Abstracts for Technologist Scientific Program: SNM 24th Annual Meeting—Chicago

MONDAY JOHN EVERS THEATRE
4:00 p.m.-5:36 p.m

SUBMITTED PAPERS I

Moderator: Paul E. Christian

INSTRUMENTATION

GALLIUM-67 CAMERA IMAGING SPECTROMETRY. Elbert L. Lands. University of Chicago Hospitals and Clinics, Chicago, Ill.

This comparative study of the 94, 183, and 296 keV energies of Ga-67 was undertaken to optimize multiple window settings for an Anger camera.

The Searle Radiographics L.F.O.V. was used to image the following: (a) intrinsic flood field and quadrated bar phantom, (b) sensitivity of the camera system to Ga-67, i.e., "counting rate observed with a 20% window width," (c) a liver-slice phantom with hot and cold areas in 2 in. of scattering medium under conditions of varied spectrometer settings.

The data reveals the camera system sensitivity response to the Ga-67 energies to be, 58%--94 keV, 30%--183 keV, and 10%--296 keV. Intrinsic flood field of the 94 keV at 20% window has acceptable uniformity, while the floods of the 183 and 296 keV appear mottled. Intrinsic bar phantom studies reveal the 94 keV peak to be poorly resolved, while studies at 183 and 296 keV demonstrated better resolution. Extrinsic flood field studies at the 94 keV peak with scatter are mottled at window widths smaller than 20%. Window widths of 20% and greater show greater uniformity. The results of the extrinsic modified liver-slice phantom studies performed in scatter showed best resolution obtained with spectrometry of: 10%--94 keV, 20%--183 keV, and 20%--296 keV. The next best was: 20%--94 keV, 20%--183 keV, and 20%--296 keV.

If the 20% window was used on the 94 keV peak, there would be slight resolution loss, but a 20% gain in counting rate. This appears to be the most satisfactory compromise between sensitivity and resolution for routine imaging.

A COMPUTERIZED ENHANCED SUBTRACTION TECHNIQUE FOR Ga-67 SCANNING. Dayton A. Rich, Vijay M. Dhawan, John J. Sziklas, Richard P. Spencer. Hartford Hospital, Hartford, Conn.

Preliminary reports have indicated the usefulness of Ga-67 and Tc-99m, in combination with a subtraction technique, in the diagnoses of inflammatory and some neoplastic lesions. A computerized Ga-67/Tc-99m subtraction technique has been utilized which significantly enhances the ability to localize abnormal Ga-67 foci. An Ohio Nuclear series 100 camera interfaced to an Ohio Nuclear 150 data system was used in the study. With a 20% window, the pulse height analyzer was calibrated to accomodate the 140 Kev photopeak of Tc-99m and the 184 Kev photopeak of Ga-67; all data were stored on magnetic tape. Images were replayed into the dual 16K, 128 x 128 matrix with a memory-to-memory subtraction feature. Both Tc-99m and Ga-67 images were expressed as 100%. Then the Tc-99m image was processed with gradually increasing weighting factors from 10% to 60%; each subtracted from the unweighted (100%) Ga-67 image which was photographed off a black and white video screen. By using variable weighting factor, we were able to accentuate lesion contrast and localization relative to neighboring structures or organs. In 13 patients with abnormal abdominal foci of Ga-67, the subtraction scans correlated well with the post operative diagnoses. In 3 patients with suspected osteomyelitis, there was no excess gallium on subtraction. This tended to rule out the diagnosis. The subtraction technique has proved to be of significant value in the exact localization of abnormal Ga-67 foci, and in diagnosis in selected cases.

"Cold-Spot Technique and Enhancement of Image Quality in Pancreatic Scanning. George Lis, Said M. Zu'bi, John P. Sullivan and Suresh M. Brahmavar, Baystate Medical Center, SH-WW Unit, Springfield, MA.

Pancreatic scanning has been subjected to more modifications than any other nuclear medicine procedure; but it still continues to be a challenge for most of the nuclear medicine departments with standard instrumentation. Computer subtraction and video-tape replay have been successfully employed by some to obtain better quality images. The method presented enables us to obtain consistently reliable images of high quality in routine pancreatic scanning. The lowest activity area or "cold-spot" in the abdomen is chosen as the scanner set-up point. The light source voltage is adjusted so that "cold-spot" is just above the lower knee (light grey) of the density curve. The selected range differential must vary with cold-spot percentage of scale to achieve an equivalent of 40% suppression. These set-up factors ensure a high contrast and controlled background sensitivity for all pancreatic scans using a rectilinear scanner.

Better enhancement of image quality is achieved by the use of two overlapping films in the cassette to record the photo scans and scanning done at "Double speed and Half Line Spacing." The second film with its filtered image gives better anatomical definition of pancreas and liver. Scanning at double speed and half line-spacing results in averaging of density fluctuations due to random count-rate.

The routine pancreatic study includes scanning at 10 minutes and 40 minutes post-injection of Se-75 and Tc-99m sulfur colloid liver scan of the patient in the same position. The successful implementation of these techniques in a total of 720 pancreatic scans with consistently high image quality have made the rectilinear scanner an instrument of choice for pancreatic study at our medical center.

FLUORESCENCE THYROID SCANNING: PROPER SELECTION OF ENERGY WINDOW. Michael V. McCormick, Heinz W. Wahner, and Alan L. Orvis. Mayo Clinic and Mayo Foundation, Rochester, Minn.

X-ray energy spectra from a thyroid fluorescence scanner were studied to determine factors influencing images and quantitation of iodine. An electronic background subtraction device (net peak processor) was used (Kevex model 4840). An x-ray fluorescence scanning system was adapted to a rectilinear scanner. The amplified detector output signal was supplied as input to one multi-channel and two single-channel analyzers. Single-channel analyzer discriminators were set for windows at the K-alpha iodine peak (28.5 keV) and at a region selected to be equivalent to the background within the K-alpha iodine peak. The logic signals from each single-channel analyzer were fed into the net peak processor, which provided an output signal equivalent to the net count in the iodine peak. This signal is used for photorecording and scaling. 1. The lowest detectable iodine concentration in water phantoms was 0.1 mg/ml. 2. The smallest cold region visualized in 0.4 mg/ml iodide (normal thyroid iodine concentration) was 0.7 cm. 3. Distortion of the spectrum was seen in patients who had taken I-131 and Tc-99m, thus invalidating the net processor technique. 4. Changes in the spectrum were noted when counts were collected from different parts of the neck. 5. The net peak processing technique only marginally improved the image quality of a thyroid phantom. 6. This technique reduced the information density (about 30%) compared with counting without correction. The resulting scans show greater statistical variation and contrast.

A DYNAMIC HEART MODEL FOR THE ASSESSMENT OF VENTRICULAR TIME ACTIVITY CURVES. Edward Raab, Edward Nickoloff, Henry Manspeaker, Bertram Pitt, Henry Wagner, Jr. Johns Hopkins Hospital, Baltimore, Md.

Various techniques are being developed to measure ventricular time/activity curves (TAC). To evaluate these techniques a dynamic heart model, consisting of a rubber balloon immersed in water to which Tc-99m was added to simulate background activity, was attached to a pump which could be varied by a known volume. By varying the stroke volume, rate, and pulse ratio TAC with shapes similar to those obtained by contrast angiograms in patients were produced.

The model, filled with either contrast media, or Tc-99m as a standard, was used to test various techniques: (A) contrast single plane angiograms - 60 frames/sec. (B) A scintillation camera/computer system - 60 frames/cycle, using a fixed area over the balloon to monitor the activity. (C) A scintillation camera/computer system with 28 frames/cycle using an automatic edge detection program which tracks the activity throughout the cycle. (D) A hand held nuclear detector with 196 channels/cycle held over the pulsing volume of activity.

In method B,C,D, background activity was subtracted from the original curve to give a final TAC which was compared to the reference balloon data. The ejection fraction calculated from the balloon was 46%, by method A 51%, B 39%, C 45%, D 43%.

This model appears useful for evaluating various techniques used to monitor ventricular TAC.

LONGITUDINAL MULTIPLANE EMISSION TOMOGRAPHY (PHO/CON, SEARLE RADIOGRAPHICS, INC.)--PROBLEMS FACING THE TECHNOLOGIST. Terry Brown, Charles Armstrong, Barry S. Brunsden, and Elbert L. Lands. University of Chicago Hospitals and Clinics, Chicago, Ill.

Experience gained on the basis of one thousand studies performed during an eight-month period in 1976 revealed there are a number of complex, new, and unfamiliar problems associated with multiplane tomography which face the technologist. This paper discusses the common difficulties encountered:

(a) Choice of appropriate tomoplane separation;
(b) Optimization of film exposure (intensity) for multiplane images;
(c) Correct detector positions;
(d) Instrument misplacement of tomoplanes;
(e) Count rate limitations.

Methods devised which overcame or minimized these problems included:

(1) a new imaging data checksheet and patient exam record,
(2) a new phantom (a paired double helix or "clock" phantom) which allows both verification of choice of tomoplane setting and accuracy of instrument tomoplane placement.

It has become apparent, however, that successful clinical studies require a particularly close interaction between the nuclear physician and technologist. Strict adherance to setup procedures and use of the phantom resulted in consistant performance and high quality longitudinal multiplane tomograms.

THE TOMOSCANNER WITH MULTIANGLE READOUT METHOD. Audrey M. Samuel. University of California, San Francisco, Ca.

We are currently evaluating the clinical utility of the Anger multiangle readout system. The purpose of the presentation is to explain those aspects of the system which are of particular interest to the nuclear medicine technologist.

The multiangle viewing system operates in conjunction with the Anger tomoscanner. The imaging unit consists of two sodium iodide crystals, one above and one below the patient. The unit utilizes focusing collimators. The detector arrangement and associated electronic readout system produce two separate image formats. One set consists of six anterior and six posterior tomographic images. The exact planes and separation of planes can be selected by the operator. The second set consists of seven multiangle images from each detector which are displayed in a non-tomographic manner.

The tomoscanner with multiangle viewing features gives the observer twenty-six scintigraphs from a single rectilinear scan. The multiangle feature of the tomoscanner enables one to see around overlying objects that might otherwise obsure lesions. These images can be viewed separately or as stereoscopic pairs.

DUAL INDEPENDENT PHOTOPEAK ANALYZER PERFORMANCE FOR A MULTIPLANE TOMOGRAPHIC SCANNER. Alnoor H. Koorji, Ernesto V. Garcia and August Miale, Jr. Division of Nuclear Medicine University of Miami School of Medicine, Miami, FL.

A commercially available multiplane tomographic scanner (PHO/CON) was evaluated for Ga-67 imaging to determine the photopeak and window width combination to achieve optimal resolution and information density (ID). This evaluation was accomplished with the 380 KeV collimator and a 45 degree angled line source resolution phantom immersed in 15 cm of water. The line space separation and width derived from the image of this phantom allows one to measure the spatial resolution at depth in scattering media in any selected tomographic plane as well as the thickness of the plane. Each of the four photopeaks of Ga-67 were used individually with only one analyzer with varying window widths from 10-40%. Five photopeak window width settings giving the best performance in terms of resolution and information density were chosen. Then the experiment was repeated using the dual photopeak analyzer set at all possible combinations of the best settings chosen earlier. The results in order of preference were:

Energy Window (Kev,%)	Average ID	Resolution mm	Speed cm/min
(93,20) (296,30)	1000	12	350
(93,20) (184,30)	820	13	500
(184,20) (296,20)	800	12	250

These findings can be applied to the clinical situations with optimal results.

TUESDAY JOHN EVERS THEATRE
2:00 p.m.-3:15 p.m.

SUBMITTED PAPERS II

Moderator: Stephen A. Kuhn

RADIOIMMUNOASSAY

COMMERCIAL QUALITY CONTROLS AND TARGET VALVES FOR RADIOIMMUNOASSAYS. Rebecca Washburn, Jo-ann Dalton, Suresh M. Brahmavar and Said M. Zu'bi, Baystate Medical Center, SHWW Unit, Springfield, MA

The rapid increase of use of radioimmunoassays in patient care and physician's reliance on the results for drug monitoring has led to a great emphasis on the quality assurance of the test results. The quality assurance takes on added significance when the commercial kits and controls are used in such radioimmunoassays. A series of determinations in Folate assays showed a large discrepancy between the measured and the target values for one of the quality controls supplied by a commercial manufacturer.

In order to pinpoint the problem whether discrepancy is due to the technique of assay, problems related to the folate kit or the control itself several independent investigations were undertaken by our laboratory, kit manufacturer and quality control manufacturer. The average values are:

BMC	10.2	ng/ml
Control Manuf.	10.3	ng/ml

Kit Manuf. 11.6 ng/ml
Target Value 1.4 ± 0.3 ng/ml

An analysis of these independent determinations indicate that measured values of quality control in question were consistently in disagreement with the target value given by the control manufacturer. Hence, this discrepancy between measured and suggested target value is attributed to the possible deterioration of the quality control.

In closing, we would like to point out that the cooperation given by the quality control manufacturer in pinpointing the reasons of observed discrepancy was less than satisfactory.

COMPARISON OF THREE KIT METHODOLOGIES FOR THE MEASUREMENT OF SERUM TRIIODOTHYRONINE. Helen H. Mikesell, Eileen L. Nickoloff, and Wayne Kasecamp. The Johns Hopkins Medical Institutions, Baltimore, Maryland.

Three kits for the measurement of serum triiodothyronine were evaluated and compared: Corning Solid Phase, Abbott Charcoal and Abbott PEG. The following parameters were studied: inter-run and intra-run precision, recovery of added triiodothyronine, and the observed normal range in healthy subjects.

Coefficients of variation intra-run were 7.5% at the 380 ng/dl T3 level and 10.1% at the 160 ng/dl level for the Abbott PEG kit. Abbott Charcoal showed C.V.'s of 7.6% at the 160 ng/dl level and 5.7% at the 390 ng/dl level. Corning's Solid Phase demonstrated C.V.'s of 6.2% at the 150 ng/dl level and 8.5% at the 270 ng/dl level. Inter-run coefficients of variation for the three kits were 4.3%, 15.2% and 4.4% respectively, at the 150 ng/dl level.

Recovery of human triiodothyronine added to T3-free serum (Endocrine Sciences, Tarzana, Calif.) averaged 110% by the Abbott PEG kit, 130% by the Abbott Charcoal method, and 103% by Corning Solid Phase at levels of 60, 150 and 300 ng/dl.

T3 levels in 70 healthy euthyroid subjects were found to be 83-211 ng/dl with Abbott PEG, 74-203 ng/dl with Abbott Charcoal and 90-200 ng/dl with Corning Solid Phase kit. These values are expressed as ± 2 S.D. from the mean. In addition, T3 values were compared for 15 clinically diagnosed hyperthyroid patients, 8 clinically hypothyroid patients, 7 patients with TBG abnormalities and 9 pregnant subjects.

Partly on the basis of these results, we have selected the Corning Solid Phase kit for use in our laboratory.

CLINICAL APPLICATIONS OF PROLACTIN BY RADIOIMMUNOASSAY. Judy Williams. The Methodist Hospital, Houston, Texas.

The clinical evaluation of prolactin (HPrL) is undertaken in order to clarify its importance in hypothalmic-pituitary disorders.

A radioimmunoassay double-antibody technique is used for the determination of serum HPrL levels. This method includes two 24 hour incubations at room temperature. A maximum percent bind is achieved between 45 and 50% and the calibrated standard preparation is capable of measuring up to 100 ng/ml. The normal range for females is 2-25 ng/ml, for males 5-15 ng/ml. Dynamic studies may be incorporated for additional case information. Thyroid releasing hormone (TRH) is used as the HPrL stimulant, and L-Dopa the suppressant.

An assessment of chromophobe adenoma cases reveals HPrL levels well over 200 ng/ml with no response to TRH and a 50% suppression response to L-Dopa. Post treatment (i.e. surgery and/or x-ray) HPrL measurements show a definite decrease as compared to the pretreatment level.

Cases of primary amenorrhea with or without galactorrhea result in HPrL values of approximately 150 ng/ml. TRH studies reveal a nonresponsive reaction. Secondary amenorrhea, usually accompanied by galactorrhea, exhibit HPrL values between 35 and 70 ng/ml. TRH studies show a prolonged, flat peak. Both primary and secondary amenorrhea patients show suppressed serum HPrL levels after the administration of L-Dopa.

Prolactin determinations are becoming part of the clinical workup for pituitary adenomas and infertility. This is due not only to the improved HPrL assay but also to a greater understanding of the clinical role of this hormone.

HUMAN SERUM FERRITIN ASSAY - AN EVALUATION OF A COMMERCIAL KIT. K. Tripses, N. Clark, K. Kirchhoff, L. Padellford. Iowa Methodist Medical Center, Des Moines, Iowa.

The purpose of this study was to evaluate the Fer-Iron Kit produced by Ramco Laboratories, Houston, Texas, for the measurement of human serum ferritin; to determine a normal range for our laboratory, and to discover any correlation between ferritin levels and iron storage levels and other non-specific factors affecting ferritin concentration.

The kit was used as directed. Thirty-seven hospital patients were studied and 26 normal blood bank donors. Of these 24 were normal females and 32 were normal males. Normal levels of hemoglobin, hematocrit, white blood cells, bilirubin and alkaline phosphatase were required to qualify the hospital patients as normal. In addition 11 abnormal patients were studied.

The ferritin levels of the normal population were found to have a positively skewed distribution. A logarithmic transform of the data showed a normal distribution. Ranges were determined both by log transform and percentile. The range of abnormals showed a slight overlap with the high normals. A normal male was used as a control. The precision on a day to day basis was acceptable. Patients with abnormal ferritin levels had either non-specific factors known to elevate ferritin levels or increased iron stores on bone marrow. Non-specific factors present included high liver enzymes and high total bilirubin levels.

We found this kits were to give reproduceable data, and to be easy and efficient to use. Our normal range compared closely with that found in the literature.

LABORATORY INFECTION CONTROL

A MODEL INFECTION CONTROL PLAN FOR A NUCLEAR MEDICINE LABORATORY. Theodore Sorandes. University of Maryland Hospital, Baltimore, Md.

Since the goal of all clinical nuclear medicine laboratories is to deliver optimum patient care in the most efficient manner, this project was undertaken to develop a model infection control plan which would support this goal and fulfill the Joint Commission for Accreditation of Hospitals requirements for infection control plans. The effectiveness of this model infection control plan is obtained by eliminating one or more of the six linked factors which must be present for the transmission of infections to occur: 1) a causitive organism, 2) a susceptible host (patient, technician, doctor, etc.), 3) a portal of entry (nasal, buccal, etc.), 4) a mode of transmission (air, skin, etc.), 5) a port of exit (skin, buccal, etc.) and 6) a reservoir for the organism (lung, bladder, etc.)

The infection control plan describes procedures for 1) cleaning the department physical plant, 2) handling patients requiring specific methods of isolation (respiratory, glove, etc.), 3) effectively decontaminating the department equipment and utilizing infection control techniques in performing nuclear medicine procedures. In addition, the model infection control plan suggests how the department may document its compliance with the infection control plan by using such methods as administrative control, check lists, etc.

RADIOPHARMACEUTICALS

EFFECT OF REDUCED Tc ON IMAGING WITH THE SCINTILLATION CAMERA. Lynne M. Koester, Patricia Frank, and Mary Ann Leeper. Searle Laboratories, Skokie, Illinois.

The clinician is acutely aware of the distorted distribution of an imaging agent when sodium pertechnetate is present. The purpose of this study is to demonstrate the distribution pattern of reduced technetium (another

imaging agent contaminant) at varying pH's.

The reduced technetium was produced using the standard tin chloride reduction procedure. The pH was then adjusted to the desired level using .1N hydrochloric acid. Rabbits were studied at pH 1 (the pH of the product following the reduction procedure), pH 3 and pH 6. Higher pH's give cloudy solutions with SnOH as the colloidal contaminant. Monkeys and dogs were also examined at pH 1 and 3 to study inter-species variation. Animals were injected intravenously via either the marginal ear vein (rabbits) or the saphenous vein (monkeys and dogs). Animals were imaged using an LFOV camera and all data was analyzed by the computer for total counts in the animal and percentage of counts in each organ with significant concentrations.

At pH 1, both rabbits and dogs exhibited a minimum of 40% of the total radioactivity in the liver over a 24 hour period. In addition, there was significant splenic and intestinal pick-up over the same time period. Distribution data for pH 1, pH 3 and pH 6 will be discussed in depth with special focus on correlations among the three species tested. This work should make it easier for both clinician and technician to recognize reduced technetium contaminations of radiopharmaceuticals.

EVALUATION OF COMMERCIAL Tc-99m-MAA RADIOPHARMACEUTICALS. Kathy Baron, Bonnie Clay, A. Michael Zimmer, Dan G. Pavel. University of Illinois Medical Center, Chicago, Illinois.

Our laboratory evaluated the radiochemical purity, stability, particle size and total number of particles of four commercial MAA manufacturers including Macrotec (Squibb), Pulmolite (NEN), TechneScan MAA (Mallinckrodt), and Lungaggregate (Medi-Physics). The radiochemical purity and stability was evaluated by injecting between 40-45 mCi of Tc-99m pertechnetate into commercial MAA preparations and evaluating the radiochemical purity and stability of the preparations up to 4 hours post-formulation by chromatographic analysis (Whatman 31 ET paper and acetone). The particle size distribution and total number of particles/kit were determined by injecting an exact volume of 0.9% sodium chloride into 4 vials of each manufacturer's kit, placing multiple samples on a hemocytometer, and counting the number and size of particles under a microscope.

Results indicated that the labeling efficiencies of all kits were initially greater than 98% and remained greater than 98% up to 4 hours after preparation. Particle size for the commercial kits was generally between 5-30 µm except for one manufacturer's product where the majority of particles ranged from 30-50 µm. The total number of particles in the commercial kits ranged from 2.0 million particles to 9.9 million particles.

We have clinically evaluated 2 commercial MAA kits and have observed unexplained organ concentrations including thyroid and kidney even though the labeling efficiencies of these preparations were greater than 98%. We are currently investigating the causes for extraneous organ uptake.

WEDNESDAY JOHN EVERS THEATRE

2:00 p.m.-3:30 p.m.

SUBMITTED PAPERS III

Moderator: Toussaint B. Battison

LABORATORY OPERATION

QUALITY ASSURANCE OF PATIENT CARE. Elaine D. Pritchard. Kaiser-Permanente Medical Center, San Francisco, CA.

How do we motivate medical-professional personnel to deal with the "whole" patient? In this age of specialization I have witnessed people being referred to as the elevated bilirubin, the dislocated shoulder, or the brain scan. Are we so technically elevated that patients are no longer people, are our thoughts dislocated to the point of indifference, and should we not be scanning our brains to re-call the perspective of health care for the patient as a whole entity? Nobody in the system, except the patient, seems primarily concerned about the total experience of the patient.

Patient care as a "whole" entity by the Nuclear Medicine Technologist. We bear the responsibility for performing diagnostic procedures efficiently and to assist for the common goal of the medical team. We hope to achieve this by utilizing our learned technology. Through self-analysis, a technologist must realize that he is a person also, and this person must apply the learned technology in a desireable way most condusive to patient cooperation. No matter what degree of technological expertise we have acquired, without a consenting applicant, i.e. patient, we can make no application.

Technologists must accept the challenge of self-evaluation as the means towards becoming conscientious members of the medical team that treats the whole person. Be it far better that we ourselves and our peers seek self-improvement, self-motivation, than to be misjudged by outsiders. We should be dedicated to continued growth of whatever skills necessary to function to the best of our ability. We are responsible.

AN EFFECTIVE MEANS OF SCHEDULING SIMULTANEOUSLY ORDERED NUCLEAR MEDICINE AND RADIOGRAPHIC EXAMS. L. David Wells, Ralph G. Robinson and Buck A. Rhodes, Kansas University Medical Center, Kansas City, Kansas 66103.

Efforts in our laboratory to eliminate radiology and nuclear medicine exam scheduling problems have lead to the design and implementation of 2 charts. These charts, consisting of some 70 radiology exams on the X axis and 90 nuclear exams on the Y, are for use by staff physicians, ward personnel and nuclear medicine or radiology scheduling personnel, and provide an effective guide for scheduling simultaneously ordered nuclear medicine and radiographic exams.

A barium exam performed before a liver scan, or a brain scan performed before a liver scan may cause imaging artifacts or poor quality images. If these exams are not carried out in the proper sequence, poor quality patient care can result because the patient is either delayed and has to pay additional hospital expenses or the patient may have to receive extensive bowel preps in order to have his exams performed properly.

The principle and use of these charts is somewhat similar to that of a mileage chart; the order of sequence and exam time between scheduling the 2 studies is found at the X (radiology exam) and Y (nuclear medicine exam) intersect.

The introduction of these 2 charts to staff physicians, ward and scheduling personnel has eliminated most of the confusion in scheduling simultaneously ordered nuclear and radiology exams. Furthermore, these individuals find the charts to be very valuable in eliminating QUABS (quality assurance breakdowns in nuclear medicine patient care) associated with patient scheduling.

RELOCATING A NUCLEAR MEDICINE LABORATORY. S. A. Kuhn. Iowa Methodist Medical Center, Des Moines, Iowa.

When this medical institution allocated money from the capital building fund for a new Nuclear Medicine facility, it became important to plan and properly relocate an entire Nuclear Medicine Laboratory from an old building to a new structure.

Factors considered during the planning of the relocation were: route, doorway and hallway dimensions, elevator capacities and slope of floor surfaces. The temperatures of areas to be traversed were also studied. Coordinating the move with patient workload was important to reduce the loss of patient study time.

A moving crew was assembled. One heavy duty, four-wheel supply cart and two patient transport carts were used as moving vehicles. The factory installed castors on some in-

struments were utilized to move items that could not be dismantled. Scintillation instruments and accessories, clerical supplies, patient files and all other apparatus needed for in vitro and in vivo radionuclide studies were relocated.

A total of six Sodium Iodide (Tl) crystals were relocated without adverse effects from temperature change or vibration.

At no time during the transition were the patients of the Medical Center without emergency Nuclear Medicine services. Our Nuclear Medicine relocation project was successful because of careful planning, coordination, and diligent work by all.

DESIGN CRITERIA FOR A NUCLEAR MEDICINE DEPARTMENT. Janice C. Honeyman. University of Virginia Medical Center, Charlottesville, Va.

An attempt was made to design a comprehensive nuclear medicine department for a 225 bed private community hospital without an existing department. Data was collected through interviews with referring physicians, using documented statistics and equipment catalogues. Functions and objectives were outlined, workloads projected, equipment costs calculated, and basic budget proposed. The final result was a compact department equipped for imaging and wet lab procedures costing about $150,000 original outlay with the first year's revenue projected at $116,330 and recommendations for future expansion.

CARDIAC IMAGING

SPECTRUM OF TECHNICAL FACTORS AFFECTING THALLIUM-201 AND Tc-99m PYROPHOSPHATE IMAGING IN ACUTE MYOCARDIAL INFARCTION. Linda M. Pytlik, Harvey J. Berger, Alexander Gottschalk, Barry L. Zaret. Yale University, New Haven, Ct.

Although thallium-201 (Tl-201) and Tc-99m pyrophosphate (PYP) imaging are commonly used to diagnose and localize acute myocardial infarction (MI), technical factors may compromise effective interpretation of some images. Therefore, the spectrum of technical problems which could affect image interpretation was evaluated in 385 coronary care unit (CCU) patients (pts) suspected of having sustained an acute MI. Tl-201 imaging was performed in 176 pts, PYP in 209 pts, and dual imaging in 101 pts. Anterior and left anterior oblique images were obtained in the CCU using a stationary computerized multicrystal scintillation camera with a high resolution parallel hole collimator.

With Tl-201, the following problems were encountered: excessive uptake in the stomach or liver, obscuring inferior or apical segments (15 pts); radiation attenuation by overlying ECG leads (2); and residual radiation from previous Tc-99m scan (4). With PYP: uptake in bony fractures or metastases (6); unexplained uptake in nipple (1); skeletal muscle uptake after cardioversion (4); radiation attenuation by pacemaker wires (1); intense blood pool activity, due to renal insufficiency in some pts (6); and diffuse non-cardiac uptake, due to poor PYP preparation (4). Problems with both PYP and Tl-201 did not occur in the same pt.

The CCU technologist should recognize these patterns of uptake and repeat the scan after changing the obliquity, repositioning the pt, using lead markers to identify non-cardiac PYP uptake, delayed PYP imaging, and injecting Tl-201 with the pt sitting up before a meal. This should decrease the incidence of false-positive or negative infarct images. Although technical problems occurredin 11% of images, their incidence decreased with experience.

LEFT VENTRICULAR EJECTION FRACTIONS USING A MULTI-CRYSTAL SCINTILLATION CAMERA. Kathryn Wilkins and Lionel Reese, St. Joseph's Hospital, University of Western Ontario London, Ont.

Left Ventricular Ejection Fractions (E.F.) were measured after the injection of a bolus of Tc-99m Gluconate using the Baird System 70 multi-crystal camera which is computerized and has been programmed for ejection fraction calculation. The ejection fractions so calculated were compared to values obtained by conventional contrast angiography.

Experiments were designed to test the importance of collimation, the projection used and variations in the parameters chosen for the subsequent data analysis.

In one series of experiences alternate anterior and 45 degree left anterior oblique (LAO) views were obtained after the injection of 30 mCi using moderate collimation (1½). In ten patients studied there was poor correlation with catheterization studies (r=0.30, for LAO - 45 degrees).

In a second series of preliminary experiments, correlation was markedly improved. Count rates were improved and the required injection dose reduced to 15 mCi by reducing the collimator to 1 inch. A better bolus was attained by increasing and standardizing the volume injected. The effect of changing the parameters for the E.F. soft-ware was also investigated. It was found that E.F. calculations were critically dependent on the background subtract frame. A correlation of E.F. obtained in the LAO-20 degree view to values obtained at the time of catheterization gave a statistically significant relationship ($r=0.82$, $P < 0.01$). Repeat studies resulted in ($r=0.96$, $p < 0.01$).

Non-invasive E.F. determination appears possible if the LAO-20 degree view is used with a specific standardization.

TECHNICAL REQUIREMENTS IN ECG-GATED HEART STUDIES PERFORMED AT REST AND DURING EXERCISE. Bonnie A. Mack, Jeffrey S. Borer, Michael V. Green, Stephen L. Bacharach, and Gerald S. Johnston. National Institutes of Health, Bethesda, Md.

Recent reports have described an ECG-gated scintigraphic imaging system that permits the measurement and visualization of left ventricular function at rest and during bicycle exercise. Such a system provides the potential for unmasking cardiac abnormalities not evident at rest. In order to conduct such rest-exercise tests successfully, the technologist must be knowledgable in areas not normally associated with nuclear medicine imaging procedures. In addition to the operation of conventional equipment, the technologist must have a command of cardiac anatomy, physiology and electrocardiography and in their variations with disease, and of computer operations. During these procedures the technologist, under the supervision of a cardiologist, monitors the status of the patient through repetitive blood pressure measurements, observes the patient's ECG for abnormalities, monitors exercise levels obtained on a bicycle ergometer and initiates and monitors computer operations. Finally, the technologist must evaluate the final results. Since these, and similar cardiac procedures, are likely to become commonplace in nuclear medicine laboratories, these technical requirements and the results of typical rest-exercise studies are presented in a short film.

EXERCISE TECHNIQUES FOR RADIONUCLIDE ANGIOCARDIOGRAPHY. Bryce B. Bates, Stephen K. Rerych, and Robert H. Jones. Duke University Medical Center, Durham, N. C.

Evaluation of cardiac function during exercise stress provides important information unavailable from studies performed at rest. Adequate data are difficult to obtain at exercise because of the brief duration of the cardiac cycle, the rapid transit of tracer through the heart, and patient motion during exercise. Use of a high count rate gamma camera provides statistically valid data reflecting count changes over the precordium at 50 msec intervals during the initial passage of a 25 mCi bolus of Tc-99m. During rest and exercise, radionuclide angiocardiograms were performed in the erect position on 36 normal subjects and 23 patients with coronary artery disease (CAD). The ECG was telemetered and the blood pressure was monitored with an Arteriosonde. A prior treadmill exercise test in all subjects with CAD had documented the heart rate-blood pressure (HR-BP) product at which ischemic myocardial changes occurred on ECG. A bicycle ergometer provided a gradually increasing work load from 2 Kp to 7 Kp to achieve 80% of the maximal HR-BP product achieved during treadmill testing. Cardiac chamber wall motion and volume changes during individual cardiac contractions were assessed at heart rates greater than 200 beats/min. Normal subjects

showed a decrease in pulmonary transit time from 6.2 sec to 2.3 sec and an increased ejection fraction from .70 to .86 (P<.01). Patients with minimal CAD increased cardiac function to a subnormal level. Moreover, patients with severe myocardial ischemia actually decreased contractility during exercise. Properly performed resting and exercise initial transit radionuclide angiocardiograms provide important hemodynamic information with little patient risk.

THURSDAY JOHN EVERS THEATRE
4:00 p.m.-5:36 p.m.

SUBMITTED PAPERS IV

Moderator: Kathy Tripses

CLINICAL PROCEDURES

THE ACIDIFIED GASTROESOPHAGEAL SCINTISCAN,A RAPID TEST FOR THE DETECTION OF GASTROESOPHAGEAL REFLUX. Leon S. Malmud, Robert S. Fisher, John P. Capuzzi, Carol Grabowski, N.David Charkes, Temple University Hospital, Philadelphia, PA.

Roentgenographic techniques for the detection of gastroesophageal reflux (GER) are relatively insensitive and correlate poorly with clinical symptoms. Computer processed gastroesophageal scintiscanning (GES) detects and quantitates GER rapidly and with a high degree of sensitivity. The purpose of this study was to alter the standard GES in order to provide a more rapid,noncomputerized test for the detection of GER,without loss of sensitivity. The acidified GES is performed by the oral administration of 300 uCi Tc-99m sulfur colloid (SC) in a 300 ml solution containing 150 ml 0.1 N HCl and 150 ml orange juice.Fifteen minutes later sequential 30 second gamma camera images are obtained using a diverging collimator,as an external abdominal binder is inflated from 0 to 100 mm Hg readings at 20 mm Hg increments. A positive test is defined as visual reflux of stomach activity into the esophagus. Forty patients with heartburn and a positive acid reflux test and 20 normal controls were studied. Each had a standard GES and an acidified GES performed on the same day. Using the acidified GES without quantitation 36 (90%) of symptomatic patients had detectable reflux compared to 30 (75%) of patients studied without acidification. Only 22 (55%) of the symptomatic patients had roentgenographic evidence of GER. Conclusions: (1)the standard GES is a more sensitive technique for the detection of GER than is any standard radiographic technique,(2)the detection of GER is enhanced by the acidified GES. We suggest that the acidified GES without data processing is the most rapid,sensitive, and readily available technique for the detection of GER.

DIAGNOSIS OF COLD THYROID NODULES WITH RADIONUCLIDE SCANS AND ULTRASOUND. Theresa Ciez. Grant Hospital, Chicago, Illinois.

These clinical studies were formulated to evaluate whether cold nodules seen on radionuclide scans were cystic or solid in nature on ultrasound exams. Cystic nodules or fluid-filled nodules can be aspirated and the fluid examined. If no malignancy is revealed, surgery is not required. Solid nodules or masses are suspicious for carcinoma. Ultrasound examinations can aid in differentiating cystic nodules from solid nodules. In early diagnosis of cold nodules, almost every patient had surgery to determine if the nodule was a carcinoma. Ultrasound may alleviate the need for surgery in a percentage of cases with cystic nodules which can be aspirated without the trauma of surgery.

METHOD FOR PERFORMING Tc-99m PERTECHNETATE THYROID UPTAKE. Theodore Sorandes, University of Maryland Hospital, Baltimore, Maryland 21201

This study was undertaken to determine if diagnostic Tc-99m uptakes could be performed by using a gamma camera and inexpensive image data processing equipment.

Patients referred to this laboratory for I-131 thyroid uptakes and Tc-99m thyroid scans had 5 and 20 minute Tc-99m thyroid uptakes performed, utilizing the 4 mCi Tc-99m scan dose which was administered intravenously. The uptakes were performed by obtaining scans at a 10 inch collimator to skin surface distance and utilizing a 1 minute preset time. The images were simultaneously recorded on an Elscint VDP-II display processing unit. A Picker thyroid phantom filled with 40 uCi of Tc-99m and water was imaged in a similar manner.

The following procedure was used to determine the count rate of the thyroid gland minus background: an "area of interest" was used to flag the thyroid gland, "background substraction" was used to eliminate all counts not contained in the thyroid gland but included in the area of interest. Using the identical technique, the standard counts were obtained from the thyroid phantom. The thyroid uptakes could then be calculated.

The Tc-99m uptakes were classified as being in the hypo (<.25%), hyper (>5.5%) or euthyroid range (.25% - 5.5%). To determine the diagnostic value of the Tc-99m uptakes, the classification derived from the Tc-99m uptake was compared to the classification derived from the I-131 uptake, T-3, T-4, and ETR. In the 22 patients tested to date, there has been a correlation coefficient of .91.

SIMULTANEOUS DUAL ISOTOPE SCHILLING TEST. Clement J. Stankiewicz, John L. Giga, Frederick L. Weiland, and Robert F. Carretta. Wilford Hall USAF Medical Center, Lackland AFB, Tx.

We have recently evaluated a commercial kit that combines the stage I and stage II Schilling tests using Cobalt-58 labeled B-12 and Cobalt-57 labeled B-12 with intrinsic factor. Certain inherent drawbacks make the Schilling test less than ideal in order to determine whether a megoblastic anemia is secondary to either pernicious anemia, malabsorption, or other etiologies. A recurrent problem is either the failure of the patient to collect a full 24 hour sample or the inadvertent loss of such sample by ward or laboratory personnel. Utilizing this new technique, the patient is given both isotopes simultaneously and the ratio of Cobalt-57 to Cobalt-58 in a 24 hour urine specimen is determined. The use of a ratio makes errors in urine collection less critical than that of the classical Schilling test. In addition, the stage I and stage II tests are done simultaneously, confirming or excluding the diagnosis of pernicious anemia using just one procedure.

TECHNICAL ASPECTS OF I-125 FIBRINOGEN TESTING FOR THE DETECTION OF DEEP VENOUS THROMBOSIS. Vincent L. Sgroi and Kenneth M. Moser. Pulmonary Division, UCSD School of Medicine, San Diego, CA.

Historically, the detection of deep venous thrombosis has been difficult because of the lack of a simple, accurate and quick screening test. Recent technical advances have produced a number of sensitive procedures for confirming the presence or absence of thrombosis. One such procedure is the radioactive fibrinogen test, which our laboratory has been clinically evaluating for the past three years.

The procedure consists of three basic steps: (1) the patients thyroid must be blocked; (2) an intravenous injection of approximately 100 uCi of I-125 Iodine labelled fibrinogen; (3) approximately 4-6 hours post injection the patient's legs are marked at two inch intervals and each point is scanned using a portable scintillation counter. The radioactivity at each site is calculated as a percentage of the precordial count. A positive result was recorded whenever an extremity counting site revealed a count 15% higher

than either an adjacent site (above or below) on the same leg, or the same location on the contralateral leg, and this difference persists for at least 24 hours. Counts were repeated at least every 24 hours for at least three days.

During the past three years we have studied over 200 patients using the above protocol and have experienced a high degree of correlation with other diagnostic tests. The purpose of this paper is to more clearly define the technical aspects of performing a radiolabelled fibrinogen test. Such areas as physiology, instrumentation, and data presentation will be discussed so that the technologist will have a working knowledge of this procedure.

DEEP AND SUPERFICIAL VENOUS THROMBOSIS BY RADIONUCLIDE VENOGRAPHY. Ken Barat, Charles Schwab, Division of Nuclear Medicine, Kansas City College of Osteopathic Medicine, Kansas City, Mo.

The accurate and safe detection of embolism and venous thrombosis are of major medical importance. This includes peripheral as well as deep vein thrombosis. To evaluate Radionuclide Venography using 99mTc-M.A.A., 200 studies were performed accompanied by a lung scan.

Our technique involves the use of a double set of tourniquets right above each ankle (to yield deep vessel flow), intravenous injection of 2mCi 99mTc-M.A.A. via a 25 guage butterfly connected to a 3 way stopcock with a 12 cc saline flush. Dynamic images are taken every 5 seconds (checking venous occlusion and peripheral flow as the tourniquets are released). Static images are taken after a lung scan is performed and each leg has been well exercised. Forty-five percent of the patients studied showed positive venograms, with sixteen percent having an accompanying positive lung scan. Fourteen percent showed negative venograms and positive lung pathology. Clinical patient follow-up shows an extremely high rate of correlation with our radionuclide findings.

While a radionuclide venogram will not tell the age of a clot, we find it to be a sensitive and accurate examination; extremely good for thrombosis below mid-thigh. It is simple to perform and should become a routine nuclear medicine procedure, especially when coupled with the I-125 Fibrinogen study.

COMPARISON OF I-131 AND I-125 LABELED FIBRINOGEN FOR MONITORING RENAL ALLOGRAFTS. Theodore Sorandes, James Quinlan, and Michael Loberg. University of Maryland Hospital, Baltimore, Md.

This project was undertaken to compare the use of commercially available I-125 labeled pooled fibrinogen to I-131 labeled autologous fibrinogen (labeled using the method described by Loberg, Miller, Cooper) in the early detection of acute rejection in patients receiving renal allografts. Twenty-two recipients of renal transplants were studied. In addition to the fibrinogen studies, all patients had Tc-99m DTPA renal flow studies performed.

Patients were administered 100 uCi of either I-131 or I-125 labeled fibrinogen intravenously. Measurements using portable counting equipment were taken over the patient's heart and transplant kidney using the method of Quinlan and Dagher. Comparison data of the I-125 and I-131 labeled fibrinogen was obtained so that the following could be evaluated: 1) average count rate obtained from each radiopharmaceutical, 2) waiting time required before re-injection was necessary, 3) effects of geometry (patient position) on counting results, 4) effects of surgical dressing on counting results, 5) comparison of preparation time of each radiopharmaceutical, and 6) interference of Tc-99m DTPA flow study.

Results indicate that I-131 labeled fibrinogen is the agent of choice for monitoring renal allografts.

INCREASED SPECIFICITY OF GALLIUM SCANS BY LIVER SUBTRACTION TECHNIQUE. Linda M. Thorson, Gilbert P. Becker, and Heinz W. Wahner. Mayo Clinic and Mayo Foundation, Rochester, Minn.

Abscesses near the liver and spleen present special diagnostic problems even with all available radiographic and scanning procedures. Using a dual-isotope subtraction technique (gallium citrate, technetium sulfur colloid), we have been able to reduce the number of equivocal scans from 8% to 2% and therefore diagnose upper abdominal abscesses more confidently when liver or gallium scans alone were normal or equivocal. The procedure is as follows. In cases of a suspected upper abdominal inflammatory process, 5 mCi of Ga-67 citrate is given intravenously, and 48 hours later a gallium scan is performed with a Pho-Con tomographic scanner only. If the results are equivocal, a subtraction scan is performed. The patient is positioned supine for an anterior abdominal view. An LFOV gamma camera, a medium-energy collimator, 20% window peaks at 180, 300, 390 keV, and an on-line MDS computer are used. First an anterior static gallium liver frame of 1 million counts is recorded, followed by a 100-second crossover static frame in the Tc-99m window. Tc-99m sulfur colloid is then injected and a static frame of 500,000 counts is collected in the same position starting 10 minutes later. The sulfur colloid frame is then corrected for crossover from Ga-67, normalized, and subtracted from the gallium frame. Normalization is performed with a light pen-selected area in the liver. Subhepatic, subdiaphragmatic, intrahepatic, and chest wall abscesses have been demonstrated by this technique.

Author Index: Technologist Abstracts