninvasive procedures would securely demonstrate or exclude an intracranial mass lesion. In 147 patients suspected of having an intracranial mass lesion the results of skull radiography, electroencephalography, echoencephalography, isotope angiography, and brain scanning were analyzed. The overall accuracy of the combined techniques was 79%. Of these patients 12% had true-positive findings; 67%, true negative; 21%, false positive; and none had false-negative findings. A variety of central nervous system disorders was represented in these patients. The negative reliability of the noninvasive procedures was absolute in the sense that all neuroradiologic procedures were also negative. Conversely, in cases with proven pathology, one or more of the screening procedures demonstrated the lesion. The authors found that the EEG and the brain scan were more reliable than skull radiography, blood flow study (radionuclide), and echoencephalography. They found that the EEG gave the most false-positive results.

Effect of Flow Rate of Lavage Fluid on the Removal of Radioactive Particles from the Lung by Bronchopulmonary Lavage. S. A. Felicetti, S. A. Silbaugh, and B. A. Muggenburg. *Health Phys* 28:399-404, 1975.

The purpose of this investigation was to determine the effect of fluid flow rate during bronchopulmonary lavage based on the removal of radioactive particles from the lungs of dogs. Cerium-144 was labeled to fused clay particles and placed in an aerosol, and dogs were exposed for 15-32 min until a level of approximately $8 \mu\text{Ci }^{144}\text{Ce/kg}$ was attained. The dogs underwent bronchopulmonary lavage in both lungs 48 hr after inhalation of the particles. The lavage fluid was introduced at two flow rates: 0.67 liters/min and 1.7 liters/min. Fast lavage removed a lesser amount of the radioactive material from the right lung than the slower lavage; however, there was no correlation with flow rate in the left lung. For the total lung, 24-40% of the initial dose was removed by lavage. The authors felt that the use of bilateral bronchopulmonary lavage was preferable to the unilateral method and that removal of inhaled particles from the lung did warrant further study.

Thallium-201 for Myocardial Imaging: Relation of Thallium-201 to Regional Myocardial Perfusion. W. Strauss, K. Harrison, J. K. Langan, E. Lebowitz, and B. Pitt. *Circulation* 51:641-645, 1975.

The purpose of this investigation was to examine the relationship of the regional myocardial distribution of the tracer thallium to that of potassium and microspheres in laboratory animals and to define the best parameters for imaging. Mice were administered ^{201}Tl , ^{43}K , and ^{81}Rb and were sacrificed at intervals of up to 2 hr. After ligation of the anterior descending coronary artery in dogs, ^{201}Tl and ^{43}K were administered intravenously, and the dogs were

sacrificed at intervals of up to 30 min. In another group of dogs with partially occluded circumflex arteries, ^{201}Tl was given intravenously and microspheres were labeled with ^{86}Sr and were administered into the left atrium. These dogs were immediately sacrificed. It was determined that in mice the greatest concentration of radionuclide in the myocardium was thallium (2.08%) followed by potassium (1.25%) and rubidium (1.15%) at the 10-min postinjection interval. In those dogs with occlusion of the left anterior descending artery, thallium better defined the lesions than did potassium. A correlation coefficient of 0.97 was found in the regional distribution of ^{201}Tl and microspheres under the conditions of partial arterial occlusion and reactive hyperemia. The authors concluded that ^{201}Tl might be useful in the evaluation of the distribution of regional myocardial perfusion.

Detection of Acute Myocardial Infarction by Technetium 99m-Polyphosphate. P. McLaughlin, G. Coates, D. Wood, T. Craddock, and J. Morch. *Am J Cardiol* 35:390-396, 1975.

The authors evaluated the results of 39 $^{99\text{m}}\text{Tc}$ -polyphosphate myocardial imaging studies in 34 patients. Images were obtained in the usual sequence of projections and data stored in a computer. A control group of 17 patients who had not had a recent mild myocardial infarction was studied, and 17 patients who had had an acute myocardial infarction were studied from 3 to 20 days after the onset of symptoms. Of 16 studies in 12 patients with transmural myocardial infarctions, 13 were positive, 2 were normal, and 1 was questionable. The location of infarction by imaging corresponded to that indicated by ECG criteria in eight of the ten patients with positive images. In five patients with nontransmural myocardial infarctions imaging was positive in two and questionable in one. In one patient a questionable image was normal 16 days later. The authors felt that the method might prove useful in clinical situations such as cardiac surgery in which standard diagnostic aids are difficult to interpret.

Myocardial Imaging with Indium-113m and Technetium-99m Macroaggregated Albumin: New Procedure for Identification of Stress-Induced Regional Ischemia. J. L. Ritchie, G. W. Hamilton, K. L. Gould, D. Allen, and J. W. Kennedy. *Am J Cardiol* 35:380-389, 1975.

In patients with severe coronary stenosis under conditions of stress, flow demand is increased, but blood flow distal to the stenosis fails to increase. The investigators wished to study changes in flow from contrast medium-induced hyperemia as an indication of impaired coronary flow reserve. Coronary hyperemia was induced in 49 patients by intracoronary injection of Hypaque-M, 75%. The four- to five-fold increase in coronary blood flow observed following injection of the radiocontrast material was similar in magnitude to that occurring with maximal exercise stress. Following injection of the contrast material for arteriography, coronary blood flow was permitted to return to normal. Then $^{113\text{m}}\text{In}$ - or $^{99\text{m}}\text{Tc}$ -macroaggregated albumin (MAA) was

injected into the left coronary artery. Coronary hyperemia was then induced with intracoronary contrast material and, within 5–8 sec during the period of peak hyperemia, the second isotope was injected into the left coronary artery. The size of the MAA particle preparation was identical for both isotopes. Radionuclide images were obtained in the anterior, left lateral, left anterior oblique, right anterior oblique, and left posterior oblique projections. Of the 49 patients who had suspected coronary artery disease, 10 had no significant lesions by contrast arteriography, and all had normal nuclide images and computer data gathered during coronary hyperemia were normal. Of the 39 patients with significant obstructive coronary artery disease, 37 had abnormal nuclide images at rest or during contrast agent-induced hyperemia or both. Patients who had had previous myocardial infarctions demonstrated resting perfusion abnormalities that frequently became more abnormal during periods of hyperemia. Patients who had significant coronary disease but who had not had a previous infarction usually demonstrated abnormalities only during periods of coronary hyperemia. The images were computer processed, count levels were equated for the two radionuclides, and one subtracted from the other to demonstrate changes that occurred between rest and hyperemia. The figures are worth reviewing.

Regional Cerebral Blood Flow Changes after Bilateral External Carotid Artery Ligation in Acute Experimental Infarction. J. Abraham, E. O. Olt, M. Aoyagi, Y. Tagashira, N. Achari, and J. Stirling. *J Neural Neurosurg Psychiatry* 38:78–88, 1975.

The authors measured regional cerebral blood flow in baboons in which acute cerebral infarction had been induced by occlusion of the middle cerebral artery before and after ligation of the external carotid arteries. Regional cerebral blood flow was measured by intracarotid injection of ^{133}Xe and the scintillation camera. A standard grid for assessment of 13 selected cerebral regions was used on all animals. The ^{133}Xe was injected by catheter into the linguofacial artery and data were recorded for 10 min. The middle cerebral artery was cannulated at the time of occlusion in two animals and, 30 min after the evaluation of the steady state, a small bolus of ^{133}Xe was injected into the stump and clearance measurements were repeated. Measurements of regional cerebral blood flow were first made with the right external carotid artery ligated, followed by ligation of the left. The measurements were made at 30, 60, and 120 min after ligation. The authors found that after bilateral external carotid artery ligation, flow in the ischemic and nonischemic areas was greatly enhanced and flow in the hyperemic areas was significantly reduced, presumably since these vessels had provided collateral circulation to the ischemic zone with a favorable redistribution.

Brain Scanning in Cerebral Vascular Disease: A Reappraisal. D. M. Welch, R. E. Coleman, W. B. Hardin, and B. A. Siegel. *Stroke* 6:136–141, 1975.

The authors reviewed 162 patients admitted during a 5-year period with a diagnosis of cerebral vascular disease. The mean age of the patients was 65 years (range, 26–90 years). The final diagnoses of the patients on discharge were complete stroke, reversible ischemic neurologic deficit, or transient ischemic attack. The frequency of the abnormal brain scan was evaluated in relation to diagnosis, time after onset of symptoms, effect of delayed imaging, and the degree of clinical neurologic recovery. In those patients with com-

pleted thrombotic infarctions, 39% had abnormal scans with hemispheric lesions and 14% with posterior fossa lesions. Three of seven patients (43%) had abnormal brain scans following completed hemorrhagic infarctions. Only 2 of 14 patients (14%) with ischemic attacks or reversible ischemic neurologic deficits had abnormal scans. In those patients with completed infarctions, 27% had positive brain scans within the first 2 days after the infarction. In 10% of the positive cases, only the delayed views were abnormal. The frequency of abnormal scans was significantly greater in those patients who died or who had a large neurologic deficit at the time of discharge as compared to those patients with lesser residual deficits.

Detection of Skeletal Involvement in Hodgkin's Disease: A Comparison of Radiography, Bone Scanning, and Bone Marrow Biopsy in 38 Patients. A. Ferrant, J. Rodhain, J. L. Michaux, E. L. Pairet, B. Mالدague, and G. Sokal. *Cancer* 35: 1346–1353, 1975.

As part of staging of Hodgkin's disease the authors investigated results of scanning and x-ray films in 38 patients, ranging from 18 to 58 years with a mean of 30 years. None had received chemotherapy and ten had received radiotherapy. Each patient had had a radiologic skeletal examination and scintigraphy using $^{87\text{m}}\text{Sr}$ and $^{99\text{m}}\text{Tc}$ -polyphosphate, and one or more bone marrow biopsies. Of the 38 patients 14 had skeletal involvement that was proven histologically in 11. The radionuclide studies were positive in ten patients and in eight the images provided the first suspicion of bone involvement. In five patients the radiographs were positive. Physiologic involvement of bone marrow was associated with the clinical Stages IIIB or IVB in all cases but one. Histologically proven bone marrow involvement by Hodgkin's disease was associated with obvious reaction in six cases as demonstrated by bone scanning. The authors felt that bone marrow involvement may at times precede local osseous involvement. They concluded that a reasonable approach to the problem of bone marrow or osseous involvement by Hodgkin's disease would be performing a bone scan initially followed by bone marrow biopsy from a suspicious area.

Positive Scans in Angiographically Proved Cases of Recanalized Cerebral Infarction. T. Irino, M. Taneda, and T. Minami. *Stroke* 6:132–135, 1975.

Twenty patients with an acute major cerebral arterial occlusion were diagnosed on the basis of physical and angiographic findings within 24 hr of the stroke. Each had a sudden onset of hemiplegia. Eight demonstrated internal carotid arterial occlusion and the other 12 demonstrated occlusion of the proximal portion of the middle cerebral artery. Fourteen were diagnosed as having thrombosis due to arteriosclerosis and six as having cerebral embolism. A second angiogram was performed on the third day after onset of symptoms and, if recanalization was not demonstrated, the angiogram was repeated on the seventh day. Brain imaging was performed in the fourth week after the stroke. Scans were interpreted as negative, equivocal, or positive. Neurologic deficits were classified as severe or moderate. Followup angiography showed complete clearing of the occlusion in four cases of internal carotid arterial occlusion and five with middle cerebral occlusion. The clinical cause of all recanalized cases was judged as severe while four of the nonrecanalized cases were judged as moderate, and the remaining seven as severe. All nine cases of recanalization showed positive scans with distribution in the cere-

bral artery. All patients with severe neurologic deficits had positive scans while those without abnormal uptake of radionuclides had moderate deficits. The study demonstrated that positive radionuclide scans could be obtained in patients with and without recanalization and emphasized the diagnostic value of the brain scan in the subacute or chronic stage of cerebral infarction, particularly in those patients with no arterial occlusion appearing on the angiogram.

The Effect of Cerebral Infarction on Regional Cerebral Blood Flow in the Contralateral Hemisphere. S. Lavy, E. Melamad, and Z. Portnoy. *Stroke* 6:160-163, 1975.

The authors studied the effect of acute cerebral infarction on the regional cerebral blood flow (rCBF) in the contralateral hemisphere in 20 patients. The mean age of the patients was 65 years. Occlusion of a major artery, either internal carotid or middle cerebral, was demonstrated in nine of the patients. All patients were severely affected with a hemiparesis or a comparable deficit. Regional cerebral blood flow was determined by the carotid injection of ^{133}Xe . The clearance of the radioisotope was followed for 10 min with 24 scintillation detectors positioned over the hemisphere. Mean arterial blood pressure, p_{CO_2} , and pH determinations were determined prior to the injection of the radioisotope. The rCBF was found to be reduced, sometimes markedly. In the younger age group (from 40 to 59 years) the reduction was greater, 40-47%. The rCBF (rCBF depression) was not related to cerebral dominance. Decreased flow occurred in patients who were fully alert or who had disturbances of consciousness although it tended to be more diminished in the latter. The decreased rCBF in the nonaffected hemisphere is part of a general phenomenon that affects the entire brain and is caused by globally reduced cerebral metabolism.

Liver and Pancreas Scanning in Extra-Hepatic Obstructive Jaundice (with Special Reference to Tumors of the Bile and Hepatic Duct). J. E. Agnew, O. James, and A. D. Bouchier. *Br J Radiol* 48:190-199, 1975.

The authors wanted to answer two possible questions about combined liver and pancreas scanning: (A) Is there a recognizable liver scan appearance in extrahepatic obstruction, whatever the cause? (B) Can combined liver and pancreas scanning help distinguish carcinoma of the bile and hepatic duct, pancreatic carcinoma, and nonmalignant extrahepatic obstruction from one another? In 25 patients with carcinoma of the bile and hepatic duct, liver scans were reported as abnormal in 23. In 16 scans with hilar defects 13 demonstrated some degree of "branching" of the defect. The pancreatic scans in these 25 patients were interpreted as abnormal in 20 cases. At autopsy or surgery the pancreas was found to be normal in 18 patients. Thirty patients who had carcinoma of the pancreas and obstructive jaundice were studied. Only one of these patients had a normal liver scan and 60% demonstrated a hilar defect. In 29 of the 30 cases the pancreas scans were considered abnormal. In 17 patients with nonmalignant obstructive jaundice and a normal pancreas, 15 demonstrated abnormal liver scans. Ten of the 17 patients demonstrated some degree of abnormality in the pancreatic scan. In 20 control subjects only 10 of the liver scans were interpreted as completely normal and 25% of these were considered as false-positive liver scans but none had hilar defects. Twenty percent of the pancreatic scans in the normal control subjects were interpreted as false positive. The authors concluded that a normal pancreas scan

virtually excluded pancreatic carcinoma as the cause of obstructive jaundice. If the pancreatic scan demonstrated markedly reduced uptake, the probability of carcinoma of the pancreas or of the lower end of the common bile duct was increased. They also concluded that combined pancreas and liver scanning cannot always distinguish between the different forms of extrahepatic obstructive jaundice.

The Measurement of Regional Ventilation During Tidal Breathing: A Comparison of Two Methods in Healthy Subjects and Patients with Chronic Obstructive Lung Disease. A. H. Secker-Walker, P. O. Alderson, J. Wilhelm, R. L. Hill, J. Markham, J. Baker, and J. Potchen. *Br J Radiol* 48:180-189, 1975.

Regional ventilation was measured in 17 healthy volunteers and 24 patients with chronic obstructive lung disease during tidal breathing by means of ^{133}Xe . Xenon was breathed for 4-5 min and then the xenon was washed out. The washin was controlled by the time required for the patient to inhale 40-50 liters of ^{133}Xe and air mixture and washout was terminated 2 min after the lung field was cleared. Data were collected by means of a scintillation camera and small digital computer. The regional ventilation was calculated as a distribution of tidal volume per unit lung volume and, from the washout curves, as a fractional exchange of air per second. The authors found that when ventilation is calculated as the fractional exchange of air per second, there is a statistically significant difference obtained both for regional and total lung between patients with chronic obstructive lung disease and normal subjects. Quantitative results for the relative distribution of tidal volume per unit lung volume was found to closely correspond to previously obtained values. The authors concluded that the measurement of regional ventilation as the fractional exchange of air might be more realistic than those methods that determine the relative ventilation or only evaluate the first portion of the ^{133}Xe washout.

Liver Scanning in Patients with Suspected Abdominal Tumor. H. J. Fee, E. K. Prokop, J. L. Cameron, and H. N. Wagner, Jr. *JAMA* 230:1675-1677, 1974.

The authors studied 70 patients with a high probability of abdominal tumor. Ten-view liver and spleen radionuclide images were performed after administration of $^{99\text{m}}\text{Tc}$ -sulfur colloid. The scans were interpreted as either uniform distribution or nonhomogenous distribution with or without clear-cut focal defect. Exploratory laparotomy was performed within 1 week of imaging in all patients and biopsies were performed in questionable cases. All patients in whom metastasis had been verified by previous surgery or needle biopsy were excluded from the study. In 59 of the 70 liver scans (84%) the presence or absence of metastatic disease (confirmed by surgery) was correctly detected. In the 48 patients who were found free of metastasis by surgery, 6 had abnormal liver scans, a 13% incidence of false-positive results. Of 22 patients with proven metastasis, 5 had normal scans, a 23% incidence of false-negative results. In two the false-negative lesions were less than 1 cm in size. The authors concluded that the chance for error was too high when liver scanning alone was used to determine the existence of metastasis.

Dosimetric Model for the Gastrointestinal Tract. K. W. Skrable, G. Chabot, J. Harris, and C. French. *Health Phys* 28:411-428, 1975.

A dosimetric model for the gastrointestinal tract has been proposed for the calculation of the dosimetric average dose

equivalent and dose equivalent rate to an entire segment as well as instantaneous values at any location within a given segment as applicable to single or continuous uptakes of parent and daughter radionuclides. The model is based on a general equation applied to a physiologic model appropriate to the chronic long-term exposure of standard man. It is proposed that a dosimetric average dose equivalent rate be used to establish the critical segment and corresponding maximum permissible daily activity ingestion rates. In the cases studied, the instantaneous and dosimetric average dose equivalent rates in the critical segment do not differ by more than a factor of 2, which is not considered excessive and would not require the application of a dose distribution factor. Despite large differences in the physiologic parameters and the dosimetric models, the maximum permissible daily activity ingestion rates proposed here do not differ for the cases studied by more than a factor of about 3 from current ICRP recommendations.

Characterizations of Malignant Gliomas and Cerebrovascular Disease by Cerebral Dynamic Study. L. R. Witherspoon, R. S. Preissig, M. S. Mahaley, et al. *Stroke* 6:199-205, 1975.

The purpose of this study was to develop a standard technique for analyzing activity versus time course obtained from each cerebral hemisphere following the intravenous injection of a bolus of ^{99m}Tc -pertechnetate. One dynamic fusion study was performed in each of 25 normal patients. A total of 120 studies was performed in 42 patients with anaplastic gliomas and 51 studies in 47 patients with cerebral vascular disease.

Region-of-interest "cursors" of equal size were selected to cover the pathologic portions of the affected hemisphere and identical contralateral area. The parameters chosen to characterize the studies were the peak count rate in the region of interest and the time from arrival of activity in the region of interest to the peak of activity. The expected variations of these two parameters were established with the normal group by the percentile method. Patients were classified as abnormal only if the time difference between peak hemispheric activities was greater than 1.5 sec or if the activity at the peak differed by greater than 10%. Sequential photographs were obtained every 2-3 sec. Gliomas that demonstrated activity in the region of interest also showed diminished arterial phase activity in the tumor-bearing hemisphere on the scintiphotos. Both early and increased region-of-interest activity was associated with increased arterial phase activity on the scintiphotos in patients with gliomas. In those patients with cerebral vascular disease the delayed, delayed and increased, or delayed and decreased region-of-interest patterns were demonstrated as diminished arterial phase hemispheric tracer activity in 17 of 19 series of scintiphotos. In 8 of 17 studies a later increase in tracer activity in the abnormal hemisphere was recognized on the photographs.

After surgery increased activity in the tumor-bearing hemisphere was usually presumed to be actively growing tumor associated with clinical deterioration. The quantitative technique, however, was not sufficiently more sensitive for abnormal tracer distribution in gliomas than was visual inspection of the scintiphotos. In patients with cerebral vascular disease the most frequently observed pattern was delayed time peak activity; by contrast, in patients with anaplastic gliomas peak activity was decreased but there was

no delay in the time to peak activity. In 7 of the 51 studies on patients with cerebral vascular disease tracer distribution interpretation was based on visual inspection of the scintiphotos alone. The delayed time activity peak defined by region-of-interest analysis in 19 patients was correctly characterized by scintiphotos in only 8 of these patients. These findings suggested that region-of-interest analysis of hemispheric activity was the more sensitive means of determining or detecting abnormalities on cerebral dynamic studies in cerebral vascular disease than visual inspection of scintiphotos.

The Distribution and Dosimetry of ^{111}In -Bleomycin in Man. E. D. Williams, N. V. Marrick, and J. P. Labner. *Br J Radiol* 48:275-278, 1975.

The distribution of ^{111}In in the human body was studied following the injection of ^{111}In -bleomycin for tumor localization. The measurements were made by means of a 5-in., dual-detector scanner interfaced to a computer. Scan data were recorded for each 8-mm movement of the detectors. Calibration of the scanner was obtained with a source of ^{111}In in a water-filled tank, and scans at different depths. The geometric mean of the total number of counts obtained from the two detectors was found to be within $\pm 4\%$. Adjacent background counts were subtracted from the regions adjacent to each specific organ. Attenuation factors were also determined and corrected. Total-body retention was obtained by means of an iodine crystal detector from the anterior and posterior projections at a distance of 2.8 meters. Retention was determined with each scan examination. Estimated average absorbed doses were determined for the liver, spleen, kidneys, bladder, red bone marrow, and whole body. The absorbed dose varied from 0.26 to 1.03 gm/mCi of ^{111}In -bleomycin for the liver. The estimated error was approximately $\pm 10\%$ of the major value. The whole-body retention was found to be 58% at 24 hr. There was little change in distribution of radioactivity after 24 hr.

^{111}In -Labeled Bleomycin: Clinical Experience as a Diagnostic Agent in Tumors of Thorax and Abdomen. N. V. Marrick, J. P. Lavender, G. W. Poole, P. Stradling, M. L. Thakur, and L. H. Walter. *Br J Radiol* 48:279-285, 1975.

The purpose of the investigation was to determine if there was adequate concentration of ^{111}In in neoplasms for detection, what types of neoplasms can be detected, whether or not occult deposits can be detected, and if accumulation occurs in inflammatory tissue. Sixty-five patients with a variety of neoplasms were studied. Most of the imaging was performed at 72 hr. Tumor uptake of the radiopharmaceutical was visualized in 53 out of 62 scans when tumors were present. The extent of the tumor was underestimated in seven patients and overestimated in five. High interfering uptakes of radioactivity were found in the marrow, spleen, and liver. No lesions of the lungs were detected either peripherally or in the hilar areas that were not visualized by chest x-ray films. In four cases of recurrent tumor all were correctly identified. The bleomycin was also found to be effective in the detection of carcinoma of the breast, and head and neck carcinoma. Two inflammatory lesions were also detected. The authors concluded that ^{111}In -labeled bleomycin does accumulate in a variety of tumors, but that it has not proved effective in demonstrating primary neoplasms, that increased uptake is found in some inflammatory lesions, and that detection was most effective in recurrent carcinoma.

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