

Abstracts in this section pertain to papers to be presented at the 34th Annual Meeting of SNM's Southwestern Chapter, March 16-19, 1989, Little Rock, Arkansas. Program Chairman: Harold Neely, MD.

## SCIENTIFIC PAPERS

Obtaining SPECT Myocardial Sectional Images Utilizing a Rotating Patient Chair. R. Blumhardt, W. Phillips, J.R. Bergh, R.W. Ware, J.C. Lasher. University of Texas Health Science Center, San Antonio.

Single photon emission computed tomography can be accomplished by rotating the patient in a chair in front of a stationary camera. This technique has two practical limitations: one cannot image a debilitated patient and immobilization of the patient is difficult. However, patients undergoing myocardial imaging typically are not debilitated. Further, we have developed a chair that has minimized patient motion, allowing acquisition of high quality myocardial SPECT images utilizing technetium-99m hexamibi. This system provides an economical way to perform myocardial SPECT images, and permits imaging cardiac patients in an upright position.

IS ROUTINE BONE AND LIVER IMAGING IN DETECTION OF OCCULT METASTASES IN REGIONALLY ADVANCED MELANOMA JUSTIFIED? R.J. Campeau, W.A. Salven, E.T. Kremetz. Tulane University Medical Center, New Orleans, LA.

The usefulness of routine bone and liver imaging in regionally advanced melanoma (Stage IIIA, B or AB) was evaluated since it is established that bone and liver imaging are of little value in detection of occult metastases in patients with localized melanoma. A retrospective study was carried out in which medical records of 336 melanoma patients initially staged at our institution between January 1980 and July 1986 were reviewed. Ninety-four patients with regionally advanced disease, but no metastatic disease, by physical exam, chest radiographs and pathology reports had bone scintigraphy and liver imaging (scintigraphy, CT or US) studies. All patients had liver function tests (including alkaline phosphatase and lactic dehydrogenase). Of 68 bone scans performed, none was positive for metastatic disease. Of 97 hepatic imaging studies, two patients had multiple focal defects consistent with metastatic disease (one by CT, one by scintigraphy). In both of these patients, liver enzymes were abnormal. Four patients with initially normal liver imaging studies subsequently, (2,4,16,21 months) demonstrated a rise in liver enzymes and conversion to abnormal liver images consistent with metastatic disease. In regionally advanced melanoma, bone and liver imaging appears unwarranted when signs and symptoms of dissemination are absent by history, physical examination, chest radiography, and hepatic serum enzyme determination.

THE EFFECT OF SHORT-TERM ETHANOL CONSUMPTION ON THE R-E CELL FUNCTION OF THE LIVER: AN EVALUATION OF Tc-99m-SULFUR COLLOID AND E. COLI EXTRACTION CAPACITY BY THE ISOLATED PERFUSED RAT LIVER. Mitali Chaudhuri, Wayne Schwesinger, and Tuhin K. Chaudhuri. Univ. of Texas Health Science Center, and V.A. Medical Center, San Antonio, Texas.

Alcoholics suffer from sepsis more frequently than non-alcoholics. To test whether short-term ethanol consumption has a demonstrable effect on the Kupffer cells of the liver, 8 rats were fed a liquid diet mixed with ethanol (35% of the total calories) for a period of 3 months. A group of eight control rats were paired with equal caloric and equivalent diets but without ethanol. The isolated rat liver perfusion system was used to study the E. Coli and Tc-99m-sulfur colloid extraction power of the Kupffer cells. Alcoholic animals gained less body weight than the control group. However, alcoholic livers weighed 10% more than those of the control group (p 0.05). With a bacterial concentration of ten million/ml and a flow rate of 20ml/min of the perfusate, the control rat livers extracted 64% of the bacteria in a single pass while the alcoholic group extracted 54% (p 0.05). Tc-99m-sulfur colloid uptake paralleled the bacteria uptake. Light microscopic studies demonstrated fatty infiltration within the alcoholic livers, while electron microscopic studies localized the engulfed bacteria within the Kupffer cells of the liver. From these results it is concluded that, even short-term ethanol consumption causes intrinsic damage that inhibits its ability to extract bacteria and sulfur colloid.

DOSIMETRY OF IODOANTIPYRINE LABELED WITH RADIOACTIVE IODINE. \* R.Y.L. Chu, S.U. Ekeh, C. Basmadjian. University of Oklahoma Health Sciences Center and Veterans Administration Medical Center, Oklahoma City, Oklahoma 73104.

To determine dosimetry of iodoantipyrine labeled with radioactive iodine, the pharmaceutical labeled with I-131 was injected into 41 female rabbits. These rabbits were sacrificed in groups at 0.5, 6, 12, 17, 24, 36 and 48 hours after injection. Organs, body fluids and tissue samples were assayed. Results were corrected for decay and then were fitted by a least-square method to a model of one or two exponential functions. With these functions and the decay constants of I-123, I-125 and I-131, cumulated activities were computed for the respective radioisotopes. Tables from MIRD were then used to compute the absorbed dose to various organs and tissues. The bladder received the greatest radiation dosage, which

is 3-5 times the whole-body dose. The whole-body absorbed doses from I-123 and I-125 are comparable, whereas that of I-131 is 4-5 times as much.

\*This work was supported by a grant from the Veterans Administration.

RADIOAEROSOL CONTAINMENT SYSTEM. V.J. Ficken, L.D. Morefield, C.J. Ryals and E. W. Allen. The University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma.

During the administration of aerosolized <sup>99m</sup>Tc-DTPA to the patient, <sup>99m</sup>Tc-DTPA can leak from a poor seal formed by the patient's mouth around the aerosol delivery mouthpiece. To contain this release we have developed a radioaerosol containment system (RCS) which effectively scavenges the aerosol from an area around the patient's face. The RCS unit is comprised of an oxygen face tent specially adapted to receive the mouthpiece of a radioaerosol delivery system (RDS) and the patient uses the mouthpiece normally. The usual oxygen delivery port of the face tent is connected to a fine particle moisture exchange filter and vacuum system which creates the necessary air flow.

The vacuum may be conveniently created from pressurized oxygen and a venturi system or directly from a small hand held vacuum cleaner. Using a graduated manometer we determined that a negative pressure of 2 cm of water is required to effectively scavenge the radioaerosol which may be released when an oxygen flow of 12 l/min to the patient is used. Of the four types of commercially available filters evaluated, the Pall-HME was found to be the most efficient filter for clearing the aerosol.

We have quantitatively measured with the RCS the amount of radioaerosol released during a standard procedure using 60mCi of <sup>99m</sup>Tc and a nebulizer oxygen flow at 12 l/min for 6 to 8 minutes. An average of 230uCi (range 2 to 1350 uCi) <sup>99m</sup>Tc was released from each of five cooperative patients during the aerosol delivery procedure.

In conclusion, an economical and disposable device has been developed which minimizes the release of radioactive aerosol during delivery of the aerosol to the patient. The device is well accepted by the patient and it has also permitted the quantitative measurement of radioactive aerosol which may be released to the room atmosphere.

SLANT-HOLE SINGLE PHOTON EMISSION COMPUTED TOMOGRAPHY (SH-SPECT) EXPERIENCE WITH 305 CONSECUTIVE-201 MYOCARDIAL TOMOGRAMS. B.F. Byrd, R.E. Jackson III, A.C. Gonzalez. Amarillo Diagnostic Clinic, Amarillo

The advantages of slant-hole single photon emission computed tomography are: (1) low cost (2) adaptability to most any camera and computer system (3) patient comfort (standard imaging tables can be used) (4) production of interpretable analog planar slices of statistically adequate counts as well two-dimensional computer reconstructed slices (5) clear analog display of pulmonary activity (6) easy analog display of potential errors in acquisition such as patient motion, arm-vein artifact, heart size changes, and repositioning errors (7) rapid computed processing (total reconstruction and processing time of less than 4 minutes per patient) (8) potential adaptability for HS-SPECT of small areas such as the spine or thyroid. SH-SPECT was used consecutively in 305 cases, of which 292 had anatomic confirmation. True positives were 84% and false positives 16%. False negatives and true negatives could not be estimated since diagnostic negatives were not usually catheterized. We conclude from these results that SH-SPECT is comparable in accuracy and offers less grounds for acquisition and processing errors than Thallium-201 rotational SPECT. Discussion of the technique and detailed analysis of data will be presented.

UTILIZATION OF AUTOLOGOUS LABELLED <sup>111</sup>INDIUM LEUCOCYTES IN INFLAMMATORY BOWEL DISEASE. W. T. Harris, J. L. Prather, D. Weiss. St. Vincent Infirmary Medical Center, Little Rock, Arkansas.

A series of patients presenting with abdominal-pelvic symptoms were scanned with <sup>111</sup>Indium Leucocytes in an attempt to identify patients with inflammatory bowel disease. The results were compared to biopsy findings, fiberoptic examinations and radiographic examinations. <sup>111</sup>Indium leucocyte imaging was extremely sensitive in detection of disease as well as showing the severity of disease. Example cases will be shown.

APPLICATIONS OF CLINICAL PET IN A COMPREHENSIVE CANCER CENTER. E.E. Kim, R.S. Tilbury, T.J. Tewson, A. Ebran, N. Mullani, and T.P. Haynie. UT M.D. Anderson Cancer and UT Health Science Center, Houston

Development of a clinical Positron Emission Tomography (PET) program in oncology at the UTHDACC was begun in 1984 to promote the use of the technology in the investigation of cancer. The presence of a clinical PET center at the UTHSCH was an influence in the decision. The Positron Diagnostic and Research Center (PDRC) began operations at the same time at UTHDACC in 1981 installing a 42 MeV cyclotron for neutron beam therapy of cancer patients. Quantitative determination of blood flow, oxygen utilization, glucose and amino acid metabolism for tumor diagnosis and therapy are planned to increase our fundamental understanding of in vivo cancer

metabolism. One of the major clinical problems to be studied is the differential diagnosis of residual or recurrent tumor from the therapeutic complications including necrotic processes in the brain and liver by utilizing  $^{18}\text{F}$ -FDG and  $^{15}\text{N}$ -ammonia. Other research projects will measure the rate of utilization of important biochemical substances that supply energy to tumors, and in pharmacokinetic studies of cancer chemotherapeutic agents. The progression or regression of tumors under different forms of treatment can be determined at a time when modification in the treatment plan can be undertaken. In this way, PET technology has the potential to reduce costs and improve the quality of life in patients suffering from cancer.

EVALUATION OF RESPONSE TO INTERFERON THERAPY IN HAIRY-CELL LEUKEMIA BY Tc-99m COLLOID LIVER/SPLEEN SCANS. E.E. Kim, R. Abello, D.A. Podoloff, L.M. Lamki, T.P. Haynie, G. Mavligit. UT M.D. Anderson Cancer Center, Houston

Hairy-cell leukemia is a distinct lymphoid tumor, and the hairy-cells infiltrate the bone marrow, the red pulp of the spleen, and the portal triads of the liver.

We have prospectively evaluated the findings of liver/spleen scans using Tc-99m sulfur colloid in patients with histologically proven hairy-cell leukemia. The disease in 41 patients was seen predominantly in men (M:F=35:6) with ages ranging from 30 to 77 yrs. Twelve patients were treated with splenectomy and the other 29 with alpha-2b interferon.

Of 30 patients without prior splenectomy, 25 had splenomegaly (mild 12, moderate 2, marked 11) on initial scans. Two of them showed slight colloidal shift from the liver to spleen, and three revealed minimal marrow activity in the spine. No space occupying splenic lesions were noted. There were mild to moderate hepatomegaly in 5 of 41 patients on initial scans. Hepatic activity was uniform in 40 patients.

Sixteen patients with splenomegaly had follow-up scans following interferon therapy, and enlarged spleen rapidly became smaller and returned to normal in 13 within 5-27 months. Splenic activity became relatively greater than the liver activity in 8 patients in 8-24 months without suggesting an immunologic splenic response to interferon therapy. Further study of the degree of this change with other parameters of clinical response is under evaluation.

It is concluded that Tc-99m colloid liver/spleen scans are very useful in assessing response to interferon therapy in hairy-cell leukemia.

DETECTION OF BREAST CANCER WITH INDIUM-111 LABELED MONOCLONAL ANTIBODY B72.3 L. Lamki, A. Buzdar, E. Singletary, D. Podoloff, M. Rosenblum, L. Esparaza, V. Bhadkamkar, R. McGuire, J.L. Murray. UT M. D. Anderson Cancer Center, Houston, Texas & Cytogen Corporation, Princeton, New Jersey.

We have evaluated the pancarcinoma MoAb B72.3 for detection of primary breast cancer. Fourteen preoperative patients (pts) with breast cancer (2 with bilateral lesions) were evaluated using 0.2 mg of B72.3 (6 pts), 2 mg (6 pts) or 20 mg (2 pts) intravenously. In each case the MoAb was labeled with 5 mCi In-111 using the Cytogen GYK method of conjugating bifunctional DTPA to the carbohydrate moiety of the IgG. All pts tested negative for anti-mouse antibodies (HAMA) prior to injection. Scintigraphic digital images were acquired at 4 hours (h) and again at 48h and 96h including total body, spot views and SPECT of chest and abdomen. Regions of interest over specific organs were utilized for body distribution. Blood and urine were collected serially for pharmacokinetics and In-111 excretion. We detected 14 out of 14 breast lesions (100%) and the 2 not detected turned out to be true negatives. Three metastatic lesions were also detected in 2 pts. Two occult lesions were detected in one pt that were confirmed in follow-up. There were 7 axillary lymph node lesions and none of them imaged. There was no evidence of toxicity. Additionally, none of the pts developed HAMA on repeat examination and on follow-up. This study suggests that In-111 B72.3 has a very high sensitivity for primary breast carcinoma and low sensitivity for axillary lymph node metastases.

PHASE II CLINICAL STUDY OF THERAPEUTIC USE OF STRONTIUM-89 FOR PALLIATION OF PAINFUL BONE METASTASES. L. M. Lamki, T.P. Haynie, F. Dexeus, D. Johnson, C. Logothetis, A. von Eschenbach. UT M. D. Anderson Cancer Center, Houston, TX.

Strontium-89 chloride (Sr-89) (T<sub>1/2</sub> 50.5 days) a B emitting analogue of calcium, was evaluated in painful bone metastases in a dose-ranging study of 20 patients (pts): 19 males with prostatic cancer, median age 61, and 1 female with breast cancer, age 33. All pts had at least 2 areas of painful metastases and were not considered suitable candidates for further x-ray or chemotherapy. Pts were divided into 4 groups of 5 pts each according to dose of Sr-89 injected intravenously (25, 40, 55 or 70 uCi/kg). Pts were followed for up to 3 months post a single injection of Sr-89 (provided by Amersham International, Arlington Heights, IL). Diaries regarding pain, medication use and sleep were kept daily. Hematology and blood chemistry evaluations were performed serially. Urine excretion of Sr-89 was measured for 24 hours post-Rx. Bone scan and bone survey were performed at beginning and end of the study. There were eleven patients (55%) who had overall improvement while 9 pts (45%) deteriorated. Ten out of 20 pts completed the 3 months evaluation, and 8 (80%) of these had improvement. Pts who improved reduced analgesic intake by 25-75%. Hematologic

toxicity was observed in 9 pts (3 slight and 6 mod/severe drop of platelet count). There was a positive correlation between clinical improvement and no hematologic toxicity. No statistical correlation was observed between dose or urine excretion of Sr-89 and overall response.

PRECISION OF REGIONAL BMD FROM TOTAL BODY SCANS. A. LeBlanc, V. Schneider, D. Engelbretson, H. Evans, S. Jhingran. The Methodist Hospital, Krug Int., U.T. Health Science Center, Houston.

Significant controversy exists as to which skeletal region is most appropriate to accurately diagnose disease and to monitor changes in bone mineral. The newer instruments capable of scanning the whole body would have significant utility if multiple regions could be investigated simultaneously with a precision equivalent to specific regional scans. We have attempted to assess this by scanning a whole body phantom (Rando) twenty times over a 12 month period and by repeat weekly scanning (2-5 times) of nine normal volunteers (37 scans). Each scan was performed and analyzed by the same individual. The automatic region selection was adjusted to match the previous scan as closely as possible. For the 20 phantom scans, a coefficient of variation (C.V.) was calculated for the total body and each region. Similarly a C.V. was obtained for each region of each subject and the mean of the individual C.V.'s for each region were then calculated. The results are:

	% Coefficient of Variation									
	head	arms	legs	trunk	ribs	pelvis	spine	thoracic	lumbar	total
Phantom	3.0	3.0	2.0	2.0	3.0	3.0	2.0	4.0	5.0	1.0
subjects	2.7	2.7	1.1	2.0	1.9	1.5	2.0	3.4	3.9	1.4

From these results we conclude that the total body scan has excellent precision and while some regions have acceptable to good precision, e.g., legs, trunk, spine, other regions have poor precision, e.g., thoracic and lumbar spine.

COMPARISON OF GASTROESOPHAGEAL SCINTIGRAPHY AND BARIUM EXAMS WITH pH PROBE STUDIES IN PEDIATRIC PATIENTS. JC Leonard, WR PUFFINBARGER, MF MORRIS, DC MOUTOS, R TORRES-PINEDO. CHILDREN'S HOSPITAL OF OKLAHOMA AND THE UNIVERSITY OF OKLAHOMA, OKLAHOMA CITY.

Numerous studies are employed to evaluate the child with feeding problems. We identified 31 children with an average age of 1.72y, range 14d-13y, with 25 being less than 1y, who had both 24 hour pH probe and isotope (GER) studies within 5d of each other. Seventeen children had barium (Ba) UGI within 15d of GER. 29/31 had probe study evidence of GE reflux and 25/29 were identified by GER (sens=0.86%) and 10/15 had reflux on Ba (sens=0.67%). Four patients had false (-) GER, five had false (-) Ba and GER and Ba each had one true (-) and one false (+) exam. The true positive ratio for GER was 0.94 and 0.63 for Ba.

Prior to selecting a therapy regimen, the rate of gastric emptying (GE) is frequently needed. GER identified 12 pts with GE <50% at 1 hour, while Ba identified only 5, 1 of whom was normal by GER. While patients with delayed emptying tended to have an abnormal endoscopic evaluation, a definite relationship could not be shown, possibly related to the interval between exams.

In summary, the isotope GER exam is an excellent outpatient screening test for reflux. While the identification of reflux may be superfluous if a probe study is used to identify a pattern of reflux, the information regarding GE is useful in the selection of additional studies and in planning a treatment regimen.

VALIDATION OF THE GATES GFR METHODOLOGY IN CHILDREN. WR PUFFINBARGER, DM BURROW, JC LEONARD. CHILDREN'S HOSPITAL OF OKLAHOMA AND THE UNIVERSITY OF OKLAHOMA SCHOOL OF MEDICINE, OKLAHOMA CITY.

The Gates method of measuring GFR is widely used, but the youngest patient in his series was 17y, in part related to the difficulty of obtaining adequate 24 hour urine collections. Schwartz has published formulas which relate serum creatinine (Scr) to creatinine clearance based on the patient's height and an age specific constant. We identified 85 patients with a Gates GFR, using background regions inferior to the kidneys, and Scr determination within 24 hours and compared the resultant calculations of GFR.

AGE	7d<age<1y	1y<age<13y	13y
NUMBER	19	43	19
SLOPE	1.13±0.22	1.01±0.16	0.80±0.15
INTERCEPT	-4.1	8	15.3
R VALUE	0.783	0.704	0.789

Test of the mean differences failed to show any significant difference between the methods. With a lateral background there was no significant difference between the methods, but the two Gates methods are not identical when using the same regression equation. The inferiorly placed regions yield a consistently higher value. In addition, correcting for body surface area resulted in a grossly overestimated GFR for infants, with less effect being noted as the child approached a standard 1.73m<sup>2</sup> surface area.

In conclusion, the Gates method is accurate for monitoring renal function in children and the method intrinsically corrects for body surface area differences.

ABSORPTION OF Tc-99m: PERTECHNETATE DURING NUCLEAR CYSTOGRAPHY IN PATIENTS WITH BLADDER AUGMENTATION. B.L. Lowe, J. C. Leonard. Oklahoma Childrens Hospital, Oklahoma City, Oklahoma.

Although absorption of Tc-99m Pertechnetate (04) during cystography has been documented in blood samples at the completion of cystography (1), visual uptake of the tracer has not been demonstrated in routine studies (1,2). Patients with bladder augmentation using segments of bowel have different absorption properties and absorb Tc-99m04 across the implanted membrane. Eleven patients were studied

following bladder augmentation using segments of bowel. All studies using Tc99mO4 demonstrated an increase in body background activity when compared to pre-operative studies and studies performed on patients without bladder augmentation. Faint visualization of the kidneys from removal of this background activity, rather than from reflux, was observed in four patient studies. The possibility exists that this removal of background counts could be confused with actual reflux in these patients and could subsequently affect GFR results if done immediately post cystography. This phenomenon was prevented in three post-operative studies by using Tc99m sulfur colloid for nuclear cystography. Recent changes in NRC regulations, regarding routes of administration, now permit the use of this compound without requiring license amendment.

1. Conway, J. et al American J. of Radiology 115:720, 1972
2. Blaufox, M. et al J. of Nuclear Medicine 79:239, 1971

**SCINTIGRAPHIC DETECTION OF PARATHYROID ABNORMALITIES UTILIZING TECHNIUM 99m/THALLIUM 201 SUBTRACTION TECHNIQUE.** D.W. Weiss, J.C. Kleinschmidt, W.T. Harris, J.L. Prather. University of Arkansas for Medical Sciences and St. Vincent Infirmary, Little Rock, Arkansas.  
Functional parathyroid abnormalities are readily detectable due to improved techniques of serum calcium determination and parathyroid hormone assay. Variable anatomy of the multiple parathyroid glands including possible mediastinal or entirely intrathyroidal placement complicates surgical removal of hyperfunctioning tissue. Preoperative localization of parathyroid adenomas, hyperplasia, or, rarely, parathyroid carcinoma can be performed scintigraphically utilizing a Technium 99m/Thallium 201 subtraction technique. Our experience with 33 patients from 1985 through 1988 will be summarized along with correlation with serum calcium determinations, parathyroid hormone assay, and surgical pathology. Sensitivity and specificity of the exam and importance of the size of the adenoma will be discussed.

**COMPARISON OF SERUM ALKALINE PHOSPHATASE LEVELS AND BONE SCINTIGRAPHY IN THE EVALUATION OF STRESS FRACTURES IN MILITARY BASIC TRAINEES.** Nancy Zefo, James D. Heironimus, Frederick L. Weiland. Wilford Hall USAF Medical Center, Lackland AFB, San Antonio.

The level of serum alkaline phosphatase (AP) can rise after any uncomplicated fracture. We prospectively evaluated 75 airman basic trainees, ages 18-26, with bone scintigraphy for suspected stress fracture of the lower extremities and compared scintigraphic results with AP levels obtained at the time of the evaluation. Stress injuries were graded using the criteria described by Zwas, et al. Normal AP levels at our institution are 53-126 i.u./L in females 16-49 years, 75-286 in males 16-18, and 34-126 in males 19-39.

All patients except one had AP levels within normal boundaries. In the 46 females evaluated, however, levels  $>$  than 100 appeared to significantly correlate with stress injuries Grades III-IV ( $p < 0.05$ ). Conversely, levels  $<$  100 correlate with injuries Grades 0-II, low probability for significant injury. In the 29 males examined, the correlation between AP levels and grade of stress injury was not statistically significant ( $p = 0.18$ ). Of additional interest, females overall had lower normal AP levels than males. One female patient with an abnormally high level (229) demonstrated multiple Grade IV injuries.

Previous studies have shown that fractures of higher grade (III-IV) require prolonged rest to achieve recovery. Our preliminary investigation suggests that in female basic trainees referred for evaluation of stress fracture, an AP level  $>$  100 i.u./L correlates with significant injury, probably necessitating bone scintigraphy for assessment of fracture location and prolonged rest for recovery. A level of 100 indicates a normal patient or one with mild injury that can be rested short-term and may not require scintigraphy at the time of initial evaluation.

**AN EVALUATION OF FLOOD FIELD CORRECTION IN THALLIUM SPECT RECONSTRUCTION.** B.L. Lowe, E.D. Ferguson, R.L. Nickerson, E.W. Allen, M.D. VA Medical Center, Oklahoma City, Oklahoma.

Flood field correction of SPECT images has been viewed as necessary for accurate reconstruction. However, it is possible that flood field correction may not be necessary for thallium SPECT images since thallium images inherently have poor resolution. The flood field correction takes up a large amount of computer memory and the correction adds onto processing time. We undertook a study to determine if there is a statistical significance between flood field corrected (FFC) thallium images and non-flood field corrected (NFPC) thallium images on the Siemens ZLC 7500 orbiter camera using a circular orbit of 180° and imaging for 30 second per image in 3° increments. 10 patients were studied with each patient study being both FFC and NFPC. The statistical analysis was done on Maltese Cross images which are parametric representations of the SPECT image short axis slices of the heart from the apex extending to the base. Horizontal image profiles through the center of the these parametric images thus represent data from the septum, apex and posterolateral wall while vertical profiles provide data on the superior, apex and inferoposterior walls. No statistical difference was demonstrated between FFC and NFPC results at the 99% confidence level. Although our Siemens Orbiter ZLC 7500 camera shows no significant difference between FFC and NFPC, the camera should be carefully monitored for non-uniformity, collimator defects or any changes in resolution, since these factors could affect the raw image uniformity. Each camera should be tested to insure that the systems uniformity is adequate before omitting the flood field correction in thallium reconstruction.

**COMPARISON OF IMAGING PARAMETERS MEASURED FOR THREE MODERN GAMMA-CAMERA SYSTEMS.** E.L. McGuire, G.V. Dalrymple, John L. McClellan Memorial Veterans' Hospital and University of Arkansas for Medical Sciences, Little Rock.

Physical imaging parameters, including SPECT, have been measured

and compared for three modern gamma cameras -- GE 400A/T, Siemens ZLC 7500, and Toshiba GLC-602A. Test protocols include some NEMA tests. Data we present are conventional resolution, uniformity, and sensitivity values, as well as similar SPECT values measured using the Jaszczak phantom.

**COMPARISON OF INCSTAR CYCLOTRAC<sup>®</sup> (I-125) AND SANDOZ SANDIMMUNE<sup>™</sup> (H-3) WHOLE BLOOD ASSAYS FOR THE MEASUREMENT OF CYCLOSPORINE (CsA).** L.A. Monroe, W.H. Moore, R.D. Dhekne, S.A. Healy. St. Luke's Episcopal Hospital and Baylor College of Medicine, Houston.

CsA is a potent immunosuppressant used in organ transplantation which requires frequent monitoring of blood levels. A new generation of RIA kits based on monoclonal antibodies (MAB) has been introduced for the specific measurement of CsA parent compound. We compared two liquid phase competitive RIA methods utilizing the same MAB, INCStar Cyclotrac<sup>®</sup> (I-125 Cs) and Sandoz Sandimmune<sup>™</sup> RIA (H-3 Cs) using whole blood specimens from 170 cardiac and renal allograft recipients. Both methods employ whole blood extraction with methanol. H-3 Cs utilized charcoal separation of bound and free antigen followed by liquid scintillation counting, while I-125 Cs involves a double antibody separation. All CsA specimens were collected in EDTA and analyzed the same day according to the respective kit protocols.

Intra-assay precision at CsA concentrations of approximately 100, 200, and 500 ng/ml was 9.8, 6.9, and 7.8 CV% for I-125 Cs and 6.9, 5.3, and 5.3 CV% for H-3 Cs. Interassay precision at the same CsA levels was 16.7, 10.3, and 14.1 CV% for I-125 Cs and 13.2, 17.5, and 15.4 for H-3 Cs. The lowest detectable concentration (3 SDs from the counts at maximum binding) was 21.5 ng/ml for I-125 Cs and 25 ng/ml for H-3 Cs. Average recovery of CsA using 4 high patient samples diluted to low concentrations were 114% for I-125 Cs compared to 104% using H-3 Cs. In 170 patient samples assayed by I-125 Cs (y) and H-3 Cs (x), correlation was 0.927, slope = 0.978X, intercept = 16.41.

In conclusion, I-125 Cs using the specific MAB produced by Sandoz gives comparable results to H-3 Cs with the same antibody, and offers the advantages of faster turn-around-time and convenience of gamma counting.

**PROSTATIC ACID PHOSPHATASE (PAP) AND PROSTATIC SPECIFIC ANTIGEN (PSA) IN PROSTATIC CARCINOMA.** L.R. Witherspoon, S.E. Shuler, H. Neely, R. Sonnemaker, K. Alyea, S. Gilbert, F. Baird. Ochsner Clinic and Alton Ochsner Medical Foundation, New Orleans.

We examined the utility of PSA and PAP in a three year prospective study of 224 patients with prostatic carcinoma, using competitive RIAs from Diagnostic Products Corp, Los Angeles, CA. A single measurement was made in 57 patients; 879 were made in the remaining 167. There was no change in clinical course in 81 patients while 86 experienced 75 episodes of progression (p) and 53 of regression (r). We calculated the sensitivity (se), specificity (sp) and positive predictive value (ppv) of the two markers, using PAP 2.0, PSA 5.0 ng/ml as upper limits for absence of disease. Both changed simultaneously in 26 episodes of p and in 42 of r. In p, PAP increased first 3 times, followed by PSA twice, while PSA increased first in 41, followed by PAP in 21. In r, PAP declined first in 3 followed by PSA, while PSA declined first in 8 followed by PAP in 7. In p, se of PAP was 67%, of PSA 92% (93% for both markers combined). In r, se of PAP was 98%, of PSA 100%. Either or both markers were elevated in 12 of 81 patients thought not to have disease (sp 88%). The ppv for an elevation of PAP was 94%, 92% for PSA. We find that PSA is clearly superior to PAP in its ability to detect progression of prostatic carcinoma, while the two markers are similar in documenting response to therapy.

**DIAGNOSIS OF CORONARY ARTERY DISEASE IN CARDIAC TRANSPLANT PATIENTS.** W.H. Moore, R.D. Dhekne, E.J. Ladwig. St. Luke's Episcopal Hospital and Baylor College of Medicine, Houston.

Patients who have undergone cardiac transplantation have a higher prevalence of coronary artery disease (CAD) than would be expected for the relatively young age of the cardiac donors. Physiologic changes associated with denervation during the transplantation procedure adversely affect the ability of standard noninvasive tests to detect this CAD. Limited heart rate response to exercise and absence of anginal chest pain coupled with the possibility of other, non-CAD causes of cardiopulmonary disability in these patients, make clinical diagnosis of CAD difficult.

For this pilot study, we performed radionuclide cardiac imaging in 63 patients 3 to 58 months post-transplantation. Segmental wall motion abnormalities were present in 51% of patients but did not correlate with the presence or absence of CAD though there was good correlation with the presence of cardiac dysfunction. Myocardial perfusion scans were performed in 18 patients using Tl-201 and were highly sensitive and moderately specific for CAD.

We suggest that thallium scanning, based on higher specificity will be the method of choice for the evaluation of CAD in transplant patients. Further studies are ongoing.

**SPECT LIVER/SPLEEN SCANS IN PATIENTS WITH LEUKEMIA.** D.A. Podoloff, W. Broussard, E.E. Kim, L.M. Lamki, M.J. Keating, T.P. Haynie. University of Texas M.D. Anderson Cancer Center, Houston, Texas.

Liver/Spleen Scans in 48 patients with leukemia were performed with dynamic perfusion, static planar images and SPECT following 6-8 mCi Technetium-99m sulfur colloid. Using a GAP collimator, SPECT studies were performed with 64x64 matrix and 128 steps (approximately 100,000 cts/image). Filtering of raw data was accomplished with a Butterworth filter ( $CO = .35$  Nyquist,  $pf = 10$ ). Transverse, coronal, and

sagittal images were obtained. Images were interpreted with regard to organ size, liver/spleen count density ratio, focal or diffuse defects as seen in planar and SPECT images by experienced nuclear medicine physicians. In 31 of 48 patients (65%) significant nonuniform distribution of Technetium-99m sulfur colloid on SPECT images was seen, but not readily apparent on planar static studies. Compared to standard imaging criteria such as liver/spleen size, scintiangiographic findings, liver/spleen count density ratio, and focal or diffuse defects, the diffuse nonuniformity was the commonest finding in this group of leukemic patients, observed in 13 of 14 patients with CML, 10 of 17 patients with CLL, 3 of 5 patients with Hairy Cell Leukemia, and 5 of 12 patients with other leukemias. Correlative images, pathology reports, liver chemistries, and clinical outcome evaluation was accomplished in these leukemic patients. In leukemia nonuniformity on SPECT is the commonest scintigraphic abnormality, although it is nonspecific and multifactorial in nature, at times associated with infiltration, abnormalities of liver chemistries, but also not necessarily predictive of any clinical condition or course. The finding of diffuse nonuniformity on SPECT images in leukemic patients must be evaluated with caution.

**COMPUTER SUBTRACTED THALLIUM CARDIAC IMAGES: DESCRIPTION OF METHOD AND REPORT OF RESULTS OF TWO HUNDRED PATIENTS.** G.L. Purnell, B.J. Baker, C.M. Boyd, and G.V. Dalrymple. John L. McClellan Memorial Veterans's Hospital, University of Arkansas for Medical Sciences, and Radiology Consultants of Little Rock, P.A., Little Rock.

<sup>201</sup>Thallium exercise stress studies frequently are used for the non-invasive diagnosis of Coronary Heart Disease as well as for following patients after treatment (angioplasty, surgery, or medical). Unfortunately, interpretation of the studies is difficult even if one has sophisticated image processing capability (SPECT, "bull's-eye" analysis, etc.). We have developed a method which uses only raw planar images (anterior, 35° LOA, and 65° LOA). The computer finds the maximum pixel count for each image. An average is made of 9 pixels adjacent to the maximum pixel. The original images are then manipulated such that either the range 65%-100% or 75%-100% of the count rate is displayed on a color coded scale. The immediate post stress images and the 4 hour redistribution images are displayed side-by-side. The results of this simple operation allow regions of reversible ischemia as well as fixed defects to be visualized rapidly. The method can be used with the most limited nuclear imaging systems. The cost is less than \$5.00 per patient (for Polaroid film).

We will present results of 200 consecutive examinations. The computer subtraction method will be compared with other types of output: 1) filtered images, 2) SPECT analysis, and 3) "bull's-eye" analysis.

**SIGNIFICANCE OF DIFFUSE HEPATIC UPTAKE ON RADIOIODINE (I-131) DIAGNOSTIC AND POST THERAPY TOTAL BODY SCANS (TBS) IN PATIENTS WITH WELL DIFFERENTIATED THYROID CANCER.** A. Ramos-Gabatin, W.T. Phillips, R.W. Ware, R. Blumhardt. Wilford Hall USAF Medical Center and University of Texas Health Science Center San Antonio (UTHSCSA)

Diffuse hepatic uptake has been reported in a few patients with residual postoperative thyroid tissue or with functioning liver metastases who received I-131 diagnostic tracer and/or therapy doses from which images were derived. We retrospectively reviewed the TBS of patients who had thyroidectomy and radioiodine therapy for well differentiated thyroid cancer at UTHSCSA during a 10 year period from 1977 to 1987. We report the frequency and possible significance of the diffuse liver uptake both in the diagnostic and post therapy TBS. There were 73 diagnostic and 30 post therapy TBS in 30 patients (10M, 20F, mean age 35 years). Total body scans in relation to liver uptake were categorized as follows: Group 1: Diagnostic TBS without neck or thyroid activity - not one had hepatic uptake (34 TBS). Group 2: Paired post diagnostic and post therapy TBS - 23 sets of post-diagnostic and post therapy TBS (total - 46 scans in 19 patients). Only one of the 23 diagnostic TBS (4%) had 1+ diffuse hepatic uptake which became 2+ in the post therapy scan. Fifteen of 23 (65%) post therapy TBS had diffuse hepatic uptake versus 8/23 (35%) without hepatic uptake. The 14 patients (out of the 15) who had hepatic uptake had negative TBS during the 1 to 6 year follow up period. Group 3: (a) Unpaired diagnostic TBS with neck activity (16) - 2/16 (12.5%) had 1 to 2+ diffuse hepatic activity; (b) Unpaired post therapy TBS (7) - 4/7 (71%) had 1 to 4+ diffuse hepatic uptake. Summary and Conclusion: 1) Diffuse hepatic uptake is seen in 8.5% (3/35) of positive diagnostic TBS; (2) It is more frequent in post therapy TBS occurring 65% of the time (19/30 post therapy TBS). 3) Diffuse hepatic uptake seems to be related to the I-131 dose but not to the time of imaging or subsequent TBS results.

**A PROSPECTIVE COMPARISON OF TECHNETIUM 99m-Hexamibi (RP-30A) AND THALLIUM-201 SPECT SCINTIGRAPHY IN THE DIAGNOSIS OF CORONARY ARTERY DISEASE.** Captain Penny R. VandeStreek (ACP Associate), Colonel Frederick L. Welland (ACP Member), Major David A. Belvedere, Major Leo J. Spaccavento, F.A.C.C.P., Dr. Warren Breisblatt, F.A.C.C.P., Wilford Hall USAF Medical Center, Lackland AFB, Texas, 78236.

The purpose of this study was to compare Technetium 99m-Hexamibi (RP 30-A) to Tl-201 myocardial imaging in the evaluation of patients with suspected coronary artery disease. We studied fifteen patients (12 male, 3 female, mean age 53.4 years) prospectively with Tl-201 and RP 30-A SPECT imaging. All patients had coronary artery angiography. There were 22 significantly stenosed coronary arteries found in 11 patients. Immediate and delayed stress images were obtained after an average dose of 5.4mCi Thallium-201. RP 30-A rest and stress studies were done within one week of thallium imaging utilizing an average dose of 32mCi. The exercise double product was similar for both studies. The left ventricle was divided into 6 segments in each of 3 short axis and 1 long axis tomographic projection. Images were interpreted by 4 blinded observers. Analysis of the Tl-201 and RP 30-A results identified 338 evaluable L.V. segments with an overall concordance of 75.4%. Thallium-201 revealed myocardial defects in 97 segments with detection of 17 of 22 (77.3%) significant coronary stenotic lesions. RP 30-A detected 85 abnormal segments, also corresponding to 17/22 stenosed

arteries. Thallium sensitivity for any significant CAD was 91% with specificity of 25%. RP 30-A had sensitivity of 73% with a specificity of 50%. These differences were not significant.

RP 30-A had a behavior similar to Tl-201 in our initial 15 patients. If these observations are confirmed by further investigation, the numerous advantages of technetium over thallium may make RP 30-A the imaging agent of choice in the evaluation of patients with suspected CAD.

**A PULSE SEQUENCE FOR CINE NMR IMAGING OF THE HEART.** R.E. Wendt III, P.H. Murphy, W.H. Moore. Nuclear Medicine Service, St. Luke's Episcopal Hospital, and Department of Radiology, Baylor College of Medicine, Houston, Texas 77030.

We have developed and evaluated an NMR imaging pulse sequence which produces high quality cine images of the human heart. It uses an ECG-triggered, velocity-compensated FISP sequence with an asymmetric echo. The desired anatomic levels (typically one or two in number) are excited repeatedly during the course of the R-R interval to achieve high temporal resolution. The T<sub>R</sub> of the single level sequence is 25 ms which provides a 40 frame/s cine rate. We have found that 128 line, two acquisition data produce better images than do 256 line, one acquisition data. Since gradient-refocused sequences such as FISP require steady state excitation of the spins, the duration of the data acquisition is 272 times the patient's R-R interval. Patients are usually imaged in a short axis view. The blood in the chambers appears bright and, in normal volunteers, relatively uniform. With a tip angle of 30°, the myocardium is readily distinguished from the blood. The velocity-compensation of the slice-selection and frequency-encoding gradients and the short echo time T<sub>g</sub> virtually eliminate phase-encoded motion artifacts in patients with regular heart beats. The frame rate of this pulse sequence exceeds the cine display capacity of the NMR imaging console, so we transform the images to a multigated format and use a nuclear medicine computer system for display, analysis, and videotaping. The images are analyzed for wall thickening and chamber volume. Traditional gated blood pool techniques such as phase analysis are relatively uninformative. The NMR data are tomographs rather than projections and the intensity of the blood in the NMR images is influenced by turbulence and by cohesive motion.

## SCIENTIFIC EXHIBITS

### UNUSUAL AND SUBTLE SCINTIGRAPHIC FINDINGS IN THE EVALUATION OF THE BATTERED CHILD

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The incidence of non-accidental trauma, or at least public awareness of it has increased dramatically over the past several years. Child abuse is second only to sudden infant death syndrome and true accidents as a killer of children. This problem has not only medical but social and legal ramifications as well. Consequently, recognizing non-accidental trauma has become increasingly important for the radiologist.

Nuclear Medicine Imaging plays a key role in the evaluation of skeletal trauma. Recent findings in our department show that diagnoses other than skeletal trauma are often identified by recognition of subtle and unusual scintigraphic findings. The subject material will place strong emphasis on the less mentioned but often more important visceral and intracranial injury. Selected scintigrams from 21 cases of child abuse as well as appropriate correlative radiographs will be presented.

Specific scintigraphic abnormalities to be demonstrated include:

- Visceral and soft tissue (e.g., duodenal hematoma, splenic laceration, renal contusion, hepatic hematoma, rhabdomyolysis and soft tissue hematoma).
- Cranial (e.g., intracranial bleed, edema, and infarct, cephalohematoma, skull fracture and widening of sutures).
- Skeletal (e.g., subtle long bone fractures as well as the more obvious and typical diaphyseal and metaphyseal fractures).

**AN ISOLATED RAT LIVER PERFUSION SYSTEM FOR THE STUDIES OF R-E CELL FUNCTION: VIABILITY OF THE SYSTEM AND THE SIMILARITY OF BACTERIA AND Tc-99m-SULFUR COLLOID REMOVAL POWER OF THE KUPFFER CELLS.** Mitali Chaudhuri, John Seidenfeld, Roy Baldwin and Tuhin Chaudhuri. University of Texas Health Science Center, John Marshall High School and V.A. Medical Center, San Antonio, Texas.

Since the liver is the major organ of reticulo-endothelial cell location, an isolated rat liver perfusion system was used to study: a) viability of the liver perfusion system b) the cellular localization of the captured bacteria, and c) the effect of flow rate and bacterial concentration of the perfusate on the extraction capacity. With the exception of cellular localization, bacterial studies were compared with Tc-99m-sulfur colloid studies. It was found that the system could remain viable at least for two hours. With a bacterial (*Pseudomonas aeruginosa*) concentration of 10 million/ml and a flow rate of 20 ml/min, the rat liver could extract about 65% of the bacteria in a single pass. The extraction capacity was diminished with the increase in the flow rate. The percent extraction was also diminished with the increase in bacterial concentration but the total extraction was increased. The percent extractions of Tc-99m-sulfur colloid used in the same experiments were parallel with those of the bacteria. Electron microscopic studies revealed the bacteria localization to be within the Kupffer cells. It is concluded that isolated liver perfusion system is a viable method for measuring the bacterial and sulfur colloid phagocytic power of the liver.

Using this model, effects of drugs and alcohol consumption may be studied in laboratory animals.

**OPTIMUM ENERGIES FOR DUAL ENERGY ATTENUATION CORRECTION IN SPECT.** T.M. Lembcke, V.J. Ficken, E. W. Allen. The University of Oklahoma Health Science Center, Oklahoma City, OK.

SPECT quantitation depends upon accurate, sensitive depth correction. The dual energy technique of Martin and Rollo (1974) suggests itself for pixel-by-pixel correction of SPECT images. This study centers on determination of optimum energies to produce the most accurate, sensitive depth index. Algebraic modeling of a simple distribution was used to determine the necessary pixel counts for the required statistical uncertainty. Optimum collimator and detector energies, source-detector distance, intervening tissues and energy related attenuation differences were considered. In the modeled example below a 1 cm line source (perpendicular to the detector face) was placed 10 cm within an extended attenuator. In this example 75keV was the lowest energy selected although most gamma cameras permit energy selection down to 60keV. The number of detected events required per pixel for different precisions for various energy pairs was determined.

Depth	Precision	Detected events required per pixel for energy pairs							
		75keV-160keV	75keV-200keV	75keV-364keV	100keV-200keV				
10cm	1.2cm	724	1084	455	652	240	229	1161	1396
10cm	0.6cm	2896	4335	1820	2610	958	916	4643	5585

These results show that count requirements are minimized through maximization of attenuation coefficient differences. However, this must be considered within the limitations of collimator septal penetration. These results suggest that under best-case conditions (i.e. no background, no scatter) these count requirements can be met in normal clinical procedures.

**MEASUREMENT OF A GLOBAL UNIFORMITY INDEX FOR A 1.5 TESLA MAGNETIC RESONANCE IMAGER.** A. Marcu, J.R. Prince, D.A. Wilson. Magnetic Resonance Center, University of Oklahoma Health Sciences Center, Oklahoma City, Oklahoma 73190.

"Flood field" uniformity is an important metric for describing image quality in all digital imaging modalities. Measurement of this metric is complicated in MRI by the large number of imaging planes, the known non-uniformities resulting from coil design and the various operator-selectable parameters which can affect uniformity. We have characterized the temporal and spatial features of image uniformity in a head coil to pro-

vide a baseline for future quality control studies and to aid in the development of correction schemes for quantitative analysis.

All studies were performed on a Philips Gyroscan S15 imager. Cylindrical phantoms were filled with water doped with  $\text{CuSO}_4$ . Standard spin echo pulsing sequences were employed which covered the range of parameters used in our clinical setting. The average of the central 400 pixels in an image is calculated (= C). The uniformity index (UI) studied is the percentage of pixels that ranges from C-10% to C+10%.

Our study demonstrates that the following fluctuations in the UI occur: long-term temporal fluctuations, < 10% ( $\pm 1$  S.D.); repetition time, < 10%; image type (M vs. R), < 15%; resolution matrix, < 20%; field of view, < 25%; slice orientation, < 30%; slice position, < 30%.

This study points to the need for multiple uniformity corrections for quantitative analysis. Improved system stability is also needed. Temporal fluctuations of  $\pm 10\%$  appear to be the limiting factor in devising quantitative schemes.

**AN EXPERT SYSTEM BASED ON A THEORETIC MODEL FOR QUANTITATIVE ESTIMATION OF VESICO-URETERAL REFLUX.** U.Satyannarayana. ALL INDIA INSTITUTE OF MEDICAL SCIENCES, New Delhi.

A theoretic model has been proposed for quantitative estimation of vesico-ureteral reflux from intravenous radiomucclide voiding cystography (IRVC). The renal system is arbitrarily divided into 5 regions, the kidney region proper, the upper, middle and lower regions of the ureter, and the bladder region. The background subtracted counts in these regions are referred to as A, B, C, D and E respectively. The theoretic model suggests mild reflux if  $(D - B)$  is significant and moderate to severe reflux if  $(C + D) - 2B$  is significant. A new parameter the Vesico-Ureteral Reflux Index (VURI) is proposed:  $VURI = ((C + D) / 2B) \times 100$ . An arbitrary grading system is evolved, which is as follows: VURI of 90 to 110 as normal, 110 to 140 as mild reflux, 140 to 170 as moderate reflux and 170 to 200 as severe reflux. A computer program has been developed in microsoft basic on an ESPL PC AT for quantitative estimation of VUR based on the above theoretic model. Software conversion of the Basic program into Turbo-Prolog and 'C' language resulted in an expert system. It is concluded that expert systems and parallel distributed processing approach using neural network architecture can increase the sensitivity of IRVC for quantitative estimation of VUR, obviating the need for Direct radiomucclide cystogram (DRCC) and Urine flowmetry (UFMT) in a selected group of patients.