Abstracts for Technologist Scientific Program for 22nd Annual Meeting

Radionuclide Technology in the Diagnosis and Management of the Traumatized Patient. *Larry E. Alt, Barbara Koch, Kenneth B. Miller, Kathy A. Virant, and B.C. Berg. St. Francis Hospital and Peoria School of Medicine, University of Illinois, Peoria, Ill.*

Because of their ease of performance and noninvasive technique scintillation camera images can provide surgeons with a rapid and accurate diagnosis of the extent of internal abdominal trauma.

In addition to the routine methods of hepatosplenic and renal imaging, special equipment such as a Lucite-top imaging table and a Surgilift sling are employed. Often patients in traction or circular beds require the use of the pinhole collimator to obtain lateral views.

Adult patients are routinely injected with 10 mCi ^{99m}Tc-sulfur colloid for hepatosplenic images and 15 mCi ^{99m}Tc-DTPA solution for renal images. For pediatric patients, we follow the dosage schedule used by Children's Memorial Hospital, Chicago, Ill. In addition to the routine anterior, posterior, and both lateral projections, sometimes supplementary views such as obliques, as well as "yoked" projections or decubitus positions are necessary.

Using a parallel hole, high resolution collimator, the average time required for a hepatosplenic imaging study is approximately 20 min and approximately 10 min for renal studies. It is desirable to obtain delayed renal images 30–60 min after injection for additional evaluation, patient condition permitting.

Our institution is a regional trauma center in the Illinois statewide trauma organization. As a member of this trauma network, we have performed over 1,000 hepatosplenic and renal trauma studies, with the positive cases revealing multiple, but consistent, patterns of splenic rupture, hepatic laceration, renal contusion, and amputation. A pattern of expected frequency and association of combined organ injury has also been established.

Our experience has shown that the scintillation camera, with properly trained technologic and physician expertise, can contribute greatly to the diagnosis and management of the acutely traumatized patient.

Convenient, Inexpensive Trapping of Radioxenon. *Norma S. Anderton, Gary Myers and Paul H. Murphy. St. Luke's Episcopal-Texas Children's Hospitals, Houston, Texas.*

The evaluation of respiratory function with radioactive xenon has gained widespread use in clinical nuclear medicine. In a busy laboratory, a sizable quantity of radioxenon gas is used and thereafter usually released to the atmosphere. The release of this activity of the atmosphere can produce average concentrations exceeding maximum permissible concentrations at the exit point; therefore, other means for disposal may be required. We have investigated the feasibility of trapping xenon gas on activated charcoal chilled to $-4°C$.

Initially, a small trap was assembled to determine the ability of commercially available activated charcoal to absorb radioxenon at $-4°C$. Full-scale models of the traps were then built. Two traps were used in tandem to determine the efficiency and capacity for absorbing the xenon gas. A comparison was also made of the trapping efficiency on a given trap at the beginning and end of its useful life.

The traps, consisting of 18-in. lengths of 4-in. diam PVC pipe sealed with connectors on each end, are capable of trapping over 90% of the xenon collected from 10—15 patient studies. The residue from a patient study consists of approximately 30 mCi of xenon gas contained in a 100-liter collection bag. The traps are stored in a freezer section of a conventional refrigerator during their useful period. Thereafter, they are stored in a hood for decay. Five traps are used in rotation, each trap being

effective for approximately 1 week of clinical studies. The quantity of xenon released to the environment is reduced to approximately 3% by storage for decay before release.

Activated charcoal at −4°C has proven to be a useful mechanism for the trapping and storage of radioactive xenon gas following use in clinical lung studies. The system is very convenient to use and is inexpensive.

Multi-Purpose Double-Barrel Syringe: An Aid in the Administration of Radiopharmaceuticals. *Sheldon J. Ashley. Flushing Hospital and Medical Center, Flushing, N.Y.*

A new syringe design that affords the flexibility of administering two individual injectable materials intravenously through a single successful venipuncture is described. The syringes were constructed by recombining the component parts of two commercially available disposable hypodermic syringes and needles. Once assembled the unit can be gas sterilized. This integral unit can perform the chore of intravenous injection with greater ease and benefits to patient, technologist, and physician.

The double-barrel syringe has applications primarily in three varieties of examinations which are routinely prescribed. These examinations are dual radionuclide procedures, dynamic flow studies in which a bolus injection must be delivered immediately followed by a saline flush, and administration of macroaggregated lung materials, which have been prevented from mixing with venous blood during venipuncture by using the double-barrel syringe.

When compared to alternative methods such as starting a normal saline i.v., using a butterfly infusion set, maneuvering a three-way stopcock or using a standard hypodermic syringe and needle, the double-barrel syringe is easier to handle and has fewer drawbacks.

Considering that patient risk and discomfort are minimized, and that radiation exposure due to repeat examinations is reduced, the significance of the new syringe design becomes apparent.

Iodine-125-Digoxin Radioimmunoassay: Kit Comparison. *D.J. Battaglia, C.F. Burkhead, M.L. Cianci, and O.B. Hunter, Jr. Oscar B. Hunter Memorial Laboratory, Washington, D.C.*

Concern for reproducibility and accuracy of ^{125}I-digoxin RIA determination led to the investigation of three commercially available kits, two of which involved charcoal separation techniques: (A) dextran-coated charcoal; (B) charcoal in barbital buffer; and (C) antibody-coated tubes and buffer wash. Manufacturers of the last two kits supplied standards in serum. Standards for the first kit were dissolved in 5% ethanol, necessitating the use of in-house digoxin-free serum. Nonsignificant binding samples were required with the first two kits with percent total binding values of 0.4−1.2 and 10−12, respectively. Procedures were similar in volume of reagents, buffering of reaction and incubation times required. Four to five assays of each kit were run, each including a complete standard curve, three samples and 1:1 dilutions, and one sample repeated four to five times per assay. Dilutions were prepared using 100λ each of digoxin-free serum and sample. All standards and samples were routinely done in duplicate and reported as an average value. Standard deviations and percent coefficient of variation values were compared for intra- and overall variability. Dilution accuracy was evaluated as a variance from undiluted value. Flexibility of procedure within prescribed protocol was viewed as a function of percent total binding consistency of standard curves. Normalization of standard curves, accomplished by arbitrarily choosing a specific percent total binding for 0 ng/ml standard and correcting the percent total binding of the remaining standards, was used to evaluate reaction kinetic consistency. Averages of percent coefficient of variation for the replicate sample were 8.6, 8.7, 12.4 for the three kits, respectively. Dilution accuracy was comparable, all with average variabilities from whole values of 0.53−0.56 ng/ml. Normalization of standard curves proved reaction kinetics to be consistent within each kit and similar in all three. The least sensitive area of the standard curve was seen beyond 4 ng/ml indicating the inclusion of the 8 ng/ml standard (second kit) to be misleading since accuracy in that range is subject to question. The greatest fluctuation in standard curves was observed in the antibody-coated tube procedure. Variability in this case appeared to be a function of sensitivity to mixing during incubation, rendering the third kit less flexible in terms of individual technique.

PDS 3 Computerized Radioimmunoassay: Modifications. *D.J. Battaglia, M.L. Cianci, C.F. Burkhead, and O.B. Hunter, Jr. Oscar B. Hunter Memorial Laboratory, Washington, D.C.*

In order to balance accurate evaluation of test results with time spent achieving such results, modifications of the Amersham/Searle PDS 3 radioimmunoassay (RIA) computer program on line with the 1185 automatic sample changer became necessary. The RIA II program analyzes data using the method of least squares fit on a minimum of three standard samples to construct a

hyperbolic standard curve. Total activity samples, precounts or an arbitrary value may be included to evaluate percent total binding, and actual dose of standards adjusted to fall on the curve are reported as computed dose. Quality control samples are judged on a pass or fail system based on a 10% variation from a predetermined value (i.e., determined averages of in-house normal and abnormal pools) programmed into a particular batch table. Any one of a set of duplicate or triplicate samples falling outside of the 10% variation range will be recorded as questionable. As in the case of TBG saturation analysis the three standard point minimum requirement must be bypassed. This can be accomplished by including three blank samples, each with an assigned value of one. In this case, although the standard point requirement is fulfilled, a standard curve cannot be plotted since all three percent total binding are less than one and fall on the same x axis of one. Thus percent total binding alone is evaluated. HAAs can also be analyzed using this modification except that by evaluating the seven negative control samples as 100% of total activity the samples are calculated as percent of the negative controls. In this case any percent total binding $\geq$ 150% is considered questionable or gray while anything $\geq$ 210% is positive or reactive for HAA. Since the PDS 3 will hold only three batch tables (individual test programs) at a time, it becomes necessary to delete batch tables when more than three tests are evaluated routinely. The inefficiency of time spent in programming batch tables led to the establishment of prepunched tapes. Answers to the PDS 3 program questions are prepunched on tape with instructions to delete at least one other existing batch table and the tape fed into the computer prior to analysis. This modification requires that the same sample holders be defined for each assay of the same test and thus the convenience of one set of total count tubes prepared for each new lot of reagents, and color sample holders for easy identification of standards and/or duplicate samples and quality control samples. Routine analysis then becomes merely a matter of loading samples into the appropriate holders and running a 60-sec tape through the tape reader.

Technetium-99m-Albumin Wall Motion Study for Left Ventricular Wall Motion. *E. Botvinick, C. Boyce, L. Bunz, and D. Shames. University of California, San Francisco, Calif.*

A quick, noninvasive procedure that fully evaluates the function of the left ventricular wall is of great importance to the cardiologist and the patient. The ^{99m}Tc-albumin heart wall motion study is simple, safe, and allows global evaluation of left ventricular wall motion.

Patients with suspected left ventricular disease are studied to determine if further studies involving potential morbidity should be carried out.

EKG leads are attached to the patient and a phonocardiogram transducer is placed over the heart. Electrocardiogram-phonocardiogram tracings are made at 50 mm/sec; the peak of the R wave indicates end-diastole and the second heart sound indicates end-systole. A gating device is preset with the time interval between the peak of the R wave and the second heart sound. The patient, in a supine position, is injected with 20 mCi of ^{99m}Tc-albumin and positioned with the scintillation detector head angled in the LAO projection over the heart. The EKG activates the gate to operate the CRT for 50 mm/sec during end-diastole and end-systole. This procedure is continued until 800,000 counts are accumulated on the scintiphoto. The same procedure is repeated with the camera in the RAO projection over the heart; the total time for the entire study is about 1 hr.

To determine the extent of the wall motion, tracings of the left ventricle at end-diastole and end-systole are made and then superimposed. Any abnormality of wall motion can easily be appreciated from the overlaid tracings. This procedure can be done accurately by hand by keeping the transducer in place during the examination and using it as a point of reference, or the data may be fed into a computer which is programmed to overlay the relevant images.

This study is not only highly accurate in its global assessment of the left ventricle but is also noninvasive. Other noninvasive studies are either unreliable, such as fluoroscopy because of the confusion presented by the soft tissue surrounding the heart, or too restrictive, such as electrocardiography because only a limited area of the left ventricle can be evaluated. The advantages of the ^{99m}Tc-albumin wall motion study suggest that this procedure will become a routine exam when left ventricular wall muscle damage is questioned.

A Technical Comparison of Scanner and Camera Imaging Systems Using the Modulation Transfer Function (MTF) as a Function of Depth. *Michael R. Budge. Toronto Institute of Medical Technology (Toronto General Hospital), Toronto, Ontario, Canada.*

It is well known that the spatial resolution of a scintillation camera is best at the surface of the collimator, while resolution of a scanner is best at its focal point. Determination of MTFs over a

specific range of object-to-collimator distances provides an effective means of demonstrating the spread of image quality for the two imaging systems.

Line-source response functions (LSRF) were determined for both the camera and scanner under conditions corresponding to the normal method of patient imaging. Data was collected with the low energy collimators normally used in obtaining a static view of an organ. A sheet of ¼-in. plywood was placed between the object and collimator to simulate the typical scattering that occurs within the patient. The object was a 0.10-ml glass pipette containing ^{99m}Tc in an area 250 mm long by less than 0.1 mm wide. LSRFs for the camera were obtained at source-to-collimator distances of 1, 6, 8.5, and 11 cm. LSRFs for the scanner were obtained at source-to-collimator distances of 7.5, 10, 12.5, and 17 cm. (The focal point of the scanner was at 12.5 cm.)

MTFs were then calculated from the LSRFs using standard techniques. The envelope formed by the MTFs was an indication of the spread of image quality due to the depth range imaged.

The spread of image quality as indicated in this technique may prove to be a valuable parameter in selecting an imaging system for a particular organ.

Human Pancreatic Imaging with ^{13}N-L-Alanine. *C.C. Chang, J. Takahashi, H.H. Neely, and D.D. Bobinet. Veterans Administration Hospital, Sepulveda, Calif., and UCLA Biomedical Cyclotron Facility, Los Angeles, Calif.*

Nitrogen-13-L-alanine has been synthesized from $^{13}NH_3$ at the UCLA Biomedical Cyclotron Facility and utilized in animals for pancreatic imaging with encouraging success. Radiopharmaceutically pure ^{13}N-L-alanine can now be synthesized using enzymes bound to porous silica beads followed by column chromatography. This report details the initial clinical trials of ^{13}N-L-alanine for pancreatic imaging in five human volunteers. Imaging was performed using either a scintillation camera (HP Searle) equipped with a tungsten collimator, a dual 5-in. scanner (Ohio-Nuclear) equipped with a 510-keV collimator, or dual 8-in. tomographic scanner (Searle) with a 364-keV collimator. Imaging began immediately after the intravenous injection of 2–4 mCi of ^{13}N-L-alanine.

Excellent images of the pancreas had been obtained in small animals using the scintillation camera with a tungsten collimator, but suboptimal images of the pancreas were obtained in humans, presumably because the pancreas is situated so far from the face of the camera crystal. A poor image of the pancreas was obtained with a dual 5-in. scanner. Excellent images of the pancreas were observed on several anterior "cuts" using the dual 8-in. tomographic scanner, even though suboptimal 364-keV collimators were used. Interfering activity from the liver was largely eliminated from these tomographic images. Further improvement in image quality is anticipated when this instrument is equipped with 510-keV collimators.

Halogenated amino acid analogs studied by other investigators have showed potential usefulness for pancreatic imaging in animals, but these agents have been disappointing in human trials. Nitrogen-13-L-alanine is a true amino acid with a more natural label. These studies demonstrated no species differences in pancreatic uptake of ^{13}N-L-alanine, but species differences exist in renal excretion.

The results of these initial studies demonstrate the potential usefulness of ^{13}N-L-alanine for human pancreatic imaging, especially when utilized with a tomographic imaging system.

Rapid Determination of Free Pertechnetate in Labeled Radiopharmaceuticals. *Lelio G. Colombetti, Steven Pinsky, Stephen Moerlien, and Angel Quaioit. Michael Reese Hospital and Medical Center, Chicago, Ill.*

The use of columns using different chromatographic media for testing unreacted TcO_4 in radiopharmaceuticals has been proposed by different investigators. Based on this idea we have developed a system that allows the running of the test in a matter of minutes.

The system consists of a small (0.2 x 5 cm) polypropylene chromatographic column with a Luer connection at the bottom and wet-packed with acid-washed alumina, of the same quality used to prepare the ^{99m}Tc-generator. The columns are washed with saline and stoppered to keep them wet until needed. A 19-gage needle is attached to the bottom of each column. A large quantity of these columns can be prepared in advance and stored until they are needed.

To perform the test, 0.2 ml of the ^{99m}Tc-labeled radiopharmaceutical is added to the top of the column. Then as 10 ml of saline is added to the column from a small buret, the stopper of an evacuated 30 ml vial is pierced with the needle attached to the column. The vacuum in the vial forces the saline rapidly through the column, eluting it in a manner similar to the elution of a generator.

These columns were used to test labeled colloids, macroaggregates, microspheres, phytate, and DTPA.

It was found that over 99% of the free pertechnetate will be eluted, while reduced and labeled ^{99m}Tc-was retained by the alumina at the top of the column.

The whole procedure takes about 3 min to run (compared to 30—40 min needed for ITLC) and it compares favorably for accuracy with other known techniques.

The Anger Rectilinear Tomographic Scanner. *Bridget H. Czerwinski and Margaret H. Comer. Rush-Presbyterian St. Luke's Medical Center, Chicago, Ill.*

Brain, ^{67}Ga total-body, and total-body bone scans taken with both the Anger rectilinear tomographic scanner and other instrumentation are compared and advantages and disadvantages are discussed.

The Anger rectilinear tomographic scanner has the properties of both a rectilinear scanner and an Anger camera. The Anger rectilinear tomographic scanner has two detectors consisting of seven photomultiplier tubes and a sodium iodide crystal 1 in. thick and 8-½ in. in diam. There are a variety of collimators ranging from low to high energies for scanning. Plane separation varies with different scanning procedures and size of patients. Maximum speed is 1,000 cm/min.

Six tomographic images are displayed by a series of six lenses of different focal lengths and aperture plate and six inverting prisms. As the images are displayed on the CRT, the film is moving at the same speed and direction as detectors. Then the images of that source remain focused at the same point on the moving film.

Display now is in two systems: an imager on top of the console and a multiimager accessory system. Format sizes vary from 5 x 7 in. to 11 x 14 in. depending on the system.

Our experiences with the Anger rectilinear tomographic scanner have shown that bone lesions not seen on ordinary rectilinear scanning have been seen on this instrument. Gallium-67 total-body scans have also had about the same results as bone scanning.

The brain scans done on this instrument have led us to put any questionable scans on the Anger rectilinear tomographic scanner, due to the fact that it can differentiate between lesions in the skull versus in the envelope.

Chemical Determinants of Accuracy in the Radioassay for Serum Folate. *Diane Forrest and Timothy Shea. Harvard Medical School and Peter Bent Brigham Hospital, Boston, Mass.*

The influence of reagent purity and interactions with serum components on the reliability of a competitive binding method for determination of human serum folates has been studied.

This radioassay employs ^{3}H-pteroylglutamic acid (H3PGA) as labeled substrate, 5-methyltetrahydrofolate (THFA) as standard substrate, Beta-lactoglobulin (BLG) as the specific binding molecule, 0.05 *M tris*-Cl, pH 8.0, with 500 mg/liter ascorbate as buffer, and dextran-coated charcoal for separation of bound from free H3PGA.

Commercially available H3PGA and THFA each exhibit one major and at least five minor species absorbing at 290 nm when chromatographed on DE-Sephadex at pH 6.0 employing an NaCl gradient in 0.1 *M* KH_2PO_4-1% mercaptoethanol. None of the minor species of either substrate bind specifically to BLG, although they do contribute to nonspecific binding when serum is assayed. The binding of chromatographed H3PGA to BLG, purified by molecular sieve filtration, is less than 100% even with excess BLG added. However, the affinity of BLG for H3PGA is significantly enhanced in the presence of a labile serum macromolecule which does not alone bind H3PGA but which alters the assay result as a consequence of its variable concentration in different serum samples.

Thus, both the purity of reagents and their interaction with BLG in the presence of serum are critical to accurate determination of serum folates. The apparent ternary interaction between H3PGA, BLG, and the serum macromolecule may explain reports of apparent "high nonspecific serum binding" and must be chemically corrected in designing a reliable clinical assay.

A Comparison of Weekly and Biweekly Generator Systems with Respect to Radiation Safety. *Anne W. Hempel and Christopher B. Martin. Roseville Community Hospital, Roseville, Calif.*

The increased usage of ^{99m}Tc as a versatile labeling radionuclide has necessitated increased activity in ^{99}Mo generator systems. Concern has been voiced about subsequently increased radiation exposure during the elution process. For this reason, radiation exposure from a 400-mCi fission ^{99}Mo generator was compared with 300-mCi and 100-mCi fission ^{99}Mo generators delivered biweekly.

The determination was carried out using a "cutie pie"-type ionization chamber, a body film badge and a TLD ring-type finger badge. The generators compared were the 400-mCi fission ^{99}Mo from Mallinckrodt and a 300-mCi and a 100-mCi fission ^{99}Mo from E.R. Squibb. All generators were provided with each company's respective additional shields. "Cutie pie" readings were taken from two

different areas adjacent to the generators before and during elution procedures. The film badges were worn only during the elution procedures each day.

The "cutie pie" readings varied greatly between the two systems. The body film badges showed no difference in exposure with the readings for both at less than 10 mR. However, the ring film badges showed a marked difference in exposure during the test periods. The single generator test ring showed an exposure of 30 mR while the dual generator test ring showed an exposure of less than 10 mR.

From a radiation safety standpoint, we have concluded that it is more advantageous to use the two-generator system. The shielding is much greater and the yields throughout the week are more nearly equal. This does away with the unneeded curie or near-curie yields on Monday, but still allows comparable and adequate amounts of technetium on Friday.

Regional Scanning Methodology Using an Overhead Scintillation Camera. *Charles A. Henry, Michael F. Barnes, Edward G. Bell, David F. Mahon, William White, Jay R. Wolff, and Ronald E. Turcotte. Crouse-Irving Memorial Hospital, Syracuse, N.Y.*

The thrust behind the development of scintillation camera modifications to allow large field-of-view images was principally dictated by the need to image the entire skeleton. To date, many total-body scintillation camera attachments have been developed and their use in general has been principally assigned to this initial clinical purpose. A lightweight overhead scintillation camera supported by a ceiling mounted x-ray tube conveyor was developed that offers significant ease in imaging the patient who may not be moved from his hospital bed. In addition, the camera may be easily modified to the scanning mode to image large areas of interest.

This paper will concern itself with the procedures used to image organ systems other than the skeleton in which significant information content is offered by an integrated image as compared to multiple selected images obtained on the standard scintillation camera.

A single pass technique is of value in the evaluation of a gamma-cisternographic study. The subarachnoid space, from the site of the lumbar injection to the region of the Pachyonian granules, may be imaged at multiple time intervals following the injection. This allows information on the rate of transit of the radiopharmaceutical as well as distribution within the CSF space.

A two-pass technique in which the camera scans one leg from its distal extremity to the pelvis and then scans the contralateral limb from the pelvis to its distal extremity may be used to evaluate the pelvis for abnormal perivesicular venous return and the lower limbs for the presence or absence of active phlebitic sites using macroaggregated albumin.

Using a single or two-pass technique depending on the body size, the entire abdomen from the epigastrium to the pelvis may be scanned with ^{99m}Tc-pertechnetate in those patients presenting with clinical symptomatology suggestive of functioning ectopic gastric mucosa.

The entire genitourinary tract may be regionally imaged in patients in which urinary drainage or ureteric reflux problems are considered.

A Tantalum Syringe Shield for ^{99m}Tc Injections. *J. Howley, H. Tipton, A. Jones, M. Dickinson, M. Green, and G. Johnston. National Institutes of Health, Bethesda, Md.*

Finger-tip radiation exposure (approaching 1 rad/min) from manipulating 15—20 mCi ^{99m}Tc in syringes during i.v. injection is a frequently ignored safety hazard in nuclear medicine. Available shields often are not used because they are deemed too cumbersome. To alleviate this problem a tantalum shield with several novel features was constructed specifically for use with ^{99m}Tc. Tantalum, a widely used metal in the missile and nuclear reactor fields, offers several advantages over other possible syringe shielding materials. It has a linear attenuation coefficient equal to lead, a tensile strength in the range of steel, and is still machineable with high-speed tools. Bulk and weight have been reduced by confining the tantalum shielding as much as possible to the syringe volume actually containing the radionuclide. The shield assembly is kept on the syringe barrel from loading time through calibration and injection. The barrel of the syringe is kept immobile in the shield by twisting the flange into a groove until a tiny spring ball plunger snaps into lock position. During the final isotope calibration procedure prior to injection, handling is reduced by simply retracting the tantalum section of the shield. The tantalum section of the shield is maintained in a retracted and elevated position by another ball-type locking device. A stainless steel shaft employing Delrin (Dupont) bushings allows smooth extension or retraction of the tantalum shielding. A recently modified clear-hubbed needle and standard Luer-Lok disposable syringe (B-D) complete the assembly. Film dosimetry has demonstrated the effectiveness of the tantalum shielding with the result that a few millimeters of

tantalum reduces the surface exposure rate to the fingers by a factor in excess of 200.

Maintaining Scintiphoto Quality. *Candace K. Johnson and Dennis W. Damm. Veterans Administration Hospital, Minneapolis, Minn.*

To achieve good quality scintiphotos, the preparation of a "programmed" teaching manual comprised of scintiphoto artifacts has been useful in maintaining technologist awareness. The programmed style allows introduction of artifacts to students prior to clinical experience.

Film artifacts are collected, compiled, and catalogued under two sections: (A) technical (technologist, patient produced, etc.) and (B) mechanical (electronic, equipment calibration, film processing, etc.).

The artifacts are placed in plastic film holders that fit a standard-sized three-ring binder allowing easy access, additions, or removals. A description, the cause, and prevention of the artifact, are listed on the back of each page. Corrected scintiphotos may accompany some categories.

The proliferation of nuclear medicine instrumentation continuously introduces new varieties of artifacts. Maintenance of the artifacts in a catalogued manual has been an effective means of maintaining an up-to-date reference source.

Evaluation of Scintillation Camera Collimators for Imaging with ^{201}Tl. *Eugene Kilanowski, Ernest Garcia, and August Miale. Jackson Memorial Hospital, University of Miami School of Medicine, Miami, Fla.*

Radiothallium has been suggested for use in myocardial visualization because of similarities between the biologic behavior of thallium and potassium. Thallium-201 (7½-hr half-life) decays by electron capture and emits mercury x-rays (approximately 70–80 keV) in high abundance and photons of 135 keV and 167 keV with 2% and 8% abundance, respectively.

Seven collimators (Searle Radiographics, Inc.) were available for this study. Line spread functions were obtained at the face of each collimator and with 3 in. of scatter medium (masonite) for both the 80-keV and the 167-keV photons. All line spread functions were produced accumulating 400,000 counts with a 20% window.

In order to perform a quantitative evaluation of the resolution and sensitivity characteristics of each collimator, the image of each line was acquired by use of an on-line minicomputer and stored on disk in a 64 x 64-word matrix format. The image of three ^{57}Co point sources at known distances for each collimator-to-source distance were also acquired in order to determine centimeter per channel conversion. A 30-channel wide profile was obtained from each line spread function from which the FWHM measurements and the modulation transfer functions (MTFs) were calculated. Relative sensitivity was obtained by recording the elapsed time to accumulate 400,000 counts. Selected collimators were also used to image a liver slice phantom. The images were recorded on 35-mm, 8 x 10 in., and Polaroid films.

The 80-keV photopeak was clearly found to be superior based on MTFs as compared to the 167-keV photopeak. The order of collimators that gave the best MTFs were the pinhole (small aperture), Div-Con (converging mode), 4,000 parallel hole, and the high sensitivity parallel hole. The pinhole collimator is least practical for clinical use because of very low relative sensitivity.

Minidigital Computer Analysis for In Vitro Laboratory. *Ilsup Kim, A. Sidney Johnston, Hunter Mermall, and Steven Pinsky. Michael Reese Medical Center, Chicago, Ill.*

Computer programs to analyze digoxin, T_3, T_4, renin and other in vitro laboratory tests have been developed to operate using FOCAL language in a PDP 8/E computer with 8K memory and no mass storage.

In our system the Packard 300 tube counter has a teletype output device that punches the count information into a paper tape. The order of the tubes is: blanks, standard tubes, control samples, patient samples, blanks.

The paper tape is transferred to the PDP 8/E input teletype where it is automatically read by the program. In those tests for which the standard curve is a straight line on a linear, or a log-log or a logit-log plot, the standard sample data is fitted by least squares to a straight line. The patient sample assay is then computed with the help of this standard curve. In those assays in which a straight-line standard curve cannot be used the count data is processed so that it is ready for the technician to use the standard curve.

The patient samples are then read and the assay results for each are computed. The computer has enough memory to store data from at least 25 patient samples and do the calculations in a block to produce a page filled with patient results, on which the patient's name may be written and the page pasted into the result book.

Advantages of this system are that it saves technologist time, particularly when duplicate samples are run for many patients, insures accuracy of calculations, is not expensive, and the method is adaptable to a variety of changing tests because of the ease of FOCAL programming. The programs are used as an educational tool by requiring student technologists to duplicate the computer output by hand calculations. As a quality control device, we have an automatic Chi-Square program and compute relevant statistical parameters for each patient run.

Radioimmunoassay of Digoxin: Which Method? *Louise Larraga, Donald E. Tow, Carolyn A. Diets, Paul F. Godin, and John S. Belko. Veterans Administration Hospital, West Roxbury, Mass.*

Since serum level of digoxin by radioimmunoassay provides a useful pharmacologic index of therapy, several methods of assays have been made available. In establishing this assay as a clinical service we evaluated the comparative costs and quality controls of the components and several methods of the radioimmunoassay.

The digoxin levels of 104 patients and two control sera were determined using all of the following methods: (A) commercial standards, ^{125}I-labeled digoxin derivative and antibodies coated onto glass beads (all these components are available and marketed as solid phase radioimmunoassay kits); (B) all of the above except for our own standards; (C) our own standards and antibodies, ^{125}I-labeled digoxin derivative and dextran-coated charcoal; and (D) our own standards and antibodies, ^{3}H-labeled digoxin and dextran-coated charcoal. All procedures were performed manually and spread over 14 runs. The quantity of antibodies used in each assay and each method was that amount sufficient to bind 40–60% of the labeled antigens. For the method involving ^{3}H-labeled digoxin, only a 0.2 ml sample of sera was used. No correction was made in liquid scintillation counting since we intended to have as equal assay times as possible for all methods. Preliminary studies made with and without correction on several runs revealed no significant differences. Results are tabulated separately.

These results indicated that within-assay and between-assay variations of each method are comparable. The comparative costs of the first, third, and fourth methods are listed. The second method is omitted since it is identical to the first method.

Costs / Sample

	Methods		
	1	3	4
Assay time (hr)	1.5	2.0	3.0
No. of samples/assay			
50	$ 1.33	0.68	0.96
25	1.80	1.12	1.12
5	5.63	4.24	6.20
2	12.80	10.15	14.45

Results indicated that the first method is most convenient but expensive. The third method appears to be the best choice.

Functional Images of the Left Ventricle. *Michael T. LeFree, Dennis L. Kuch, and Peter P. Steele. Veterans Administration Hospital, Denver, Colo.*

In order to make better use of the data available in the left ventricular radiocardiogram, we have derived functional images of the left ventricle from the dynamic radionuclidic data.

We have developed a unique system to acquire and analyze high-count-rate dynamic isotopic images. It consists of a Harshaw Chemical Co. Quantascope image intensifier scintillation camera interfaced to a Reticon 32 x 32 element silicone-diode array camera, which is in turn interfaced to a Digital Equipment Corp. PDP-12 mini-computer. A new interactive system program, "IMAGES," has been written to acquire, store, analyze, and retrieve individual studies stored on an 800,000-word disk pack. With this system we acquire 250–500 frames of high-count-rate (200,000 cps) data at 20 frames/sec. Dynamic images are stored following a pulmonary arterial wedge injection of 15 mCi sodium pertechnetate. The standard quantitative parameters of cardiac function (ejection fraction, regurgitant fraction, stroke volume, end-diastolic volume, and end-systolic volume) are calculated in conjunction with a cardiac output determined by thermal-dilution.

As an adjunct to this numerical data, we have utilized the frame-arithmetic capability of IMAGES to implement two functional images of the left ventricle: the "wall motion" image and the "regional left ventricular function" image (RVF image). The wall motion image consists of serial subtraction of end-systolic images from a summed end-diastolic image. The RVF image is produced by division of a summed end-systolic image by a summed end-diastolic image. The localized intensity of the image is proportional to the regional function of the left ventricle.

In a series of 20 patients, the functional images were compared to tracings at end-systole and end-diastole from left ventricular cineangiograms. The

detection accuracy of regional functional abnormalities was good ($r = 0.83$).

Functional images derived from dynamic isotopic data of a wedged pulmonary arterial injection serve to strengthen the role of radiocardiography in diagnostic cardiology.

A Quality Control Procedure for Pipetting Systems. *Janet M. Marks, A. Michael Zimmer, Edward A. Silverstein, and Richard A. Holmes. Milwaukee County Medical Complex, Milwaukee, Wis.*

The need for controlling the reproducibility and accuracy of pipettes is well recognized. We have developed a simplified procedure to make these evaluations by adding ^{125}I-human serum albumin to both a pooled serum and aqueous solution. Five semiautomatic pipettes—0.2 Biopette, Micro Biopette. Pipetman, Oxford, Eppendorf, and the Micromedic Automatic pipette—were evaluated. The pipettes were maintained and operated by one individual according to the manufacturer's specifications. Volumes of 10, 25, 50, and 100 μl of each solution were delivered to a counting vial and diluted to 1 ml. Tips were changed for each sample delivered in all pipettes except the automatic. Five replicate samples were dispensed for each volume. Each run was counted in an automatic scintillation counter and statistical analysis of the samples included mean s.d., s.e.m., coefficient of variation and analysis of variance.

Coefficient of Variation for Samples Delivered (%)

Pipette	Solution	Volume delivered (μl)			
		10	25	50	100
0.2 Biopette	Aqueous	—	1.97	1.93	3.07
	Serum	—	6.80	2.13	3.14
Micro Biopette	Aqueous	3.59	3.43	4.73	1.71
	Serum	2.47	3.13	3.56	2.05
Pipetman	Aqueous	11.42	6.65	3.79	3.17
	Serum	8.76	7.42	8.52	7.24
Oxford	Aqueous	5.14	—	7.96	4.04
	Serum	6.70	—	12.70	4.73
Eppendorf	Aqueous	—	0.62	0.25	—
	Serum	—	1.77	1.66	—
Micromedic	Aqueous	1.43	0.66	0.16	0.12
	Serum	0.80	0.60	0.36	0.13

The automatic pipetter was the most reproducible, with all but the Eppendorf showing considerable variation. Several of the semiautomatic pipettes gave poorer results when delivering serum instead of aqueous solutions. All but one of the pipettes had a smaller coefficient of variation when delivering larger volumes.

The method can be easily applied in any nuclear medicine laboratory for controlling the quality of the pipette and operator.

Free Technetium in Preparations of ^{99m}Tc-Diphosphonate (HEDSPA) for Bone Imaging. *Michael V. McCormick, Michael D. Sinclair, and Heinz W. Wahner. Mayo Clinic and Mayo Foundation, Rochester, Minn.*

Skeletal imaging with ^{99m}Tc-labeled diphosphonate prepared according to manufacturer's specifications revealed in certain cases significant quantities of free technetium ($^{99m}TcO_4^-$). The TcO_4^- was indicated by its activity in thyroid, salivary glands, stomach, and bladder. In these cases, the details of the preparation of the radiopharmaceutical were reconstructed, and the appearance of TcO_4^- was found to be related to the time that elapsed between the preparation of the dose and its administration. Since this time interval is an important consideration for a central radiopharmacy, further study of this problem was warranted.

Paper chromatography with untreated Whatman No. 1 paper and a solvent system of 85% methanol was used to determine the TcO_4^-. Samples of ^{99m}Tc-diphosphonate were chromatographed by the ascending method. The R_f for ^{99m}Tc-diphosphonate was less than 0.20, and the R_f for TcO_4^- was within 0.43–0.54. Strips were chromatographed, dried, and cut at an R_f of 0.30. The separate sections of the strips were counted in a NaI well counter, and the percentage of TcO_4^- was calculated using the following equation:

$$TcO_4^- (\%) = \frac{\text{count rate of } R_f > 0.30}{\text{total strip count rate}} \times 100.$$

Reproducibility of this method was ± 1.2 (s.d.) on a sample of 14.0% TcO_4^-; the coefficient of variation was 8.3%.

A ^{99m}Tc-diphosphonate preparation used for routine skeletal imaging was sampled and chromatographed at intervals of 1, 2, 3, 4, and 5 hr after preparation. Data on 11 preparations showed an increase in TcO_4^- with time (mean of 4.4% at 1 hr and of 17.0% at 5 hr).

These data suggest that ^{99m}Tc-diphosphonate should not be administered more than 3 hr after preparation because of the occasional significant quantities of TcO_4^-.

Motion Picture Format Presentation of Gated Cardiac Blood Pool Images. *Bonnie A. Mefferd, Catherine Quigley, Michael V. Green, Harry Agress, Jr., and Gerald S. Johnston. National Institutes of Health, Bethesda, Md.*

Electrocardiographic-gated images of the cardiac blood pool at end-diastole and end-systole and the complete cardiac cycle envisioned by ECG-gated

scintigraphic angiocardiography both contain information about time-dependent alterations in the chamber volumes of the heart. Presentation of these images in a dynamic (movie) format rather than as a series of static images permits the observer to readily perceive these changes, thus aiding in the delineation of cardiac anatomy, in the qualitative assessment of ventricular function and in the detection of regional myocardial dyskinesia.

Computer acquired and processed end-diastolic and end-systolic images are displayed alternately in rapid sequence by a minicomputer system.

The picture file obtained by computer-based, gated angiocardiography is compressed by a factor of four (from 100 frames/sec to 25 frames/sec) and transferred frame-by-frame from the computer display to 16-mm film. A sufficient number of these compressed cardiac cycles are copied onto a single strip of film to make a continuous loop for projection at 24 frames/sec with a conventional 16-mm projector. When projected at this rate the complete cardiac cycle, unlike the two-image display, is flicker-free and appears to occur in nearly real time.

Since several cardiac chambers are simultaneously visualized with gated angiocardiography, a flicker-free display of this information may be of substantial value as a teaching aid in the study of intracardiac dynamics as well as in the detection of cardiac abnormalities.

Influence of Charcoal Separation Technique on the Reliability of a Radioassay for Vitamin B_{12}. *Pamela Myford and Diane Forrest. Harvard Medical School and Peter Bent Brigham Hospital, Boston, Mass.*

Several features of the charcoal separation step in the competitive binding radioassay for vitamin B_{12} in serum were studied to discern their influence on reported analytical values.

The assay employed ^{57}Co-vitamin B_{12} (^{57}Co-B_{12}) as labeled substrate, hog gastric intrinsic factor (IF) as specific binding agent, and hemoglobin coated charcoal (HCC), prepared with 5 gm hemoglobin and 25 gm charcoal in 800 ml water, as the separating agent.

Since the results of the assay are directly determined from the ^{57}Co-B_{12} remaining in the aqueous phase, this *dependent* variable was measured and found to vary as indicated according to the following *independent* variables: (A) Temperature during exposure to HCC: increased the reported serum value by 18 pg/ml for *each degree* increase in temperature between 0 and 25°C; (B) time of exposure to HCC: increased the serum value by 11 pg/ml for *each minute* of exposure to HCC; (C) concentration of HCC: increased the serum value by 46 pg/ml for *each additional 0.1 ml* of HCC suspension added. The effect of time of exposure to HCC could be largely avoided by reducing the hemoglobin: charcoal ratio from 1:5 to 1:10, but significant temperature and concentration dependence remained.

These data provide a possible basis for the highly imprecise results of human serum assays for vitamin B_{12} when values from many laboratories are compared. In addition, they re-emphasize the critical need for uniformity of conditions during the charcoal separation step.

A Study of Variables Influencing Size and Texture of Macroaggregated Human Serum Albumin. *Ghanshyam C. Patel, Lelio G. Colombetti, Steven M. Pinsky, and Stephen Moerlien. Michael Reese Hospital and Medical Center, Chicago, Ill.*

Poor quality lung scintigrams obtained by ^{99m}Tc-macroaggregated human serum albumin could be due to poor labeling, improper particle size, or particles that are too soft. In order to improve the quality of the macroaggregated albumin, we have prepared a series of experiments in our laboratory to study the variables influencing the size and texture of the macroaggregated albumin.

Variables studied include pH of the albumin solution, temperature of precipitation, mixing speed, and heating time. Changing these variables, we found that the most reliable procedure to prepare macroaggregated human serum albumin suitable for lung scintigraphy is as follows:

PROCEDURE

(A) 5 ml of 25% salt-poor human serum albumin is diluted to 100 ml with saline solution.

(B) pH is adjusted to 5.9 ± 0.1 using phosphate buffers.

(C) 25 mg of sterile $SnCl_2$ is added to solution.

(D) The pH-adjusted HSA solution is heated in a water bath at 76–78°C for 15 min while stirring at 600 ± 50 rpm, using a specially designed apparatus.

(E) The particles formed are washed twice with saline and resuspended in the same volume of saline.

(F) 50 mg of polyoxyetheline-sorbitan-monooleate is added to the suspension. This surfactant will help resuspend the aggregates.

(G) The macroaggregates are divided into separate vials, each containing 5 mg/gm albumin and lyophilized.

LABELING

Add 3–5 ml sterile $^{99m}TcO_4^-$ (up to 70 mCi) to the vial, mix well, and let stand for 15 min for the labeling to take place.

Radiochromatographic techniques were used to study the percentage of labeling. Particle sizes were determined by microscopic examination.

Over 75% of the batches prepared produced particles of the proper size and texture, which resulted in high quality scintigrams.

Radionuclide Venography (RNV): Experiences with 100 Cases. *Sally K. Russell and Robert N. Odelson. Lutheran General Hospital, Park Ridge, Ill.*

Radionuclide venography (RNV) with ^{99m}Tc-labeled 3M Co. microspheres is now a well-established and reliable procedure for detection of thrombophlebitis. Its major advantages over other tests for thrombophlebitis are the ease of procedure, simplicity, minimal discomfort to the patient, and the immediate availability of results. An added advantage is the ability to do a lung scan at the same time as the RNV.

The purpose of this project was to evaluate our experience with the first 100 RNVs done at this center in order to shed some light on the problems encountered during the procedure and how to circumvent them. Various scintigraphic patterns in abnormal and normal RNV will be discussed with special emphasis on artifacts and other technical factors that may influence the procedure and interpretation of the RNV scan.

A total of 100 RNVs were performed of which 53% were abnormal. Ten patients had followup RNV scans. When possible, the results of the RNV scans were correlated with the contrast venograms and the Doppler scans (ultrasound).

With proper technique and coordination between the technologist and the physician, the RNV can be performed in approximately one-half hour and then followed by routine lung-scanning procedure. Some do's and don'ts will be discussed in a question and answer session included within the presentation.

A Dual Radiopharmaceutical Joint Scan Method for Arthritic Assessment. *M.L. Silver and N.D. Greyson. Mount Sinai Hospital, Toronto, Ontario, Canada.*

Of 622 bone scans performed since 1973, 103 patients were studied for arthritic diseases. In these patients the bones and joints were imaged with the scintillation camera using both ^{99m}Tc-polyphosphate (TcPP) and ^{99m}Tc-pertechnetate (TcO_4^-) and comparison was made of the two studies.

Each patient is scanned twice, 2 days apart. Blood pool images of each joint are obtained using 15 mCi TcO_4^- and a 15 mCi TcPP injection provides a bone scan of each joint area. Where evaluation of only a single joint is requested, immediate blood pool images are obtained using TcPP and a 2–3hr delayed scan shows bone uptake. A rectilinear scanner is used to image some joints such as knees and hips.

Blood pool images and bone scan were co-related and revealed patterns of abnormalities. Some patients demonstrated hyperemia and bone changes; others showed normal blood pools (no hyperemia) but abnormal bone scans. Co-relation was made with radiographs and clinical assessment.

The scans permitted diagnosis of various forms of arthritis. In inflammatory processes such as rheumatoid arthritis, septic arthritis and gout, both hyperemia and bone changes of actively involved joints were demonstrated. Some known rheumatoid arthritic patients showed increased activity on the bone scan but not on blood pool images showing the disease in the quiescent phase with no inflammation. Noninflammatory processes like osteoarthritis revealed bone changes on the TcPP scan but no hyperemia.

The dual radiopharmaceutical joint scanning technique shows the extent and stage of the arthritic process, gives valuable information about the nature of the disease and aids in the evaluation of treatment, often before radiographic changes are seen.

Method of Performing Ventilation Studies on Patients Requiring Respirator or Positive Pressure Machine. *T.P. Sorandes and M. Getka. University of Maryland Hospital, Baltimore, Md.*

The recent introduction of ^{133}Xe-gas technique has led to considerable advances in the evaluation of regional lung ventilation function. The lack of a satisfactory method of administering ^{133}Xe-gas has prevented utilization of this technique in patients who are on respirators or being treated with positive pressure therapy.

In the latter case, documentation of the patient's benefit from positive pressure equipment may facilitate procurement of such equipment for patient home use from various public and private agencies.

This laboratory has recently developed a technique for performing ^{133}Xe single breath followed by washout ventilation studies on patients requiring a respirator or for patients utilizing a positive

pressure machine. The technique consists of adapting a Medi-Physics Xe V.S.S. system which contains 5–10 mCi of ^{133}Xe-gas.

To adapt the system: (A) Firmly wedge a 22-mm plastic hose adapter into each end of the lead dispensing valve. (B) Wedge a 6-in. 18-mm (inside diam) rubber oxygen mask adapter hose over one of the 22-mm plastic hose adapters. (C) Place the dispensing valve "in line" with the respirator or positive pressure machine by wedging the remaining open end of the plastic adapter into the intake hose of the respirator or positive pressure machine. The adaptation is now complete.

To obtain a sharp ^{133}Xe-bolus, release the ^{133}Xe on the downstroke of the respirator or positive pressure machine. The exhaled ^{133}Xe can be collected at the exhaust port of the respirator or positive pressure machine in the routine manner.

In conclusion, the above technique has allowed this laboratory to perform ^{133}Xe-ventilation studies on patients requiring a respirator or who have to be evaluated while utilizing positive pressure therapy.

An Improved Method of Bowel Preparation for Gallium Scanning. *T.P. Sorandes, D. Porter, and J. Ryan. University of Maryland Hospital, Baltimore, Md.*

The purpose of this study was to evaluate three methods of bowel preparation and to determine which is most effective in clearing the gastrointestinal tract of excreted ^{67}Ga so that adequate body scans may be obtained.

The methods of bowel preparation were: (A) High cleansing enemas with 20% soap suds. (B) Ducolax 5-mg tablets, in combination with Ducolax suppositories. (C) Magnesium citrate, phenothalein, 2-gm tablets, in combination with effervescent suppositories. Twenty patients were studied with each bowel preparation.

The methods of bowel preparation were evaluated by having the department's nuclear medicine physicians rate the scans (excellent, no bowel seen; fair, bowel seen, interfered with abdominal interpretation; poor, bowel activity made abdominal area unreadable) using the appearance of bowel contamination as a guideline.

Effectiveness of Bowel Preparations

Preparation	Excellent	Fair	Poor
Group A			
20% solution of soap suds		50%	50%
Group B			
Ducolax	10%	20%	70%
Group C			
Magnesium citrate; phenothalein; effervescent supp.	90%		10%

This study demonstrates that a combination of magnesium citrate, phenothalein, and effervescent suppositories is the most effective method of cleaning the gastrointestinal tract so that adequate body scans may be obtained.

Fluorescent Excitation Analysis for In Vitro Tests. *S.J. Swann, L. Kaufman, D.C. Price, J.P. Huberty, P. Guesry, S. Orloff, S.T-C Hung, and M. Holliday. University of California, San Francisco, Calif.*

The assay of stable tracers by fluorescent excitation analysis (FEA) offers the advantage of simplicity, low cost, and high assay accuracy. Most importantly, it eliminates patient and attending personnel radiation exposure. The latter is of special significance in studies on children and pregnant women.

FEA involves use of an encapsulated radioactive source to momentarily excite characteristic radiation from the tracers of interest. A lithium-doped silicon (Si (Li)) detector is used for detection of the scattered primary radiation and characteristic x-rays. Data are accumulated in a compact multichannel analyzer, and readout is effected in any standard units of concentration (mg/gm, mEd/liter, or ppm).

FEA of bromine is used for determination of extracellular fluid volume, cesium for red cell volume (RCV), and Conray 60 for glomerular filtration rate (GFR). Comparative FEA studies with conventional bromine is 60 times faster than chemical microdiffusion analysis of stable bromine and avoids the need for frequent purchase of ^{82}Br without loss of accuracy. In RCV determinations 11 patients were evaluated using both the conventional ^{51}Cr technique and cesium labels. In the 10-min samples the mean difference was 0.2% with a s.d. of 4.4% and in the 40-min sample the mean difference was 2.5% and the s.d. was 7.5%. In GFR determinations, the mean ratio of ^{125}I-sodium iothalamate to Conray 60 was 1.001 ± 0.027. Studies can be performed using just three blood samples at 2, 3, and 4 hr after injection.

A recently introduced automated analyzer allows assay of from 3 to 200 samples per hour (depending on tracer concentration) with a mean analysis rate of 50 samples per hour. In vitro tests by FEA suggest a high potential for future use. Repeated tests can be done frequently without concern for radiation exposure to the patient.

The Technique of Direct Radionuclide Cystography. *Susan Weiss and James J. Conway. Children's Memorial Hospital, Chicago, Ill.*

From its earliest use, radionuclide cystography has provided the advantage of reduced radiation dose to the patient compared to roentgenographic techniques. The recent use of more ideal radiopharmaceuticals and scintillation camera imaging permits quantification of various functional parameters in addition to the simple evaluation of the presence or absence of reflux. The functional parameters determined with direct radionuclide cystography include bladder volume at which reflux occurs, actual measurement of reflux volume, calculation of drainage time, and measurement of residual urine volume. This paper describes the newest technique of direct radionuclide cystography.

Following the instillation of 1 mCi of ^{99m}Tc-pertechnetate into the bladder via catheter, the upper urinary tracts are monitored on a persistence scope as normal saline is allowed to distend the bladder. The amount of saline infused at the time of reflux is recorded. Posterior images in the supine position at high intensity settings permanently document the presence of reflux. Pre- and postvoiding counts of total abdominal radioactivity and urine collection enable quantification of residual urine volume. Images during voiding document reflux occurring with the higher bladder pressure during voiding.

Direct radionuclide cystography is considered to be more effective for detecting vesicoureteral reflux than indirect radionuclide cystography or roentgenographic cystography. The technique is relatively easy to perform, interpretation of images is not difficult, and the cost is equivalent to the other techniques. The technical pitfalls are few and easily recognizable.

Human Growth Hormone by Radioimmunoassay. *Judy Williams. Methodist Hospital, Houston, Texas.*

The rate of growth hormone secretion is subject to marked and rapid fluctuations in response to a variety of stimuli. These variations in the human growth hormone (HGH) serum level of normals decrease the diagnostic usefulness of determining HGH levels of random blood samples. Also, pituitary failure cannot be detected since the normal range goes down to zero. For these reasons, tests have been developed in which serum HGH levels are measured after pituitary stimulation and suppression.

HGH is evaluated in our laboratory by radioimmunoassay (RIA) using the Schwarz/Mann double-antibody method. The assay, which includes three incubation periods, can be completed in 48 hr. The test can measure up to 40 ng/ml in a 100-μl 1:4 diluted serum. The normal range is 0–6.5 ng/ml serum.

The stimulants we use are L-Dopa and insulin. Serum HGH levels determined for serial blood samples drawn for 3 hr after the stimulant dose is administered are compared to the predose serum level. We prefer L-Dopa because hypoglycemia occurs with insulin. If there is not a normal response with L-Dopa, insulin might then be employed as a check. Patients with pituitary failure do not respond to these agents.

Pathologic conditions producing high HGH serum levels are pituitary giants, acromegliacs, and some cases of anorexia nervosa. Hyperglycemia does not suppress HGH release in pituitary giants or acromegliacs as it does in normals. We determine HGH levels of serum from blood drawn during the routine GTT to determine if suppression occurs.

The measurement of HGH serum levels under varied pituitary stimulation has increased the number of determinations performed in our laboratory. This is due to not only an increase in the number of samples per patient, but also to an increase in the number of patients studied. This has made it economically feasible to make a HGH run every week. Before the stimulation and suppression tests were introduced, the assay was run as needed, which was usually every other month.