Abstracts for Technologist Scientific Program for 23rd Annual Meeting

TUESDAY
10:30 a.m.-12:06 p.m.

ROOM N215/217

SUBMITTED PAPERS I

Moderator: Stephen A. Kuhn

RADIOPHARMACEUTICALS

A RADIOPHARMACEUTICAL QUALITY CONTROL PROGRAM IN THE HALF TIME. D.J. Battaglia, C. DeFries, and M.L. Cianci. Oscar B. Hunter Memorial Laboratory, Washington, D.C.

In light of the growing necessity for radiopharmaceutical quality control programs and the shortage of time and personnel to implement the usually complicated and time-consuming systems, we have developed a simplified version intended as a screen for pertechnetate integrity and contamination of the common Tc-99m-labeled radiopharmaceuticals.

Immediately following radiopharmaceutical preparation each agent was spotted on individual Gelman silica gel thin layer strips (3" x 1") approximately 1 cm from the bottom. The spots were allowed to dry (10 min) while transported to the scanning room and developed in a small Eastman developing jar with 5-10 cc of 85% methanol. The solvent ascended to the top of the strip while the daily camera Q.C. was completed (5-15 min) The strips were removed, placed next to each other at the face of the high resolution collimater, and 25-50K counts were collected. With such a system, pertechnetate moves with an Rf of 1.0, while colloids and chelates reduced to Tc-99m remain at the origin. Although the system does not differentiate between these three components, it does allow recognition of inconsistencies from day to day in the proportion of Tc-99m to these components. The imaging system is capable of resolving both peaks at a minimum separation of 2 cm detecting as little as 2% activity, and allowing visual estimates of peak percentages to within 10%. Any radioactive contaminats in sulfur colloid, macroaggregates, microspheres, and chelating agents are immediately evident.

As a routine screening method for checking radiopharmaceutical integrity, we have found this simple system to be quite useful and its implementation has become an integral part of the routine radiopharmaceutical quality control program.

ARTIFACTS FOUND IN TESTING PERCENTAGE OF LABELING IN Tc-99m — PYROPHOSPHATE - A SOLUTION TO THE PROBLEM. Ghanshyam C. Patel, Lelio G. Colombetti and Steven Pinsky. Michael Reese Medical Center, Chicago, ILL.

Chromatographic techniques have been suggested as the most useful procedure to evaluate the extent of Tc-99m labeling in radiopharmaceuticals. The most commonly used procedure is instant thin-layer chromatography (I.T.L.C.) using silica gel coated cellulose strips as the stationary phase and 85% methanol as the liquid phase (Billinghurst, J. of Nucl. Med. 14 (11) 793-797, Gelman's technical publication # 32). Applying this technique, we found many artifacts in our daily testing of Tc-99m labeled pyrophosphates.

Most commonly found artifacts are long tailing or radioactivity, progressing together with the liquid front, and also more than one peak for the bound Tc-99m. These findings were not supported by clinical evaluation.

Animal experimentation shows that the addition of ascorbic acid or the purging of the radiopharmaceutical solution with nitrogen retards the process of hydrolysis and oxidation of the compounds. This process, however, did not help with the chromatographic separation of free pertechnetate from labeled radioactivity.

The use of two liquid phases, acetone and saline, and silica gel coated cellulose, as was also suggested by Billinghurst, allows the separation of the three states of Tc-99m (unbound reduced, bound, and free pertechnetate) in pyrophosphates.

After many months of routine use, this technique proved to be reliable for the testing of Tc-99m pyrophosphates than the commonly used I.T.L.C. silica gel coated cellulose strip as the stationary phase and 85% methanol as the liquid phase.

99mTc-HUMAN SERUM ALBUMIN : EFFICIENT LABELING TECHNIQUE AND IT'S IN VIVO STABILITY. Jong Il Lee, Ghanshyam C. Patel. Michael Reese Hospital, Chicago, Ill. 60616

Introduction of electrolysis technique into the labeling procedure has led to a commercially available kit for 99mTc-HSA. However, the "simple kit" still requires about 40 min of time and several cautious steps including electrolysis yet, quality of final product is not always satisfactory. Present study was undertaken to develop simpler and more efficient preparation of 99mTc-HSA.

One ml of 25% HSA was mixed with 1-5 mCi 99mTc-pertechnetate and 10-15 μg $SnCl_2$ in sterile solution. Using 1 N HCl, pH of the mixture was adjusted to 2.4 and the mixture was incubated in room temperature for 30 min.

Labeling efficiency was determined by Instant Thinlayer Chromatography (ITLC), using silica gel media as stationary phase and 85% methanol as liquid phase. The ITLC was developed for 20 min and radiochromatography was run for 10 min.

Labeling efficiency was almost 100% in all samples prepared at pH 2.2-2.5. When final pH was increased above 3.2 second peak appeared on the radiochromatogram indicating formation of other 99mTc-complex. When the pH was adjusted to 8.0 2nd and/or 3rd peak with Rf value of 0.8-0.9 appeared on the radiochromatogram.

In vivo stability of 99mTc-HSA with 100% labeling efficiency was compared to that of commercially available 131 I-HSA in 4 healthy volunteer subjects. Plasma volume obtained with 99mTc-HSA was 41% (± 7.5) larger than the value obtained with 131 I-HSA. Radioactivity recovered from the circulating plasma 2 and 18 hours after the injection was 87% (± 7.0) and 67% (± 5.4) with 131 I-HSA and 59% (± 4.6) and 28% (± 2.5) with 99mTc-HSA.

Results indicate that 99mTc-HSA can be prepared easily but is less stable in the circulation than 131 I-HSA.

RADIOIMMUNOASSAY AND IN VITRO LABORATORY NUCLEAR MEDICINE

RADIOASSAY: Normal Range Determination. D.J. Battaglia, C. Burkhead, J. Welton, and M.L. Cianci. Oscar B. Hunter Memorial Laboratory, Washington, D.C.

The value of developing normal ranges for all radioassays remains undisputed, however is often precluded by the problems of implementation and data interpretation. A methodology applicable to most radioassays which offers ease of sample collection and data handling and provides statistically valid normal ranges is described for several radioassays.

Sampling of the normal population was done by collection of sera from normal blood donors and normal ranges of these samples determined by three different methodologies and compared. Sera values from blood donor populations for Folate, B-12, T-4 CPB, T-3 uptake, T-3 RIA and TSH were first tested for non-parametric distribution. A histrogram of the data including each sera value was classified into small dose ranges and the frequency for each range determined. A dose frequency curve was constructed illustrating the doses of highest frequency and skewing from the mean. Accepting 95% confidence limits to describe the normal ranges, 5% of all of the values was disregarded equally from the high and low range, and the normal range quoted between the next lowest and highest vlaue in the population. This method relies heavily on each individual dose collected and becomes less accurate as the population is small and/or trailing is evident. The cumulative frequency was then plotted on probability paper and deviation from linearity illustrating non gaussian distribution was noted. Dose corresponding to the 2.5 and 97.5 percentiles on the probability plot (95% CL) were chosen to represent the normal ranges by this methodology. The mean and S.D. were also determined on each set of data to illustrate the error which such data handling can introduce in some normal populations.

The most significant deviation from gaussian distribution was noted for Folates and T-3 RIA assays with positive skewing from the mean. Ranges from the three methodologies compared well for TSH and T-3 uptakes. B-12 normal range by the histogram method did not agree well with the 2 S.D. and probability plot indicating error due to small population sampling. All three methodologies produced slightly different ranges for T-4 CPB assay. The probability plot, however, was chosen as the preferrable method in all cases since it takes into account error due to distribution which are not bell shaped and better estimates skewed populations.

FACTORS AFFECTING RELIABILITY OF THE GASTRIN RADIOIMMUNOASSAY. Pamela Trusten and Tim Shea, Department of Radiology, Harvard Medical School and Peter Bent Brigham Hospital, Boston, Mass.

Increasing clinical and research use of the radioimmunoassay for human gastrin makes it imperative that analytical variations be minimized. In this work, new chemical and methodological factors affecting the reliability of the gastrin radioimmunoassay were examined individually and in combination.

Gastrin is a highly acidic heptadecapeptide which tends to adsorb strongly to ion-exchange media as well as to several types of containers. As a consequence, the concentration values of standard solutions of synthetic human gastrin I require constant documentation by intralaboratory comparisons of standards and by storage at adequate ionic strength. Iodinated gastrin requires purification by ion-exchange chromatography in order to remove immunologically inactive forms. At pH 8.2, equilibrium in the assay is not reached at less than 6 hours' incubation. Separation of bound from free iodinated gastrin is adequately accomplished by CG-400 or IRP-58 anion exchange resins or by hemoglobin coated charcoal. With proper consideration of these variables, the assay results are a linear function of the volume of the test sera added over a range from 5 to 100 pg.

Several common pharmacological agents were tested for displacement of gastrin from its antibody. The following serum equivalent concentrations were found to displace 10% of bound gastrin: adriamycin, 20 ug/ml; bleomycin, 150 ug/ml; vincristin, 250 ug/ml. Significant lesser effects were observed with dilantin, gentamicin, methyltetrahydrofolate and ascorbic acid.

Determination of gastrin performed with due consideration to these clinical and chemical variables has proven to be a useful investigative aid for recurrent ulcer disease, Vitamin B-12 deficiency, and renal failure with hypercalcemia.

FACTORS AFFECTING BINDING OF FOLIC ACID TO BETA-LACTOGLOBULIN. Tim Shea and Pamela Trusten, Department of Radiology, Harvard Medical School and Peter Bent Brigham Hospital, Boston, Mass.

Beta-lactoglobulin (BLG) enjoys wide use as a specific binding molecule for radioassay determination of serum folates. Typically, H-3 or I-125 labeled folic acid (PGA) is employed as the radiolabeled species. The chemical properties of the interaction between H-3 PGA and BLG have therefore been studied to discern whether significant changes occur when human serum components either singly or in combination are present with PGA and BLG.

The test assay was conducted at pH 7.65 and 23° with Tris-Cl as buffer, H-3 PGA as the label, and dextran coated charcoal as separating agent. Under these conditions, no PGA is bound by purified human serum albumin. However, the affinity of BLG for PGA is markedly enhanced by sequential addition of folate-free plasma or serum.

This binding enhancement can be reproduced by bicarbonate ion addition or by titration with purified human serum albumin treated with a non-specific protease to hydrolyze susceptible proteins, including albumin. After isoelectric focusing of the hydrolyzed albumin solution, three separate fractions (pI=5.4, 6.7 and 9.3) containing nondialyzable binding-enhancement activity for the PGA-BLG complex were found; each focused about a pH distinct from I-125 labeled-human serum albumin (pI=4.9).

The binding of H-3 PGA to BLG is thus affected by several factors which may be present in human serum at variable concentrations. Reliable clinical determinations of serum folates must be designed to minimize the effects of these variables on assay outcome.

IN VITRO ANALYSIS OF THE PLASMA CLOTTING PROCESS USING Tc-99m LABELED AGGREGATES. Sheldon J. Ashley. Flushing Hospital and Medical Center, Flushing, N.Y.

The dynamic fibrin clotting mechanism was quantitated as uptake functions over discrete intervals of time.

Citrated platelet-rich plasma was added to vials containing TC-99m macroaggregated albumin (MAA) or Tc-99m human serum albumin microspheres (HAM) and then counted in a well scintillation counter. Calcium chloride was added to each vial to initiate the clotting process. After a selected elapsed time for each vial, the clot reaction was terminated by the addition of an anticoagulant. The residual clots were washed with normal saline and then recounted in the well. The percent uptake for each clot was calculated.

The uptake values showed a region of low uptake early in the test, followed by a short period of rapidly increased uptake, until a level of saturation was reached. The characteristic uptake patterns of the two materials were strikingly different: Tc-99m MAA showed a greater affinity for forming plasma clots.

The test showed a radionuclide uptake principle can be used to describe the clotting process. There are three phases of uptake in a clot, and Tc-99m MAA is irreversibly trapped and has a greater affinity for forming plasma clots.

A PROCEDURE FOR EVALUATING PATIENTS WITH THYROID CANCER. Lucille Bunz and Malcolm R. Powell, M.D. 350 Parnassus Ave. Suite 908, San Francisco, Calif. 94117

A procedure is described for detection of functioning metastases in the patient with thyroid cancer. The results of the study determine the feasibility of I-131 therapy and provide a basis for estimation of the I-131 therapy dose. To stimulate the thyroid cancer tissue accumulation of iodide, the plasma TSH must be sufficiently elevated. Depletion of the plasma iodide pool further augments the relative I-131 uptake. These conditions are achieved by having the patient follow a strict low-iodide diet and stop thyroxine medication for at least 6 weeks. Triiodothyronine is given temporarily but must be stopped for 3 weeks prior to the study. T3,TT4, TT3 and TSH determination confirm the patient is in a hypothyroid state and under endogenous TSH stimulation at the time of the study. The patient is administered 1 mCi of I-131 orally. At 72 hours an uptake and 1:1 ratio neck and chest scan are performed using the Nuclear Chicago Pho Dot V scanner. Anterior and posterior whole body scans are obtained using the Searle Scintiscan whole body table. Since most of the I-131 activity has been excreted and body outlines are difficult to see at 72 hours, 2 mCi of TcO_4^- is injected I.V. and a repeat total body scan is obtained with the patient in the same position to obtain the body outline. If any areas of suspicious uptake are observed on I-131 total body scans, 1:1 ratio scans and regional radioiodide uptakes are obtained for further definition. If remaining cancer tissue is found, an ablation dose of I-131 is prescribed based on the uptake in the lesion and lesion size in the 1:1 scans, radiographs, and by palpating any accessible lesions. The above protocol provides a thorough evaluation of the patient with possible residual or metastatic thryoid disease. The procedure is valuable to both the patient and clinician because of its sensitivity, specificity, simplicity and atraumatic nature.

WEDNESDAY
10:30 a.m.-12:06 p.m.

ROOM N215/217

SUBMITTED PAPERS II

Moderator: Susan Christie

RENAL IMAGING

THE TECHNOLOGIST'S ROLE IN COMPREHENSIVE RENAL FUNCTION STUDY. F.N. Kontzen, M. Barber, E.V. Dubovsky, W.N. Tauxe, and M. Tobin. Veterans Administration Hospital, Birmingham, Ala.

As the scope of renal testing by nuclear medicine increases, the role of the technologist becomes more and more crucial. At present a comprehensive radionuclide renal function study(CRFT) has replaced the excretory urogram as a screening test by the Urology Department of our institution. All kidney grafts are also followed by CRFT.

This test comprises in vitro and in vivo procedures. All aspects are carried out after injection of Tc-99m-DTPA and I-131-OIH. Blood and urine are sampled.

The complete study includes the following: 1) Tc-99m-DTPA perfusion as a dynamic and early static study to evaluate the patency of the arteries and kidney size, shape and position. 2) Ten 3-min sequential images with simultaneous renograms using 150 uCi I-131-OIH per kidney. Data are taped for computer calculation of differential function of each kidney. 3) Plasma samples are drawn at 44 min for effective renal plasma flow calculation. 4) Urine is collected at 35 min after injection and actual % dose excretion is calculated. 5) Bladder residual urine is calculated from counts over the bladder before and after voiding. 6) Total 5 dose is calculated from void- and residual urine. 7) Predicted total excretion based on the ERPF is calculated. 8) Excretory index (total excretion/predicted excretion) is calculated. 9) Quantitative scintigraphy of the injection site is carried out to assure completeness of injection.

The purpose of this paper is to discuss how this CRFT can be carried out with accuracy and speed. The importance of data processing (background subtraction, differential function calculation) in the achievement of a high degree of precision will be stressed. At the same time we would like to point out some pitfalls we have encountered.

COLOR IMAGING AND SELECTIVE CURVE GENERATION WITH COMPUTERIZED RENOGRAM IN KIDNEY TRANSPLANT MONITORING. John Mullins and Sheldon Chelsy. Division of Nuclear Medicine, UCLA-Harbor General Hospital, Torrance, Ca.

Renal transplant patients are evaluated routinely for signs of early rejection by a renogram which has shown to be the more sensitive test. Sequential scans with renographic technique are computed daily, and curves are generated by setting regions of interest (ROI) around the kidney, ureter and bladder.

Bladder to kidney ratio (B/K) accumulation at 20 minutes after injection and the blood clearance of isotope (BCI)are methods to evaluate renal function. When changes occur in the renal function, they are seen early in the B/K or BCI described by Hayes and Moore (1971). In selecting ROIs for the kidney which has a geometric shape, many times we have included the pelvis and ureters. This produces abnormally low B/K ratio with normal BCI. In order to circumvent this difficulty we have developed a macro-program in our Informatek SIMIS-3 computer system to define the kidney on the 2 minute image by its own isocontour, when there is no isotope present outside the kidney area. ROIs are also placed for the ureter and bladder. The accumulation for these two ROIs are added by the computer to give a more accurate ratio between the kidney and bladder. Color serial 2 minute scans were carried out up to 22 minutes. Having color to detect radioactivity changes, a more precise selection can be made when placing the ROIs, especially on the ureter.

Our macro-program displays in color 64 x 64 matrix, 2 minute frames of the study at 4, 10, 16 and 20 minutes and curves generated from the transplanted kidney. The calculation of the B/K ratio and the BCI are obtained automatically from the computer.

Macro-programming and computer processing of renograms with color display of images and curves are performed daily for the first two weeks after surgery. This is the best procedure to monitor patients for early renal rejection.

INHALATION IMAGING

A SIMPLE, EFFECTIVE METHOD FOR AEROSOL INHALATION SCANNING. Robert Salk and John Mullins. Division of Nuclear Medicine, Harbor General Hospital, Torrance, Ca.

For many years we have performed aerosol inhalation scans as an adjunct to perfusion lung scans to differentiate between pulmonary embolism and airway or lung disease.

We report a simple nebulizer (aerosol generator) and tubing system that has significant advantages over the electronic nebulizer we previously used.

The advantages are 1) inexpensive ($1.50 per nebulizer) versus hundreds of dollars for the electronic device, 2)

easy to use all-plastic parts, 3) disposable, but re-useable without loss of efficiency, 4) equal or better deposition of aerosol in lungs, 5) lessening of deposition in the trachea and main airway branches thus less waiting time between inhalation and obtaining high quality scans.

The nebulization occurs as the aerosol solution and air pass through a nozzle striking a round pointed pillar and then the walls of the surrounding chamber. The result is a fine aerosol that appears to be dry.

The method in which we employ the nebulizer is as follows: The nebulizer is contained in a lead shield and has a 6 liter/min. compressed air flow through it. The inhaled aerosol is distributed to the patient by the plastic tubing and valve system. This system also incorporates partial recirculation of aerosol that the patient has exhaled, so that by partially "rebreathing" the aerosol more activity is deposited in the patient's lungs. The remainder of the exhaled aerosol is exhausted thru a vent.

The use of an inexpensive, very effective inhalation device and plastic nebulizer should encourage smaller hospitals and clinics to perform aerosol inhalation scans.

CONTAMINATION OF NON-DISPOSABLE XENON VENTILATION SYSTEMS. George B. Case, Philip Matin, C.B. Martin, Roseville Community Hospital, Roseville, CA

The Xenon 133 ventilation study has been shown to be extremely useful, particularly in the definitive diagnosis of pulmonary embolism. Many types of disposable and non-disposable apparatus are available for performing the study. The use of a non-disposable systems raises the question of possible patient-to-patient contamination and its implications.

Our study of contamination involved 20 patients selected at random from routine referrals to our laboratory. Pre-sterilized components were cultured immediately after patient use by using sterile cotton swabs to wipe the interior surfaces of each of the system components. The swab samples were transferred to blood agar plates and immediately incubated.

After 48 hours of incubation, bacteria were found to be most common in those samples taken from the plastic tube in closest proximity to the mouthpiece. Twenty percent of these samples had no growth after 48 hours. Of the eighty percent of these samples which were positive, the most common bacteria found was alpha streptococci.

Alpha streptococci can cause respiratory infections, focal abscesses and urinary tract infections in other than the original host. Since these bacteria can live for over 24 hours in the environment provided by an unclean system, we must conclude that repetitive use of non-sterilized equipment can cause new disease through patient-to-patient contamination. To avoid the possibility of transmitting disease to patients, ventilation apparatus must be sterilized before each use.

RADIATION PROTECTION

PRECAUTIONS AND CONSIDERATIONS FOR RADIOIODINE-131 THERAPY PATIENTS. Marie A. Costanza, and Barbara C. Fasiska. Presbyterian University Hospital and the Radiation Health Physics Department of the University of Pittsburgh, Pittsburgh, Pa.

Recognition of the special hazards associated with radioiodine-131 treatment has resulted in the development of a comprehensive radiation safety program. Well planned and strictly followed control practices are of major importance in such cases. The procedures are designed to be specific for three classes of treatment patients: hyperthyroid and cardiac related thyroid in-patients, hyperthyroid out-patients and thyroid carcinoma in-patient cases.

The paper describes the treatment program at Presbyterian University Hospital. The safety precautions have been designed so they may be easily understood by patients and staff. The frequency of therapy procedures during the past two years and the lack of significantly related incidents involving spread of contamination, attest to the success of the program. The precautions provide a savings both in technologists' time and hospital operating expenses because of minimal decontamination requirements and subsequent reduction of down-time of patient rooms.

THE PARTICIPATION OF NUCLEAR MEDICINE TECHNOLOGISTS IN RADIATION ACCIDENT MANAGEMENT. Harold D. Hodges and William D. Gibbs. Medical and Health Sciences Division, Oak Ridge Associated Universities, Oak Ridge, TN

Most experts predict that by the year 2000 about one-half of this country's electrical power will be generated at nuclear power stations. Even though the probability for a serious radiation accident at a single nuclear power plant is extremely small, the reality of such accidents demands serious consideration and preparation. Generally, no other hospital staff members are as familiar as nuclear medicine technologists are with such practical problems as how to detect and measure radiation, how to prevent the spread of radioactive contamination, how to reduce the radiation dose to victims and attending personnel, and how to assist the physician and the health physicist in caring for radioactively contaminated accident victims. To be prepared to assume this dormant responsibility, the nuclear medicine technologist needs to test his familiarity with the necessary basic practices which must be executed immediately after an accident victim is brought to the hospital. The skills needed for the prompt and decisive action of emergency personnel can be forgotten if not tested and practiced frequently. Nuclear medicine technologists have an unusual advantage here in that many of the skills and instruments that are required are used daily by the technologist in the nuclear medicine laboratory practice.

A refresher program exists for this purpose in the Radiation Emergency Assistance Center Training Site (REACTS) in Oak Ridge, Tennessee. It provides emergency personnel including physicians, health physicists, and paramedical personnel with the training they will need in radiation accidents. This paper discusses how minor modifications in nuclear medicine instrumentation can be made quickly for radiation emergencies and how simulated accident drills can be used to test the readiness of the nuclear medicine team. (Supported by the US ERDA.)

ARTIFACTS

BONE IMAGING ARTIFACTS. Sue Weiss and James J. Conway. The Children's Memorial Hospital, Chicago, Il.

Many artifacts have been observed in studies of the skeleton with Tc-99m phosphate compounds. These artifacts can create difficulties in interpretation and many are preventable with proper attention by the technologist. The most common artifacts in children are urine contamination, radionuclide extravasation at the injection site, and soft tissue localization from intramuscular injection of medications.

Less common abnormalities include: radiation attenuation from metallic objects in the patient's clothing, residual radiation from previous studies, equipment malfunction, altered urinary tracts such as ureterosigmoidostomy, poor radiopharmaceutical preparation, and introgenic causes such as localization within a surgical scar or fixation pins.

The etiology of the abnormality should be documented by reviewing the patient's record for IM injections, bone marrow biopsy and previous radionuclide studies. Examination of the equipment, (sandbags, sheets, table, collimator face, etc.) and the patient's clothing should be done to locate sites of contamination. The etiology of most artifacts will be readily recognized in this manner. An awareness of the appearance of typical artifacts will also alert

technologist to the source of the abnormality. This information should be conveyed to the physician to prevent errors in interpretation. The purpose of this paper is to demonstrate the most common artifacts and their causes and to provide mechanisms to prevent their occurrance.

RECOGNITION OF SCAN ARTIFACTS-TECHNOLOGISTS' ROLE. Janet M. Marks, Russell Cain, Diane Winston, James Wing, Anne Schleif, Ronald Burks, and William Burt. VA Hospital, San Diego, CA.

In the course of their work, nuclear medicine technologists will be confronted with abnormal scans that are due to clinical or technical artifacts. It is important for the technologist to become familiar with the more common artifacts so that an adequate clinical study can be obtained for proper interpretation. Technical errors should be readily recognized and the need for extra precautions or changes of routine techniques should be understood by the technologist at the time of the scan and not after the study is irretrievably lost.

The purpose of this paper is to demonstrate some of the artifacts that we have encountered at our institution and to suggest procedures to minimize their occurrence. Artifacts on scans caused by pacemakers, ears, tattoos, false teeth, contaminated alcohol swabs, saliva and urine will be shown. In addition, we will discuss artifacts resulting from other diagnostic studies or from a particular sequence of multiple scans. These artifacts will include brain scans preceded by EEGs and bone scans preceded by brain or liver scans.

Technical artifacts including those resulting from the photomultiplier tube and improper peaking will also be presented.

If the technologist recognizes the various artifacts which can occur, he will be able to correct the problem and potentially save the patient the additional expense and radiation exposure of a repeat scan.

THURSDAY
10:30 a.m.-12:06 p.m.

ROOM N215/217

SUBMITTED PAPERS III

Moderator: James K. Langan

EQUIPMENT AND QUALITY CONTROL

A QUALITY CONTROL PROCEDURE FOR INSTITUTING USE OF A NEW RADIONUCLIDE. Theodore Sorandes. University of Maryland Hospital, Baltimore, Maryland.

This study was undertaken to establish a quality control procedure for the determination of appropriate pulse height analyzer setting and collimator when introducing a new radionuclide in the laboratory. Potassium-43, a radionuclide that has a complex spectrum, was used in establishing this procedure.

In order to identify emission peaks and to compare emission efficiency with and without the effects of scatter, spectrums of K-43 were obtained utilizing a rectilinear scanner with an uncollimated detector and shielded (Lucite and water) and unshielded point source of K-43 placed 12 inches from the crystal. Counts versus energy were plotted at 10KeV increments. The spectra revealed that the 380KeV peak was the prominent peak and that scatter was not a problem at the 380KeV peak. The pulse height analyzer settings were selected to include the full width half maximum of the 380KeV peak. (Fig. 2).

In selecting a collimator, factors to be compared are sensitivity and resolution. Sensitivity is compared by utilizing a point source placed at the focal point of the collimator and plotting counts versus KeV at 10KeV increments. Resolution at the various energy peaks is determined by scanning a modified star burst phantom filled with the nuclide being evaluated and using a pulse height analyzer setting as determined above. The resolution is compared by measuring width of the lines seen on the images.

The procedure described has been extremely useful in introducing new radionuclides (Ga67, Th67, etc.) in our laboratory.

DOSE CALIBRATOR FOIBLES. Walter L. Robinson. Bionucleonics, Inc. Fanwood, N.J.

Many institutions rely upon the dose calibrator heavily, and call it the most important instrument in a nuclear medicine department from a patient safety standpoint, yet are unaware of either inherent or systematic errors of assay. It is the goal of this study to accustom dose calibrator users to the quality control procedures for reliability, to minimize operational pitfalls, and to alert the potential dose calibrator customers to the important parameters of evaluation.

Two long-lived reference standards of sufficient radioactivity and a short-lived radionuclide can be used to test for stability, accuracy, precision, linearity, reproducibility, activity saturation, volume dependence, and calculation of volume.

Analysis of the dose calibrator comparison table allows potential dose calibrator customers to better understand and assess functional parameters of the instrument. A study of twenty-two dose calibrators in Eastern Pennsylvania shows that dose calibrators are not as accurate as often assumed. The operational tests described help assure ±10% accuracy of dose, and strive for ±5% accuracy.

Quality control tests for daily and long term reliability are now required by the Nuclear Regulatory Commission, and the tests must be done to assure optimum operation of this very essential instrument.

A MULTI-DETECTOR SCANNER FOR WHOLE BODY IMAGING. David J. Phegley. Donald R. Bernier, R. Edward Coleman. Washington University School of Medicine, St. Louis, Mo.

We have recently evaluated a commercially developed (Phillips) multi-detector scanner that was designed to decrease the time required for whole body imaging. The scanner consists of a detector head containing 84 individual crystals, collimators and photomultiplier tubes collecting 84 separate pieces of information. The 84 units are arranged in a parallellogram composed of 6 rows, each row containing 14 detectors. The 6 rows are offset from each other providing a line spacing of 1/4 inch. Four collimators are presently available. There is no cross table movement or indexing with the multi-detector system as in conventional rectilinear scanning. All of the patient information is collected by one longitudinal pass of the detector head. There are only two operator controls, density and scan speed. The data is displayed on 70mm film which moves at 1/10 the speed of the detector head effectively producing 10:1 minification of the image. The total number of counts collected in the image are displayed on a digital scaler. We have obtained 500 whole body images with this instrument. 150 of these patients had bone scans on both the multi-detector system and a conventional rectilinear scanner with 5:1 minification. Lesion detec-

tion was similar for both systems. The time required for a whole body bone scan with the multi-detector system was 10 minutes compared to 45 minutes for the conventional 5:1 rectilinear scan. Similar reductions in time were also achieved for whole body ^{67}Ga-citrate scanning. The multi-detector system that we evaluated was not suited for small organ imaging; however, this unit is still under development. In patients undergoing whole body scanning the multi-detector system provides a considerable savings in time for both the patient and the technologist.

THE USE OF TANTALUM-TUBE COLLIMATORS FOR SCINTILLATION CAMERAS. S.J. Swann, D.W. Palmer, L. Kaufman, C.B. Lim, and P.B. Hoffer. University of California, San Francisco, California.

Commercially available collimators must be optimized not only for sensitivity and resolution but also for manufacturing considerations including cost and suitability for mass production. Unfortunately these considerations sometimes result in undersirable compromise in sensitivity and resolution, and consequent suboptimal designs. We have evaluated a method of assembling collimators from tantalum tubes, in this case tubes with an outside diameter 0.088 inch, a wall thickness of 0.004 inch, and are 1 inch long. This collimator was compared to Searle's low energy collimators.

The parameters measured were spatial resolution (full width half maximum and full width at one-tenth maximum) at distances up to 15cm from the collimator face, sensitivity and cross-talk ("septal penetration"). All measurments were performed using a Searle Pho-Gamma IV camera and a DEC PDP/11-20 computer. The spatial resolution of the tantalum collimator is essentially identical to that of the All Purpose (LEAP) collimator, but with a 36% increase in sensitivity. This represents a sensitivity for the tantalum collimator that is just 15% lower than that of the High Sensitivity collimator. Cross-talk increased from 6% for the LEAP to 9% for the tantalum collimator. This is inconsequential in view of the large accepted scatter fractions in a conventional brain or liver study.

Collimators optimized vis-a-vis radioisotope, specific studies, sensitivity etc., can be conveniently obtained by using lead or tantalum tubes of the desired dimensions. The physician can in this manner avail himself with collimators that maximize the parameters he considers most important.

QUALITY ASSURANCE OF WHOLE-BODY TABLES. Elbert L. Lands and Bhailal Patel. The University of Chicago, Chicago, Ill.

Quality assurance of camera whole-body tables is a necessity for accurate and reliable diagnostics. Quality assurance procedures for these systems should be implemented with routine camera quality assurance programs. As in other quality assurance programs, we are concerned with the accurate and undistorted reproduction of object(s) placed within the system's field of view. Contained within the electronics circuity of the whole-body studies performed. They are: 1) Line-up - the ability of this system to correctly match up the split images. 2) Gap - the ability of the system to space proper distance(s) between each pass. 3) Shading - the ability of the system to reproduce the same intensities for each pass. 4) Distortion - the capability of the system to reproduce the true shape of the object(s) seen.

The malfunctions of these four performances of the whole-body electronics mode can not or may not be seen by ordinary means. If routine quality assurance is not performed regularly, these malfunctions can lead to poor quality studies and possibly a misdiagnosis. Our quality assurance program has been described as well as the presention of the forementioned malfunction on quality assurance procedure(s) and clinical studies.

COMPUTER ASSISTED INSTRUMENT CALIBRATION AND QUALITY CONTROL. Michael J. Tuscan, David A. Weber, and Robert E. O'Mara. University of Rochester Medical Center, Rochester, N.Y.

Instrument calibration is the basis for sound quality control. It is usually time consuming and can be inaccurate when the necessary calculations are performed at each calibration check. We have developed in our laboratory a computer program that increases the accuracy and reliability of quality control procedures. This program gives the decayed values of known standards by using an exponential decay formula, and then formats the data for individual applications. The program will assist in dose meter, probe, and scanner calibrations.

When utilized for quality control of a dose meter, the initial values of each standard are entered into the computer and the decayed values are automatically printed for as far into the future and as frequently as desired. Accurate calibration of the dose meter is then assured by comparing the actual reading of the meter to the value predicted by the computer. Probe and scanner quality control calibrations are performed in a similar fashion.

This calibration program has proven to be simple and highly accurate. Much time is also saved with this method. Quality control calculation for an entire year can be performed in just minutes. This computerized system has aided in maintaining high standards of quality control in our laboratory.

QUALITY ASSURANCE BREAKDOWNS (QUABS) IN NUCLEAR MEDICINE PATIENT CARE. L. David Wells and Buck A. Rhodes. Kansas University Medical Center, Kansas City, KS.

QUABS (quality assurance breakdowns) is a name given to that group of problems related to the management and care of patients during their encounter with a nuclear medicine clinic. The aim of this paper is to enumerate and classify QUABS; to determine how big a problem they represent in terms of numbers, effect on patient care and costs, and finally to derive guidelines for their elimination.

QUABS are errors which occur in the requisitioning and scheduling of nuclear studies, in identifying and transporting the patient, in preparing the patient for the study, in handling the patient within the clinic, in obtaining, handling and labeling of samples such as blood or urine and in the routing, processing and filing of reports, bills, etc. QUABS are problems which occur in addition to those usually associated with quality assurance, such as instrument calibration and radiopharmaceutical quality.

At least 25 different QUABS have been identified and characterized. The frequency of certain QUABS have been tabulated and some resultant costs have been estimated. For example, when a patient receives a barium enema prior to a liver or bone scan, the patient must be returned to his hospital room and be given extensive bowel preparation. This has at times cost approximately $300 for additional day of hospital care. Other costs occur due to inefficient clinic operation and to the discomfort and aggravation experienced by the patient.

Recommended guidelines begin with designing the requisition to minimize communication errors. Procedural conflicts are minimized by listing and publicizing optimum procedural sequences. Finally, all hospital personnel from the clerks to the professional can be informed about QUABS and of what their respective roles are in their elimination. To facilitate this an educational audiovisual "Cut the QUABS" is being prepared.

POSITRON EMISSION SCANNING: A NEW DIRECTION FOR NUCLEAR MEDICINE IMAGING SYSTEMS. Mary T. Clarke, Donald R. Bernier, Michael J. Welch, R. Edward Coleman, Michel M. Ter-Pogossian Washington University School of Medicine, St. Louis, Mo.

A Positron Emission Transaxial Tomograph (PETT-III) has been designed and constructed at the Mallinckrodt Institute of Radiology to obtain cross-sectional images of the distribution of positron emitting radiopharmaceuticals. With this system, quantitative information concerning the distribution of labeled metabolic substrates can be obtained.

PETT-III utilizes annihilation coincidence detection and a computerized reconstruction technique similar to that used for computerized axial tomography with x-ray transmission. Radiopharmaceuticals utilized to this time include cyclotron produced ^{11}CO-hemoglobin, ^{11}C-glucose, ^{11}C-palmitate, ^{11}C-putrescine, ^{13}N-ammonia, and generator produced ^{68}Ga-EDTA.

The technologist operating PETT-III has several responsibilities. Daily calibration checks are performed on all detectors. Attenuation coefficients must be obtained for

each cross-section prior to administering the radiopharmaceutical so that the final image can be corrected for photon attenuation. Patient positioning is critical and must be accurate for both the attenuation and emission data collections. Image reconstruction uses computer sorting and correction. Hard copy is on Polaroid film and data storage on magnetic tape.

Greater than fifty animal and thirty patient studies have been performed. The animal studies have involved myocardial metabolic studies in normal, ischemic and infarcted myocardium. The human studies have included cerebral perfusion metabolism and blood pool images as well as myocardial perfusion and blood pool studies. The combination of metabolic substrates labeled with cyclotron-produced radionuclides and PETT-III offers a new, non-invasive technique for investigating in vivo metabolism.

FRIDAY
10:30 a.m.-12:06 p.m.

ROOM N215/217

SUBMITTED PAPERS IV

Moderator: Robert J. LaDue

HEPATIC SCANNING

ROUTINE LIVER FLOW STUDIES, A REAPPRAISAL. W. J. Klenke, J. L. Giga, and R. F. Carretta. Wilford Hall USAF Medical Center, Lackland AFB, Texas.

Several investigators have suggested that the dynamic liver flow study be done routinely on all patients having a liver scan. We evaluated this procedure on 202 patients scheduled for a liver scan. The hepatic blood flow study was performed using 10 mCi Tc-99m sulfur colloid. Eight of the 202 cases had positive flow studies. Correlation of the positive flow studies with the static scintigrams and clinical history disclosed five patients with metastases, two with cirrhosis and one with an abscess. There were no patients with hepatomas. Only four percent of the 202 patients had a positive flow study. All of the patients with metastases had diffuse early arterialization, as did two patients with cirrhosis. The one patient with an abscess had an avascular area corresponding to the static scintigraphic defect. There were no positive flow studies in patients with normal static liver scans. In addition to the low number of positive flow studies (4%), the other disadvantages of routine liver flow studies include: additional cost of film, both Polaroid and 35 or 70 mm; increased study time; frequent collimator changes; and the increased radiation dose to the patient. We would propose that, although hepatic flow studies are of value in differentiating vascular from avascular space-occupying lesions, they not be incorporated as an integral part of a liver scan. Rather, selected patients having scintigraphic defects should have a liver flow study to aid in the differential diagnosis.

	Total	Metastases	Cirrhosis	Abscesses
# of Patients	202	8	3	1
+ Flows	8 (4%)	5 (63%)	2 (67%)	1 (100%)

ACCURATE PATIENT POSITIONING FOR HEPATIC SCINTIANGIOGRAPHY. J. L. Giga, C. J. Stankiewicz, D. T. Kopp, and R. F. Carretta. Wilford Hall USAF Medical Center, Lackland AFB, Texas.

This clinic investigated different techniques for the most accurate and reliable method of proper patient positioning for hepatic scintiangiograms. Neither the sole use of a lead strip rib marker, palpation, nor percussion of the liver demonstrated the accuracy of proper patient positioning to achieve a diagnostic liver flow study. However, our experience has shown at least a 97% accuracy in proper patient position with the use of a flood tank for transmission scanning and a lead strip rib marker for body landmark identification.

Patients were placed in the anterior supine position with a lead strip marker over the right tenth costal chondral margin. A transmission source of technetium pertechnetate (Tc-99m) with five to ten millicuries was placed directly beneath the patient table and facing the low energy, high sensitivity , straight bore collimated Anger camera. This clearly outlined the anatomical position of the liver. It is felt that the low rad dose of 1 mR to the patient from the 10 mCi transmission source is negligible. As this technique became routine, the technologists' efficiency increased to eliminate the use of the lead strip marker. In addition, the patient exposure time to the transmission source decreased considerably.

In conclusion, using the transmission source for patient alignment provides the technologist with the proper patient position, reduces time for patient set up, reduces the number of errors and coupled with the scintiangiogram, provides the physician with the specificity needed to rule out the possibility of a space-occupying lesion within the liver.

TECHNICAL LIMITATIONS IN DETECTION OF HEPATIC METASTASES. Jane M. Neill and Lou Bifolck, Department of Radiology, Harvard Medical School and Peter Bent Brigham Hospital, Boston, Mass.

Modern cancer management urgently requires methods for optimizing the scintigraphic detection of hepatic metastases. In order to determine whether the detection of focal hepatic defects can be enhanced by easily manipulated parameters, we have examined in detail 10 patients with known liver metastases. Each patient was studied by three views (Ant and Post, 630K; Rt Lat, 540K) obtained with a 19 photomultiplier tube-Anger camera and a 140 KeV diverging collimator after injection of 3.5-4.5 mCi Tc-99m sulfur colloid. Additional anterior views (630K) were obtained after substituting a straight bore high resolution collimator and after respiration was arrested by summation of counts collected at voluntary end-expiration. Finally, the anterior scintiphotos were obtained with a camera system containing 37 photomultiplier tubes with a low energy all-purpose collimator and large field of view.

Contrary to expectation, there was no evidence that separate or simultaneous changes in collimator, number of photomultiplier tubes, or respiration significantly enhanced detection of metastatic deposits not seen without the changes. In 2 patients focal defects were discerned more clearly by our presumed improvements, but in the other 8 no additional clarity was gained nor were new focal defects observed. In some cases interlobar or fissure markings appeared somewhat more clearly defined.

Since modern chemotherapy is generally more effective the smaller the mass of the tumor being treated, methods for finding metastases of the smallest possible size are desirable. Our data do not yet support confidence that the technical improvements studied here will significantly improve detection of metastases. (Support: NIH Grant GM-18764).

GASTROESOPHAGEAL SCINTISCANNING

FUNCTIONAL GASTROESOPHAGEAL SCINTISCANNING. John P. Capuzzi Carol Grabowski, Peter Hyams, Leon S. Malmud, Robert S. Fisher Temple University Hospital, Philadelphia, Pa.

Radiographic techniques for detecting gastroesophageal reflux (GER) do not correlate well with clinical symptoms. Gastroesophageal scintiscanning (GES) was developed in ord-

er to detect and quantitate GER rapidly and with a high degree of sensitivity. Following a 3 hour fast,the patient is fitted with an abdominal binder with manometer and drinks 300 ml of water containing 100 uCi Tc99m sulfur colloid (TcSC). Using a low energy diverging collimator,the patient is positioned upright so that the stomach is seen in its entirety in the lower third of the image. Serial 30 second exposures are obtained at 20 mm Hg pressure increments from 0 to 100 mm Hg. If no reflux occurs with the patient upright,the study is repeated with the patient supine. If no reflux occurs in the supine symptomatic patient the study is repeated in 20 minutes following an additional 100 uCi TcSC in an acid solution of 150 ml 0.1N HCl and 150 ml orange juice. If reflux occurs, the study is considered completed and indicative of GER. If no reflux occurs the study is considered normal.

Using this technique,without data processing,reflux was detected in 27 of 30 patients (90%) with symptomatic GES and a positive acid reflux test. However, the acid reflux test requires endogastric intubation,and an esophageal pH probe,and is not readily available at most institutions.

Quantitative studies have also been performed using a digital computer and magnetic tape storage. These studies were performed before and after medical therapy with bethanechol,antacid,or antacid-alginate compound or surgical treatment. The GES is the most sensitive noninvasive technique for detecting and quantitating GER. The low radiation dose, convenience, and patient acceptability of the study make it suitable for serial evaluation of various therapeutic modalities following diagnosis.

GALL BLADDER SCINTISCANNING

TECHNIQUE FOR USING Tc99m HIDA FOR GALLBLADDER FUNCTION STUDY. Theodore Sorandes, Kenneth Tyler, and Steve Sikorski. University of Maryland Hospital, Baltimore, Maryland.

The introduction of Tc99m HIDA for gallbladder imaging required the developement of new imaging techniques due to the radiopharmaceutical's rapid accumulation in the liver and excretion into the bile duct.

The following technique has been established so that optimal data may be obtained:

1. Dose - A bilirubin level is obtained immediately prior to performing the study. If the bilirubin level is normal, a dose of 29uc/kg is administered IV. If the bilirubin is elevated, a dose of up to 200uc/kg is used.

2. Imaging routine - Following administration of the radiopharmaceutical, images are routinely obtained using a scintillation camera at 1, 5, 10, 15, 20, 30, 40, 50, and 60 minutes. At 60 minutes post-injection, the radiopharmaceutical is seen in the gallbladder and intestines assuming normal gallbladder function. If the gallbladder or intestines are not seen on the 60 minute image, a 2 hr. delayed image is obtained. If gallbladder or intestinal filling is not seen at this time, an 18 hr. post-injection image is obtained. If gallbladder or intestinal filling is not observed on the 18 hr. image, total biliary obstruction is present.

To date 30 patients have been studied using the above technique. The gallbladder was visualized in 20 to 25 minutes in patients with a bilirubin as high as 7. The transverse colon was seen in 26 patients. The remaining 4 patients were diagnosed to be totally obstructed. Correlation of scan to final patient diagnosis was 100%.

CARDIAC IMAGING

DEVELOPMENT OF A RELIABLE AND REPRODUCIBLE METHOD FOR DETERMINING MYOCARDIAL/BACKGROUND RATIOS FROM Tl-201 MYOCARDIAL IMAGES. Ann Coleman, Michael Robertson, David L. Williams, and Glen W. Hamilton. Veterans Administration Hospital, Seattle, Washington.

The myocardial to background ratio (MBR) determined from Tl-201 myocardial images is variable. Factors which increase coronary blood flow (exercise, dipyridamole) increase MBR; conversely, several conditions may decrease the MBR (three-vessel coronary disease, propranolol). If MBR is to be used clinically or experimentally as a measure of relative myocardial Tl-201 uptake, reliable methods for determining MBR should be developed.

We investigated the reproducibility of MBR determinations made by two methods from digitized (64 x 64) Tl images using a dedicated computer system. Eighteen consecutive Tl-201 images from three dogs were selected for study. MBR was determined on two occasions by each of two observers using a light pen to define myocardium and background regions (LP) and by placing a 15 channel profile cursor over the image through the center of the myocardium (PROF).

In the 18 studies, MBR varied from 1.4 to 4.0 with a mean of 2.38 ± .71:1. MBR determined by LP was reasonably reproducible by one observer (r = .89) but unreproducible by the second observer (r = .56). In contrast, MBR determined by PROF were reproducible for both observers (r = .99 and .99) and interobserver error small (r = .99). MBR determined by LP was consistently less than from PROF (2.22 vs. 2.37). Differences in MBR with the LP method were due to variations in both myocardial and background counts.

The PROF method provides a reliable method for determining MBR by reducing observer decisions and hence errors.

CAMERA AND PROBE POSITIONING IN GATED LEFT VENTRICULAR FUNCTION STUDIES. Bonnie A. Mack, Catherine F. Quigley, Stephen L. Bacharach, Michael V. Green, and Gerald S. Johnston. National Institutes of Health, Bethesda, Md.

The measurement of left ventricular (LV) function with high temporal resolution ECG-gated scintigraphic angiocardiography (J. Nucl. Med. 16:95-98) depends on the unambiguous identification of the LV. If the scintillation camera (SC) normally used in this procedure is replaced with a non-imaging scintillation probe (SP), LV volume curves can be obtained in real-time, but visual information about LV location is lost. An investigation was, therefore, undertaken to determine (1) a method for locating the LV without visual cues and (2) the correct probe angulation.

Sixty-one of 75 patients studied with the SC exhibited maximal right-left heart separation when viewed from a 35 degree modified left anterior oblique (MLAO) position. The remaining 14 exhibited maximal separation within 5 degrees of this position. These data suggest the SP be fixed in space in a 35 degree MLAO orientation and moved over the chest only by translation. In a SC simulation of a SP with this angulation, it was found that the probe location that resulted in the largest end diastolic, end systolic excursion in the associated LV volume curve tended to locate the SP directly over the LV.

The efficacy of this angulation and LV location scheme was evaluated in a preliminary study in which independent SP and SC LV volume curves were obtained in the same patients. The results of this study suggest that LV volume curves obtained with the SP and SC do not differ significantly.

A COMPARATIVE EVALUATION OF IMAGING DEVICES FOR MYOCARDIAL STUDIES USING THALLIUM-201. Henry F. Manspeaker, William Montgomery, William Schafer, James K. Langan, H. William Strauss, and Bertram Pitt. The Johns Hopkins Hospital, Baltimore, Md.

The most abundant photons resulting from the decay of thallium-201 are due to the mercury x-ray (69-80 keV). Unfortunately, some scintillation cameras have poor resolution with these low energy photons. To determine the best means of imaging thallium, phantom studies were performed on a 19 and 37PM tube scintillation camera and rectilinear scanner to determine the relative resolution of each.

Images were obtained with 2 phantoms: a) an Au-195 grid phantom (platinum x-rays 66-81 keV) with central squares of 1cm x 1cm in scatter at the surface of a high resolution low energy collimator on the cameras and in the focal plane for the scanner; b) a phantom simulating the left ventricle consisting of two concentric beakers with the 1cm space between the beakers filled with 250μCi thallium-201 to simulate the wall and the inner beaker filled with water to approximate the chamber; a sheet source to simulate lung

background was behind and 3cm scatter in front. Disc shaped parafin lesions, 3.5 and 2.5cm in diameter by 1.0cm and 0.5cm thick were placed in the inter-beaker space and imaged on each instrument for a count density of 1000 counts/cm^2.

The 3.5 x 1cm and 2.5 x 1cm were well resolved on the 37PM tube camera and fairly well resolved on the 19PM tube camera. The 3.5 x 0.5cm and 2.5 x 0.5cm were poorly resolved, but visible on the 37PM tube camera but were only slightly seen on the 19PM tube camera. The rectilinear scanner was comparable to the 37PM tube scintillation camera but it took 50-100% longer to collect the data.

We conclude that thallium imaging is best done with a 37PM tube camera.

Author Index to Abstracts

Ashley, S. J., 93
Bacharach, S. L., 99
Barber, M., 94
Battaglia, D. J., 92, 93
Bernier, D. R., 96, 97
Bifolck, L., 98
Bunz, L., 94
Burkhead, C., 93
Burks, R., 96
Burt, W., 96
Cain, R., 96
Capuzzi, J. P., 98
Carretta, R. F., 98
Case, G. B., 95
Chelsy, S., 94
Cianci, M. L., 92, 93
Clarke, M. T., 97
Coleman, A., 99
Coleman, R. E., 96, 97
Colombetti, L. G., 92
Conway, J. J., 95
Costanza, M. A., 95
DeFries, C., 92
Dubovsky, E. V., 94
Fasiska, B. C., 95
Fisher, R. S., 98
Gibbs, W. D., 95
Giga, J. L., 98
Grabowski, C., 98
Green, M. V., 99
Hamilton, G. W., 99
Hodges, H. D., 95
Hoffer, P. B., 97
Hyams, P., 98
Johnston, G. S., 99
Kaufman, L., 97
Klenke, W. J., 98
Kontzen, F. N., 94
Kopp, D. T., 98
Lands, E. L, 97
Langan, J. K., 99
Lee, J. I., 92
Lim, C. B., 97
Mack, B. A., 99
Malmud, L. S., 98
Manspeaker, H. F., 99
Marks, J. M., 96
Martin, C. B., 95
Matin, P., 95
Montgomery, W., 99
Mullins, J., 94
Neill, J. M., 98
O'Mara, R. E., 97
Palmer, D. W., 97
Patel, G. C., 92, 97
Phegley, D. J., 96
Pinsky, S., 92
Pitt, B., 99
Powell, M. R., 94
Quigley, C. F., 99
Rhodes, B. A., 97
Robertson, M., 99
Robinson, W. L., 96
Salk, R., 94
Schafer, W., 99
Schleif, A., 96
Shea, T., 93
Sikorski, S., 99
Sorandes, T., 96, 99
Stankiewicz, C. J., 98
Strauss, H. W., 99
Swann, S. J., 97
Tauxe, W. N., 94
Ter-Pogossian, M. M., 9
Tobin, M., 94
Trusten, P., 93
Tuscan, M. J., 97
Tyler, K., 99
Weber, D. A., 97
Weiss, S., 95
Welch, M. J, 97
Wells, L. D., 97
Welton, J., 93
Williams, D. L., 99
Wing, J., 96
Winston, D., 96