ABSTRACTS OF 1972 SCIENTIFIC PROGRAM: TECHNOLOGISTS' SCIENTIFIC SESSIONS PRESENTED AT 19TH ANNUAL SNM MEETING

Use of Combined Transmission-Emission Scanning in Chest Disease BY DOLORES ALFIERI, DALE BERGERON, LEONARD BLUMIN, AND JOHN VOGEL, Public Health Service Hospital, San Francisco, Calif.

The inability to correlate the emission image of a lung scan or scintiphoto with the radiograph continues to plague most laboratories. Facilities for obtaining a radiograph under the same conditions as the scan are rarely available. Various attempts have been made to employ monoenergetic transmission sources to overcome this problem. These have primarily used a flood source and a scintillation camera. This report will describe the use of a monoenergetic transmission source with a rectilinear scanner to obtain a 1:1 comparison image.

A dual five-in. Ohio-Nuclear scanner was modified to house a ⅛-in. collimated 150-mCi ^{241}Am source. When in use, the ^{241}Am is mounted on the lower detector collimator. A Lucite collar is first secured to the detector to permit alignment of the source to the center of the upper probe. The pig which houses the source is fitted with a spring switch that activates a warning light on the scanner whenever the cover of the pig has been removed. Depending on the size of the patient, the transmitted gamma flux is between 60 and 200 counts/linear cm with a scanning speed of 500 cm/min and an average 5-min scanning time. Americium-241 was chosen because its monoenergetic 59.6-keV gamma permits satisfactory discrimination between bone and soft tissue thereby providing landmarks for easy comparison with the emission scan.

An advantage of this technique is that respiratory excursions affect transmission and emission scans equally in contrast to the static radiographic images obtained in full inspiration. Intercomparison is therefore possible. Its usefulness has been documented in 200 cases, each using both ^{241}Am transmission and ^{131}I-MAA emission scanning. Of these, 120 demonstrated perfusion defects due to emboli, pleural effusion, pneumonitis, emphysema, congestive heart failure, mycotic lesions, and cavitary disease. Areas of radiographic density were compatible with areas of perfusion defects in all but a few cases. In 27 of the cases with perfusion defects no comparable transmission defects were seen, suggesting a diagnosis of pulmonary embolus. Six studies were performed to evaluate the presence of a subdiaphragmatic abscess and two were interpreted as positive. In combined liver-lung studies for subphrenic abscess, a transmission scan can replace the ^{131}I-MAA emission scan for delineating the base of the lung, thereby eliminating an added internal dose and reducing radiation exposure.

Our experience with the technique indicates: (A) ease of performance and operator safety, (B) reduced radiation exposure when compared with flood sources, (C) 1:1 anatomic comparison with emission scans, (D) radiographic area density comparability with transmission defects, and (E) delineation of anatomic structure while eliminating a second radionuclide.

Procedural Change for Assay of T_4 Iodine BY DOUGLAS S. BAILEY, Valley View Hospital and Medical Center, Denver, Colo.

This comparison study of two methods for assay of T_4 iodine was conducted under the aegis of the Ames Company, Division of Miles Laboratories, to ascertain the validity of a proposed eluate count assay, rather than the standard Tetralute column count method.

This study was carried out because certain gamma-

ray counting instruments will not accommodate the columns used with the Ames Tetralute procedure. The elution procedure enables the use of the Tetralute columns with practically all gamma-ray counters. The elution procedure with Tetralute is based on measurements of the radioactivity of liquid eluates from the Tetralute columns, rather than measuring the radioactivity on the Tetralute columns.

The methodology employed for the comparison of these two methods was recommended by the Ames Company. These recommended methodologies were strictly adhered to for the duration of this evaluation. All serums that were used for this evaluation were kept under refrigeration from time of serum/cell separation until coming to room temperature prior to performing the duplicate assays on each serum specimen.

The instrumentation used for this evaluation was a Picker well counter connected to a Spectroscaler IIIA which incorporates a pulse-height analyzer in the scaler system. This instrument was calibrated on a weekly basis with a ^{137}Cs source to maintain high voltage integrity.

By using the square root of the T_4 iodine assay (column count method) as 1 s.d., there were 18 of the 200 procedures where the eluate count procedure did not fall within the 1 s.d. criteria which was applied to the column count assay. These 18 which did not correlate represent 9% of the evaluated serums.

The hypothyroids, by the column count method, when compared with the eluate count procedure, yield a 5% discrepancy.

The hyperthyroids, by the column count assay, when compared to the eluate count assay, yield a discrepancy of 4.5%.

It is the opinion of this investigator that either of the two methods for T_4 iodine assay will give valid statistical values. The eluate count assay is simple and as easy to follow as the standard column count procedure. There appears to be the same degree of reproducibility with the eluate count procedure as that which is obtained with the standard column count procedure.

Relative Thyroid Uptake BY JOHN BOOMER, Nuclear Medicine Institute, Cleveland, Ohio.

The ability of the thyroid to concentrate iodide is one of the most important and complicated physiological processes of the body. The measurement of this ability has been done with the greatest efficiency and accuracy with the use of radioactive tracers as opposed to such tests as the PBI or BMR.

The uptake of a tracer dose of radioactive iodine by the thyroid gland is the most universal of all the isotopic thyroid function tests. The only problem with the uptake has been that its percent uptake levels have been falling in recent years from "established normal levels". These established normal levels can be effected by such factors as geographical region, population characteristics, methodology, and the use of salts as preservatives. A recent article, however, published on the iodide content in bread in the New York area failed to establish any increase in iodide content. Nevertheless, no matter what the cause, our percent uptake levels *were* much lower. The problem, then, was to provide a normal range for our geographical area.

Three hundred patients were picked at random from our files dating back to 1969. Consideration was also given to T_3's, T_4's, and clinical findings. Accumulation of all necessary data was then tabulated to establish an accurate normal range for the thyroid uptake of radioiodine in the population of our region.

This study revealed that the "established normal uptake levels" of radioiodide by the thyroid had changed considerably from the time-honored values used by laboratories in our region. The new values were considerably lowered and when used properly correlate with the functional status of our thyroid population.

All technicians should be aware that they cannot settle for literature values as prescribed criterion for their normal uptake levels. Each laboratory should periodically run a statistical study of their own patients to provide quality control unique to their own facility.

Whole-Body Bone Imaging with the Gamma Scintillation Camera BY CAMILLE L. BOYCE, A. ERIC JONES, AND GERALD S. JOHNSTON, National Institutes of Health, Bethesda, Md.

Whole-body rectilinear imaging has proved to be a valuable method for assessing bone involvement in patients with a malignancy. Wider application of the method has been restricted to institutions possessing rectilinear whole-body scanners. The gamma camera with pinhole collimator may offer an alternative to the rectilinear technique when ^{18}F is used as the imaging agent. A whole-body rectilinear scanner and a gamma scintillation camera with pinhole collimator were used to image each patient in a series of whole-body scans in order to compare the quality of results with the two instruments.

Fifteen patients were given 2–6 mCi of ^{18}F intravenously, and scintiphotographic views were collected after a 2-hr waiting period. Gamma camera images were obtained using a large-hole and a small-hole tungsten insert and no insert in the pinhole

collimator. These were compared with images derived from a dual-probe rectilinear scanner fitted with high-energy, 5-in., focused collimators and 5-to-1 minification.

When the gamma camera was used, the patient was placed on a low litter, 2 ft in height, with the collimator 2 ft above the patient. A composite whole-body view was obtained in three sections. Depending on the amount of ^{18}F administered, 20,000–30,000 counts were collected for each section requiring 10–15 min/section at midrange intensity. When a suspicious area was noted, the collimator was brought closer to produce a larger, more detailed view.

Although the resolution of the whole-body rectilinear scans was superior, the images obtained with the camera and pinhole collimator were of high quality and could be relied upon to demonstrate areas of bone involvement. Camera images of sharp resolution, comparable to rectilinear views, were produced using the large-hole insertion in the pinhole collimator. Images with less resolution were obtained with the small-hole insert and with no insert. Examples of all four methods will be shown.

The use of the gamma camera and pinhole collimator with large-hole insert is presented as a method available to anyone with a scintillation camera and as an adjunct to a clinic with an overscheduled whole-body scanner.

Career Ladder for Nuclear Medicine Technicians and Technologists BY P. JOHN CADLE, Technical Education Research Centers, Inc., Cambridge, Mass.

A career ladder is a model outlining the relationship between education, training, and experience so as to encourage and stimulate career mobility. In considering the development of a career ladder for nuclear medicine technology, the following points were made by participants in a workshop on career ladders (March 1971) and refined by subsequent discussions with interested members of the nuclear medicine field.

Three job levels have been identified, with two positions below the first level and a variety of options within each level. Four types of training currently exist to prepare individuals for entry at various positions: informal on-the-job training for radiologic aids; formal 1-year nuclear medicine programs for individuals with some experience or training in a health technology; and associate and baccalaureate degree programs, preparing individuals without previous experience or training in a health technology.

The relationship between training, experience, and the level at which the individual enters the field have been examined, with emphasis on the degreed technician, particularly the BS degree. Opportunities for advancement up or across the ladder have been discussed in terms of equivalent education and work prerequisites. An ideal structure for an educational program in nuclear medicine has been outlined which allows an individual to enter the field at Level I after two years of training (AS degree) and have the option to continue on at any point for the more specialized BS degree.

Translating this ideal educational program and the model career ladder for which it relates into an acceptable and operational job structure requires understanding and cooperation among various groups in the nuclear medicine community—academic, scientific, and professional associations, and the certifying registries. In particular, the relationship between the registration examinations in nuclear medicine and real career mobility should be examined; suggestions have been made that perhaps registration examinations should be offered to people at more than one level of education or competence in nuclear medicine, so as to complement both the ideal educational program and the career ladder.

Elevated Index of Iodine Ingestion BY SONYA M. COPPEDGE AND FREDERICK R. GYDESEN, Penrose Hospital, Colorado Springs, Colo.

The confirmation of a clinically valid normal range for the radioactive iodine uptake has long been the source of inconclusive controversy. Due to its extreme vulnerability to interference from dietary sources, a reliable index of iodine ingestion is necessary for good perspective in determining the so-called normal mean. In addition, it should be appreciated that the source of exogenous dietary iodine would vary with each groups' dietary preference based on ethnic, religious, socio-economic, and geographic differences. It is the purpose of this paper to illustrate our means of confirming our normal range statistically based on our findings of the average amount of iodine ingested in Colorado Springs.

Five hundred (500) questionnaires were circulated door to door and the population interviewed as to their dietary preference. The interviewers inquired into the frequency and quantity certain foods known to have a high iodine content were consumed. The questionnaires were categorized according to age, sex, race, and geographic location within the city. Each questionnaire was individually calculated for the amount of iodine consumed on a weekly basis and averaged for daily intake, based on the tables of iodine content in foods (ref. Modern Nutrition 1968) (based on 38 μg/slice bread). The

findings were then compared with the average daily requirement of 150 μg/day.

Based on 376 (4% of total population) returns, it was determined that the average iodine intake in the city of Colorado Springs was 176 μg/day, ±28.3. This is significantly higher than the average daily requirement, considering we only examined part of the diet. This figure does not include vitamins, antihistamines, and other food supplements and drugs that contain iodine. We were able to determine that 37% take vitamins, 40% take antihistamines, and 70% take aspirins regularly.

From these findings a rigid quality control program was implemented over an 18-month period of time on our thyroid patients chosen at random (233 total patients) with special emphasis on those suspected of having dietary interference. The raw data were fed into a computer and a histogram of uptake values plotted at 6-month intervals. The distribution curve showed steady improvement with each 6-month increment and the last segment clearly showed the previously, positively skewed distribution had taken on a more Gaussian appearance. The final statistical analysis showed a mean of 22% ± 10.5%. It is felt that our current normal range of 10–30% is valid based on an average daily iodine intake of approximately 176 μg/day ± 28.3 in our city.

Eye Exposure from ^{99m}Tc BY MARTIN L. DAILY, St. Luke's Hospital Medical Center, Phoenix, Ariz.

The purpose of this study is to determine the approximate range of radiation exposure to the eyes of the nuclear technologist while performing his daily routine.

There are five types of nuclear technologist: a wet-work technologist, an imaging technologist, a supervisory technologist, an educational technologist, and an administrative technologist.

For the study, the imaging technologist is singled out because in our institution, which I believe to be typical, he routinely handles the largest amount of activity.

The most common functions of the imaging technologist are assay for ^{99}Mb and calibration of ^{99m}Tc elution from a generator, preparation of sulfur colloid from a kit, and drawing, carrying, and injecting the dose.

The eye-to-source distance during actual technologist performance was measured with a meter stick. Each performance where the eyes were exposed to the source was timed with a stopwatch.

After observing the distance and time required to perform each function a group of sources identical to those actually used in the daily routine were assembled and exposure rates obtained. The exposure rates were obtained using identical distance and time required to perform each function. A Nuclear-Chicago survey meter and a Frieseke & Hoepfner survey meter were used to obtain the exposure rates.

The exposure rates were multiplied by the average number of exposures to the imaging technologist per day and again multiplied to represent a 13-week exposure rate.

The average day included three brain scans, 10 mCi each, and two liver scans, 2 mCi each. This daily load was used to obtain exposure rate for drawing, carrying, and injecting the dose. Our week is a 6-day week.

A NEN 400-mCi generator with a daily average of 491 mCi of ^{99m}Tc was used to obtain exposure rates pertinent to assay for ^{99}Mb and calibration of ^{99m}Tc. A Nuclear-Chicago Mediac dose calibrator was used to perform both assay and calibration.

A Mallinckrodt sulfur colloid kit with a daily average of 50 mCi was used to obtain exposure rate pertinent to its preparation.

The approximate maximum exposure rate to the imaging technologist's eyes from drawing, carrying, and injecting the dose is 0.287 R/13 weeks.

The approximate maximum exposure rate to the imaging technologist's eyes from the assay for ^{99}Mb and calibration of ^{99m}Tc is 0.936 rem/13 weeks.

The approximate maximum exposure rate to the imaging technologist's eyes from the preparation of sulfur colloid is 0.343 rem/13 weeks.

The total of the three exposure rates is 1.566 rem/13 weeks.

The maximum permissible dose, outlined in Title 10 CFR Part 20, Section 20.101, to the eyes is 1.25 rem/13 weeks. As indicated by this study it would be easy to reach and exceed this limit. The use of lead syringe shields for drawing, carrying, and injecting lead glass barriers for assay, calibration, and kit preparation would reduce this exposure rate well below the limit described.

Rapid Evaluation of Renal Transplant Function BY THOMAS DAVIES AND MICHAEL HAYES, Harbor General Hospital, Torrance, Calif.

One of the serious problems in the management of the renal transplant patient is that conventional laboratory chemistry indicators of function such as BUN, creatinine, and 24-hr urine output not only lag behind the true functional status of the kidney, but also the determination and reporting of these values may require substantial additional time. The purpose of this study was to develop a practical easily calculated and reproducible means of assessing transplant function with isotopes.

Using the Picker Dynacamera, video storage sys-

tem and data processor, scans are performed daily for the first 14 days post-transplant. Along with this equipment an external probe amplifier analyzer and strip chart recording system for monitoring blood clearance from the heart are used. After the positioning of the patient under the probe, 300 μCi of ^{131}I-iodohippurate is injected intravenously. For a period of 20 min, 90-sec scintiphotos are obtained at 2-min intervals. In conjunction with the scintiphotos, information is also stored on videotape. At the end of the 20-min scanning period and after obtaining a postvoid film, the storage tape is replayed. On reply, 3 × 3-cm regions of interest are set around the kidney and bladder. The videotape system is then restarted from the beginning of the study with the processor set to accumulate and plot data on the oscilloscope for a period of 20 min. When this time is completed the renogram and bladder curve are displayed. From the information stored in the data processor a bladder-kidney ratio is calculated by dividing the radioactivity within the bladder by that remaining in the kidney 20 min following injection. The blood clearance curve from the strip chart recorder is then also calculated by dividing the counting rate at 20 min by the counting rate at 10 min. The patient is then returned to his ward and the scan results are immediately available.

In the past 2 years approximately 600 examinations were performed on over 70 renal transplant recipients using the method described. Scans, renogram replay, and calculation of indices and reporting may be accomplished in approximately 1 hr. The indices described have been found by the physicians managing the patients to show definite changes 1–2 days before conventional lab tests in early transplant rejection.

The sequential camera scan 20-min renogram in conjunction with the bladder-kidney ratio and blood clearance index is a quick, safe, and reliable means of assessing renal transplant function. Results are being used by the transplant team as predictive indicators of impending transplant rejection. This allows appropriate therapy to be started before laboratory changes or clinical signs and symptoms become apparent, thus resulting in improved prognosis for the renal translant patient.

An Inexpensive and Easily Prepared Phantom and its Uses in the Evaluation of Various Scanner Settings BY M. DE GRAFF AND N. SOLOMON, Downstate Medical Center, Brooklyn, N.Y.

The phantom is a polyethylene ice cube tray with 12 compartments (each with a capacity of approximately 30 cc). To prepare the phantom, 20 cc of water is put into each compartment. Radioactivity in the form of dilute $^{99m}TcO_4^-$ is then added to each compartment (concentrations will be discussed); 1 cc of the ^{99m}Tc is pipetted into the first compartment to represent the 100% concentration, 0.9 cc is added to a second compartment to represent the 90% concentration, 0.8 cc to the third compartment to represent the 80% concentration, etc., down to 10%. The extra compartments are used as duplicates of two of the concentrations to test the reliability of the phantom.

The phantom was then scanned numerous times to evaluate the effect of various scanning parameters: information density, contrast enhancement, time constants, density focal depth, etc. (slides will be shown to illustrate all of the above and the selection of the proper technique will be discussed.)

The purpose of this paper is to demonstrate a new versatile type of phantom and its role in establishing the scanning standards to be used in the laboratory.

Orientation and Localization BY CHARLES JOHN DUNN AND WILLIAM B. KING, Hollywood Memorial Hospital, Hollywood, Fla.

One of the most important contributions a technologist can make in securing a diagnosis with radioisotopic visualization procedures is in orientation and localization, that is, putting the visualized image into anatomic context. With the scintillation camera this task is, because of the scaled-down image, very critical. We will discuss our efforts in this area.

To permit the diagnostician to "see things as they are" we use a standard orientation such that the scintiphoto always demonstrates the entity in its normal situation. The superior aspect is at the top, inferior to the bottom and lateral aspects relative to viewer/camera image. Application of this principle to all visualization procedures, static or dynamic, serves to eliminate confusion. Mounting each photo in a set pattern also helps to reduce the possibility of error.

Along with the standardized orientation regimen we maintain a set pattern of localization with markers. While the familiar ^{57}Co markers prove indispensible in some examinations, we have found that negative markers of lead are excellent in certain other procedures; as in localization of the costal margin in liver scans. We have tried the "hot" and "cold" markers with liver, bone, placenta, and thyroid scintiphotography and will discuss the merits of each.

In imaging the thyroid, anatomic localization is especially essential. Because of the critically important character of nodules, both hot and cold, precise localization of these entities is necessary. We are

now evaluating a localization device which is simple and inexpensive, and apparently accurate.

The device is a transparent Lucite "peg-board" 3 in. square with holes ($\frac{1}{32}$ in. diam) drilled at 1-cm increments in a square pattern. Following palpation and marking of nodular margins by the diagnostician, the technologist positions the board over the neck, inserts the "pegs" (4 micropipettes containing ^{75}Se or ^{99m}Tc) into the holes closest to the marks, and makes a scintiphoto. This photo, mounted next to the regular diagnostic scintiphoto, affords reliable nodular localization.

We are comparing the merits of this "hot" marker setup with a "cold" technique using markers of lead wafers in varying shapes and sizes which are taped directly on the neck over palpable nodules. The thusly marked scintiphoto is viewed next to the diagnostic scintiphoto. The localization photo is clearly identified.

We feel that each of these efforts to improve this aspect of diagnostic nuclear medicine will contribute to better patient care.

Four-Day, Forty-Hr Week in a Clinical Nuclear Medicine Department BY KARIN GORDON, Winnipeg General Hospital, Winnipeg, Manitoba, Canada

The concept of a shorter work week and more leisure time is spreading rapidly across North America.

An experimental 4-day, 40-hr work week was instituted for a 2-month period in the Department of Nuclear Medicine of a large university teaching hospital. Advantages and disadvantages of the altered work week to patients, staff, and hospital administration were anticipated, closely monitored, and are analyzed in this presentation.

OD: Radiopharmaceuticals and Countermeasures BY DANIELLE GUEOREV, DAVID B. HERTSGAARD, AND FLOYD POTES, St. Joseph Hospital, Orange, Calif.

It is the authors' purpose in the preparation and presentation of this paper to aid coworkers in the field of nuclear medicine to reduce the degree of damage which may take place in a patient as a result of an "accidental overdose" of a radiopharmaceutical administered for a diagnostic procedure.

The dose and dose rate to the target and secondary target organs will be discussed for the most commonly used radionuclides. Our definition of an "accidental overdose" will be presented.

The physiology, metabolic pathway, and the excretory mechanisms for the most commonly used radiopharmaceuticals will be discussed. To be included are ^{131}NaI, ^{131}I-IHSA, ^{131}I-MAA, ^{203}Hg, ^{197}Hg, ^{131}I-Hippuran, ^{99m}Tc, ^{133}Xe, ^{85}Sr, ^{18}F, ^{198}Au, ^{51}Cr, and ^{59}Fe.

We will suggest measures for reducing possible cell damage by removing as much of these radionuclides as possible from the body in the event of an "accidental overdose."

In conclusion, it is not the authors' intent to provide a solution to negligence and carelessness on the part of those working in the field of nuclear medicine, but rather to aid those involved in a rare or occasional accident of miscalculation, mislabeling, or misdispensing.

Critical Review of Parameters Affecting the Properties of ^{99m}Tc-Sulfur Colloid Solutions BY J. N. HALL, R. E. O'MARA, AND I. TYSON, University of Arizona Medical Center, Tucson, Ariz.

The purpose of this study was to (A) determine the effect of different methods of heating on the particle-size distribution of sulfur colloid, (B) suggest a new method of evaluating the various stabilizers in protecting hydrophobic colloids, (C) compare the buffer capacity of the various commercial sulfur colloid kits, and (D) demonstrate that moderately high aluminum content in ^{99m}Tc eluates does not interfere with the biological distribution of ^{99m}Tc-sulfur colloid.

The samples used for particle-size distribution were heated in a water bath (80 and 100°C) for 8–10 min or in a microwave oven for 11–25 sec. Particle-size distribution was studied with an on-line Coulter Counter-Linc 8 computer system calibrated with samples of monodispersed polystyrene latex microspheres (0.29 and 0.79 microns) and/or a scanning electron microscope. Stabilizing property of protective colloids is usually expressed in terms of the gold or Congo rubin number. Protective ability of the stabilizers (gelatin, albumin, and mannitol) were evaluated by comparing the ability of the suspension to pass through a 8-micron Millipore filter which is approximately 10 times the maximum particle size. Buffer capacity of the colloid kits was determined by the ratio of the increment of strong base added to the final solution, to the change in pH brought about by this addition. Retrospective examination of liver scans and chest x-ray films on patients were made in an attempt to correlate high lung activity to high aluminum contamination in the ^{99m}Tc-sulfur colloid liver scan procedures.

The most homogenous particle-size distribution was obtained by either the microwave oven-heating method or the gelatin-stabilized sample. The gelatin-stabilized material demonstrated an average of 80% of the suspension of the Millipore filtrate while the albumin-stabilized material contained an average of

70%. The stabilizer-free and mannitol-"stabilized" filtrate contained less than 1% of the total activity. These data tend to indicate that mannitol does not function as a stabilizer in the same manner as hydrophilic colloids. Since the pH of the ^{99}Mo generator eluates can vary by approximately 3 units depending on the manufacturer, a good buffer system is necessary to insure that pH 6 is never exceeded. The buffer capacity of the Mallinkrodt colloid kits was approximately three times that of the other commercial suppliers and is probably due to the increased amount of gelatin in their product. High aluminum content in the ^{99m}Tc eluates did interfere with the preparation of the technetium-sulfur colloid as demonstrated by flocculation of the particles resulting in settling of the particles at a faster rate. However, the particles could be resuspended by agitation of the vial. Sulfur colloid samples prepared with up to 1 mg of aluminum contamination did not demonstrate any significant lung activity in rabbits.

Evaluation of a New Surface Adsorbent Test for Thyroxine (T_4) Determinations BY ALBERT R. KELLER, DAVID C. ALLEN, AND LOUIS R. WESNER, Central Pathology Laboratory, Santa Rosa, Calif.

T_4 determinations are increasingly used for evaluation of thyroid function especially to determine free thyroxine index. Present methods for T_4 determinations have been somewhat time consuming, relatively expensive to perform, and demanding in terms of technical skill. Therefore a new surface adsorbent method has been evaluated in comparison with the widely used resin sponge T_4 method. The new method is simpler to perform, requires approximately half the technologist time, and at present is lower in material cost.

The new method correlates very closely with the resin sponge method and renders in fact almost identical values. The product moment correlation coefficient r equals 0.98.

$^{99m}TcO_4^-$ Renal "Flow" Study: Importance of Static Imaging BY REGINA KOZAR AND JOSE O. MORALES, Episcopal Hospital, Philadelphia, Pa.

The availability of scintillation cameras has made possible "flow" studies of different organs. In most published methods of renal studies, serial photos are obtained at 1–3-sec intervals following the intravenous administration of the radionuclide. However, the short interval of time used limits the resolution because of the small number of counts collected. We have investigated the value of a static image obtained immediately following the completion of the serial images.

The study was done using a Nuclear-Chicago Pho/Gamma III camera with the 4,000 parallel-hole, low-energy collimator. The patient is placed in the prone position and the area of interest defined by a previous ^{197}Hg-chlormerodrin image. Fifteen millicuries of $^{99m}TcO_4^-$ are injected intravenously and eight consecutive 3-sec images are obtained for the first 30–45 sec depending on the arrival time of the bolus. Immediately thereafter, without moving the patient and after proper adjustment of the intensity setting, two consecutive static images are obtained by accumulating 500,000 counts for each. The timing of the static image is most important since, if delayed, the rapid increase of background activity will negate the value of the image.

We have found that the static image contributes to the value of the study by providing better resolution in the evaluation of renal lesions, particularly those with diminished or absent flow, such as cysts, infarcts, or necrotic areas in tumors. In addition, and most important, the single static view in itself has enough information to allow a useful interpretation, even if the serial "flow" study is technically unsatisfactory.

We believe that the static image obtained, as outlined, is of value and should be an integral part of the renal "flow" study.

Organ Localization for Therapy (Kidney and Bone) BY DONALD E. KUNDEY, MARILYN MOSS, AND HERBERT BARNES, Baylor University Medical Center, Dallas, Tex.

General organ localization is something we all do every day. We will describe organ localization for x-ray therapy of kidney and bones in this presentation.

In therapy, the kidneys are located so they may be blocked during treatment. There have been many papers and abstracts written in the past dealing with this problem, including one by Dorothy Malaret and Toby Sherman, Beth Israel Medical Center, Newark, New Jersey, describing how this is done with a single probe such as the Magnascanner.

In our department, we use the Dynapix or the Ohio-Nuclear and are able to cut scanning time to a minimum. We use DTPA which permits larger administered quantities, better statistics, and faster scanning time.

The patient is injected with 1 or 2 mCi. While still under the scanner, using the image on storage scope and marker lights which project on patient, the patient's skin is marked and the marks covered with transparent tape to keep them from being washed off. A copy of the marked scan is included on the therapy chart. Kidney outline can be projected in

this way with no magnification and more precisely than with x-ray films.

Localizing bone lesions is done when the patient is being worked up for therapy (normally a short time after having had a scan with ^{85}Sr or one of the other bone scanning agents). The patient is put under the scanner probe (in this case a 5-in. Ohio Nuclear). The howler is turned up and the probe is positioned over the patient in the general area of interest. By moving the probe and listing to howler, the center and the edges of the involved area may be found and marked, thus setting up the treatment port as in the case with the kidney.

These techniques provide more accurate treatment port definition with no additional patient discomfort or procedures and are not time consuming.

Improved System to Record, View, and Store Radionuclide Images BY JAMES K. LANGAN, T. K. NATARAJAN, AND HENRY N. WAGNER, JR., The Johns Hopkins Hospital, 601 N. Broadway, Baltimore, Md.

We have reported previously a system for displaying, reproducing, and storing scintillation camera images. The system has now been improved in the following ways: (A) Rectilinear scans are displayed directly on a cathode ray tube and photographed, (B) eight to ten life-sized images can be displayed simultaneously in a specially constructed viewer, and (C) twelve images can be stored in a single jacket.

The use of 35-mm film to record scintillation camera images is routine in our laboratory; however, rectilinear scans have previously been recorded on 14 × 17-in. radiographic film. Rectilinear scans are now displayed on an oscilloscope and photographed directly on 35-mm film. Recording rectilinear scans in this manner greatly decreases cost and both scans and camera images are presented in the same format. In comparing 35-mm images to life-sized images on radiographic film, no loss of information has been noted.

The 35-mm images are mounted in a dual-channel 3⅜ × 7¼-in. microfilm jacket. As many as 12 images can be stored in a jacket. All jackets are filed in color-coded envelopes. The envelopes are filed by patient history number. The jackets can also be filed and retrieved automatically using an automatic jacket sorter. Copies are made with a diazo printer at a cost of 4 cents a copy.

The new viewer which projects eight images simultaneously in life size is now in routine use. The images are projected on a 72 × 42-in. front viewing screen by an internal projector. The projected image has a minimum of distortion and vignetting. There is little loss in image brightness at viewing angles 45° from center.

These changes result in greatly reduced film cost for rectilinear scans, improved display of 35-mm nuclear medicine images and more efficient storage of patient studies.

Evaluation of a New In Vitro Thyroid Function Test BY MARTHA W. LEWIS, MARTHA N. WELDON, CONNIE WAYHAM, AND JERRY HILL, St. Louis University Hospitals, St. Louis, Mo.

Because free T_4 is the best indicator of the true thyroid status of a patient, its determination should be essential to the assessment of thyroid function. However, its direct measurement is difficult enough to preclude its being a routine laboratory procedure. An indirect method is therefore usually accepted as sufficient. Recent experience has shown that the FT_{4I} is an acceptable alternative to FT_4.

Our study compares the FT_{4I} as calculated from one of these indirect methods to a new and faster test based on work done by Mincy and Thorson. Both values were then compared to the final diagnosis.

Sera from 120 patients and normal controls were assayed for TBCI and T_4 by a modified Murphy-Pattie technique, and the new method combining both tests.

In the new dual analysis, the patients' alcohol-extracted T_4 is added to a buffered reference TBG-labeled with RAI T_4. By displacement and competitive protein binding a proportional amount of patient T_4 will occupy reference TBG sites and release that amount of RAI T_4 into solution. With the addition of 0.005 ml of patient serum, a new source of TBG with unbound sites is introduced. These sites will be filled by some of the RAI T_4 released from the reference TBG. Excess RAI T_4 is removed by resin and the sample vial compared to a standard serum treated in exactly the same way. Values are expressed as a ratio rather with normals being 0.86–1.13.

Our correlation coefficient in for FT_4 index and the thyroxine ratio is 0.92. The reproducibility of the test is suggested by a standard deviation of 1% of the mean value or 0.01.

The estimated time saved is 3 min/vial based on the elimination of six steps plus an additional saving of 15 min/set of standards. The probability of error is reduced by the elimination of these same six steps, four standards, and a graph plotted from the standards. The comparable values obtained for 83 euthyroid, 16 hyperthyroid, and 18 hypothyroid patients agreed with the patients' clinical evaluation except for one elevated value in a patient with metastatic

carcinoma who was thought to be euthyroid by clinical assessment and other laboratory measurements. One patient who had just been removed from thyroid medication had borderline thyroxine ratio and slightly decreased FT_{4I}.

The procedure appears to be fast, accurate, and reproducible. The results correlate well with the patients' clinical status as well as with values obtained for a free thyroxine index.

We feel that this is a dependable screening test for the assessment of thyroid function and can reliably replace the separate determinations of T_4 and TBCI.

Quantitative Analysis of Liver Images with a Gamma Camera Computer System BY J. A. MADDEN, R. C. MEADE, AND J. D. HORGAN, Veterans Administration Center, Wood, Wisc.

The purpose of this study was to develop the previously described method of Grassman, et al (*Radiology* 95: 517–523, 1970) for the routine clinical evaluation of liver images. This development involved improvements in the equipment and the operating procedures to provide for fast, simple, and reliable operation of the gamma camera computer system.

Patients are administered approximately 3 mCi of ^{99m}Tc-colloid intravenously at least 20 min before the study. The data is collected with the Pho/Gamma HP camera-PDP/12 computer system developed by the Biomedical Computer Laboratory, Washington University School of Medicine, St. Louis, Missouri. An anterior and right lateral view are taken with the patient lying.

The data is digitized into a 64 × 64 matrix in the computer memory. Data are accumulated until one cell reaches 1,000 counts. The raw data are saved on magnetic tape and processed by the computer for immediate output.

Automatic processing includes a correction for detector nonuniformity, smoothing, and automatic outlining of the liver and each defect. Final output from the computer is an outline of the liver border and included areas of defect and a printed report of the calculated area and "volume" of the liver and each defect and an assessment of the probability of tumor.

In addition to the automatic analysis, the corrected, smoothed image can be viewed with or without enhancement on the computer screen or photographed on a remote display.

A major objective was to simplify the operation of the system so that a technician with no prior computer experience could operate it. Toward that end, all computer operations are controlled by typing answers to multiple choice questions, which are displayed on the computer screen. Program and data are stored on easy-to-use LINC-format magnetic tape.

Results of computer analysis on over 200 liver images have shown that the method provides significant new information that is not available from the conventional photoscan. Parameters describing the number and size of defects can be compared to normal values to calculate the probability of tumor. Results are available to the physician in a matter of minutes after the study. In our laboratory, the system is operated by nuclear medical technologists and physicians who have had no specialized computer training.

Five-Month Evaluation of a Tomo Camera BY LOIS V. MOORE AND JOHN J. KEARNEY, Edgewater Hospital, Chicago, Ill.

Evaluational additional information received from a Tomo Camera study in the final diagnosis of several cases.

Radioisotope used and dose amount. Brain Scans: 7 mCi technetium-99m pertechnetate. Liver Scans: 1–3 mCi technetium-99m pertechnetate sulfur colloid. Instrumentation—Conventional Liver and Brain Scans using Pho/Gamma and Pho/Gamma H.P. with Persistence Scope and Data-Store. For brain scans a. cerebral blood flow is done, first using a high sensitivity collimator and data-store, followed by the scan using the high resolution collimator and taking an anterior, right lateral, left lateral and posterior view. All questionable or positive scans are repeated immediately using the tomo camera. Liver scans are done with a diverging collimator; at the conclusion of the routine liver scan, if there is a questionable or positive scan it is repeated immediately using the tomo camera.

Case 1. Brain Scan: Golf ball sized mass demonstrated on scan, also on tomo scan at 1½ and 2½ in. Proven at surgery. Tissue report to be submitted. Case 2. Brain Scan: Thalamic tumor 2.5 cm in diameter above sella turcica right anterior, seen on scan also on tomo at 3½ in. Proven at postmortem examination. Tissue report to be submitted. Case 3. Brain Scan: Hemangioma of skull 3.5 cm mass on right side of skull, demonstrated at 4th level on anterior tomo study, 4½ in. from front of head. Proven by surgical excision of lesion. Tissue report to be submitted. Case 4. Brain Scan: Right parietal mass, tomo study revealed large mass corroborated by arteriogram. Case 5. Liver scan and tomo study

both show metastatic lesions and cirrhosis demonstrated by areas of poor uptake in liver. Proven by biopsy and malignant ascites. Report to be submitted. Case 6. Liver scan and tomo study; both show large areas of deficiency of uptake. Primary malignancy demonstrated by previous surgery. Case 7. Liver scan and tomo study; both reveal areas of deficient uptake demonstrated more readily on tomo. Primary malignancy demonstrated by bronchoscopy.

The tomographic camera is of value in better defining the presence of neoplastic disease in the brain and liver.

Head Transmission Scanning in Radioisotope Cisternography BY MARK I. MUILENBURG, RAYMUNDO T. GO, TUHIN K. CHAUDHURI, AND JAMES H. CHRISTIE, University of Iowa Hospital and Clinic, Iowa City, Iowa.

The interpretation of radioisotope cisternograms is often made difficult by the lack of reference to the normal head silhouette. The purpose of the technique described is to provide a reliable silhouette of the head to help orient the physician in localizing the radioisotope concentrations in the cisternogram. The performance of a transmission scan in conjunction with the routine radioisotope cisternography visualizes the head silhouette containing the radioisotope.

In our procedure, high specific activity IHSA is injected intrathecally for the cisternography portion of the study. At appropriate postinjection intervals, a point source of 3 mCi of ^{99m}Tc is mounted in the lower probe of a dual-probe scanner after disconnection of the high voltage supply. A routine radioisotope cisternography is then performed. The pulse-height analyzer settings are then changed for ^{99m}Tc with scanning parameters chosen so that the counting rate coming from transmitted photons will not produce film exposure. The only film exposure will be from counting rates obtained with no attenuation of the transmission source photon beam. The final scan is a composite of the two scans showing the head silhouette around the radioisotope concentration.

The results at this time have produced greater accuracy in interpretation, with improvement in determining the location of the radioisotope concentration.

In conclusion, transmission scanning as described in conjunction with radioisotope cisternography provides a better method of interpreting radioisotope cisternography.

Improved Technique for Aerosol Inhalation Scanning BY JOHN MULLINS AND MICHAEL HAYES, Los Angeles County Harbor General Hospital, Torrance, Calif.

A serious problem in the performance of radioaerosol inhalation scans is that even in normal patients large aerosol particles tend to be deposited in the pharynx, trachea, and larger bronchi. This deposition confuses interpretation and may obscure abnormal areas of deposition in the diseased lung.

The purpose of this study was to evaluate the effect of additional baffles and a modified Pircher heat chamber on the deposition pattern of radioaerosols.

A standard model ultrasonic nebulizer was used to generate a radioactive aerosol fog. To this system was added a baffle consisting of a small aluminum plate at right angles to the flow of aerosol in the delivery tubing and a heat chamber constructed from a 1-liter pyrex beaker containing a 40-watt light bulb controlled by a nautotransformer. The aerosol is briefly warm while passing in and out of this chamber through holes in the lid. This heat decreases the turbidity of the aerosol and presumably decreases water droplet size by partial evaporation. Aerosol is delivered to the patient through a Rudolph valve which remains closed under the operating pressure of the system (about 1 cm of water) but freely opens when the patient breathes.

There has been a marked decrease in the tracheal uptake with the described modifications with good deposition in the lung parenthyma. This allows for improved detection of areas of abnormal turbulence such as areas of bronchial stenosis which cause abnormal deposition of aerosol and more clear delineation of parenchymal areas not receiving the aerosol.

These inexpensive and easily fabricated modifications (baffle and heat chamber) to an otherwise standard ultrasonic nebulizer greatly improve the technical quality of aerosol inhalation scans and thus permit more accurate interpretation of abnormalities caused by diseased areas.

Documenting Procedures Done by a Nuclear Medicine Technician Using an Illustrated Task Description BY DEBORAH PERKINS AND JOHN CADLE, Technical Education Research Centers, Inc., Cambridge, Mass.

In the process of developing instructional materials, we have followed a number of steps. After doing a field survey and a job family description, we began a task enumeration of all those technical tasks performed by a nuclear medicine technician on the job. After this analysis, an initial task description was begun.

These task descriptions will be illustrated by a descriptive photograph taken for each step of a step-by-step procedure for doing the individual tasks. The decision to use a loose leaf folder format was based on its effectiveness in facilitating the collection of numerous task descriptions for the anthology. In this way, new procedures could be added and old procedures removed whenever necessary. For areas such as radiochemistry and radiopharmacy, this would be very valuable due to the constant advancement of techniques. Most tasks would be described excluding those concerning nursing, secretarial, or administrative procedures. In deciding the sequence for development of such descriptions, we will use the feedback from the members of the field to decide priorities.

After discussing various ideas with members of the field, we will, wherever possible, try to incorporate theory with the task description. Thus we will have combined the hands-on activity with some theory in teaching the NMT.

We have developed some of these visual task descriptions. When all tasks have been described, we will then go on to evaluate the need for instructional materials in certain areas. These instructional materials, such as audio-visual modules, could then be developed from the existing visual task descriptions already available.

A Technique for Multiple Position Views in ^{133}Xe Ventilation Studies BY R. POLLACK AND J. GLICKSTEIN, John F. Kennedy Community Hospital, Edison, N.J.

The use of inhaled ^{133}Xe in lung scanning has been of value in evaluating decreased perfusion secondary to pulmonary embolism from decreased perfusion associated with impaired ventilation. To date, however, many investigators have used single views in the posterior positions or a single view which best corresponds to the perfusion deficit.

We have gone to performing four views on our ^{133}Xe ventilation studies for two reasons: (A) Because of the internal absorption and scattering due to the low-energy gamma ray of ^{133}Xe (85 keV), we felt that information was being lost in the single view procedure; (B) since we use xenon scanning in conjunction with the ^{131}I-MAA perfusion scan and we perform four views on the perfusion scan, we felt that the xenon scan should correlate with the same four views.

This requirement for four successive views during the ^{133}Xe ventilation study posed some complications in technique over the single view procedure.

A new technique was developed using our previous equipment for ^{133}Xe gas administration with some modification.

Our ^{133}Xe mobile administration cart was modified by the addition of a slightly longer and more flexible piece of tubing to permit patient movement during the procedure. A restraining headstrap was added to our anesthesia face mask to insure that no significant xenon leakage occurred during the movement required for patient repositioning. Because of the increased time during which the patient would be breathing the ^{133}Xe-oxygen mixture, the amount of tubing inside the cart was reduced, thereby minimizing dead space for accumulation of exhaled carbon dioxide.

Our method consists of having the patient sit in a swivel stool, facing the detector head, with his chest pressed firmly against it. An anesthesia face mask with head strap is placed on and is directly connected to our xenon administration cart. A 10-mCi patient dose of ^{133}Xe gas is administered by means of an injection gun technique directly into the tubing in front of the face mask. At this moment, the patient is also told to take a deep breath and hold it. This brings up the oxygen from a 5-liter breathing bag and achieves an instant high concentration of ^{133}Xe gas in the lungs. From this point on, the entire study is recorded on videotape and selective 10-sec exposures are made on a rapid sequencing 70-mm camera. After the initial breath holding, the patient is told to breathe to equilibrium and some additional pictures are taken in the anterior position. The patient is then pivoted 90 deg left to provide one lateral and 90 deg right to provide the other. One 10-sec exposure is taken in each of these positions. Finally, he is pivoted 180 deg to the posterior position where an additional picture is obtained and the washout sequence begun. The patient then breathes through a J valve, inhaling room air and exhaling the ^{133}Xe gas-air mixture into a closed bag. During the washout sequence, 10-sec exposures are taken at 15-sec intervals until all the xenon is visually cleared from the lungs. The entire procedure takes no more than 20 min from setup to processed film.

It should be pointed out, that this technique works well with patients able to cooperate and assume the erect position. Patients with dyspnea, extreme weakness, or dizziness may not be able to undergo this procedure.

To date, over 25 cases have been done using this method and we have experienced no significant difficulty in obtaining the required four views.

Where it is felt that multiple views will enhance the diagnostic capability of ^{133}Xe ventilation studies, a technique has been devised whereby these four

views can be obtained rapidly and efficiently on cooperative patients in a single procedure.

Radioaerosol Inhalation Lung Scanning BY ROSS POTTER, L. A. SWANSON, JOANNE BROTHERTON, AND KATHLEEN SUYENAGA, Hospital of the Good Samaritan, Los Angeles, Calif.

Radioaerosol inhalation lung scanning provides information relating to pulmonary airway patency and aids in interpretation of perfusion lung scans. In contrast to ^{133}Xe ventilation lung studies, the radioaerosol inhalation lung scan does not require scintillation cameras or other rapid imaging devices.

The procedure is rapid, safe, and aside from the cost of nebulizing equipment, requires no major capital outlay. It can be performed with radiopharmaceuticals normally found in the nuclear medicine department. Technetium-99m-albuminate or sulfide colloid are probably most commonly used although a variety of other agents can be employed.

Compared to ^{133}Xe ventilation studies, the radioaerosol inhalation lung scan has several advantages and disadvantages. Multiple views can be obtained following a single inhalation of the aerosol. The aerosol scan is probably more sensitive to partial bronchial obstruction since it is easier to see "hot" spots than areas of slightly decreased xenon gas. The low energy of ^{133}Xe is not ideal for imaging. Disadvantages of the aerosol scan include the fact that the procedure is not as physiologic as xenon gas and the results in abnormal patients are not adaptable to quantitation. In addition, the aerosol may accumulate in the pharynx, trachea, and stomach.

This paper will discuss the equipment and supplies necessary to perform the study, the practical methodology of its performance, and a review of the scans themselves. No attempt will be made to interpret the scans or to correlate results, but rather, the emphasis will be placed on the technical aspects of the study and its performance.

Radioimmunoassay, Key Method in Endocrinology BY LEA RENERTS AND SAUL GENUTH, The Mount Sinai Hospital, Cleveland, Oh.

In order to understand completely the physiological role played by a hormone and the factors regulating its secretion, it is necessary to measure the hormone in blood or urine. Bioassays and previous immunological techniques based on antigen-antibody reaction supplied valuable information but lacked sensitivity, specificity, and precision. The introduction of radioimmunoassays offers the endocrinologist a highly sensitive and generally specific system for the measurement of protein and polypeptide hormones. The principle involves the competition of unlabeled and labeled (radioiodinated) hormone for a specific antibody. Following an incubation period, separation of the tracer hormone bound to antibody from that remaining free is accomplished and the radioactivity present in one or both fractions determined. The decreased binding of the tracer hormone to the antibody in the presence of known increasing amounts of unlabeled hormone forms the basis for a standard curve to which unknown plasma, urine, or tissue samples are referred.

The methodology of tracer purification by gel filtration, and separation by a double antibody procedure will be reviewed. Diverse applications of radioimmunoassay of insulin, growth hormone, and parathyroid hormone will be presented to illustrate the value of the procedure in demonstrating endocrine pathophysiology.

1. Diurnal plasma insulin levels in normal, obese, thin diabetic, and obese diabetic subjects clearly demonstrate their differing patterns of insulin secretion. Hypersecretion is noted in the obese subject, hyposecretion in the thin diabetic, and an intermediate pattern in the obese diabetic.
2. Growth hormone responses to arginine, insulin glucose, and 1-dopa demonstrate deficiency in hypopituitarism and autonomy of excessive secretion in acromegaly.
3. Plasma parathormone responses to infused calcium differentiate primary from secondary hyperparathyroidism. Parathormone levels fall in the latter case but remain elevated in the former.
4. Measurement of parathormone in samples obtained from various sites in the neck by catheter localize the offending parathyroid gland.

It is hoped these illustrations will stimulate more widespread appreciation of the value of radioimmunoassay.

Effect of Corticosteroid Therapy on ^{51}Cr Tagging of Red Blood Cells BY SHARON D. RIDLEY, Tucson Medical Center, Tucson, Ariz.

Difficulty has been experienced in tagging in vitro the red cells of patients receiving corticosteroids, a common medication in hematological disorders. It has been suggested that this results from a direct effect of steroids on the tagging process.

Using the standard ACD washed red-cell technique, red cells were tagged with hexavalent ^{51}Cr. By comparing counts before and after two washes, the efficiency of tagging was determined on the blood of control patients, blood to which corticosteroids

had been added in vitro, and blood of patients receiving corticosteroid therapy. Mechanisms for ^{51}Cr tagging, as related to this effect, are discussed.

Cerebro Spinal Fluid Dynamics in Normal Pressure Hydrocephalus BY H. ROJEK, R. ROMERO, L. Y. YAMAMOTO, AND W. FEINDEL, Montreal Neurological Institute, Montreal, Canada.

Normal pressure hydrocephalus has been recently recognized. Pathophysiology of the disease is not at present time well documented. The intrathecal radioisotope encephalography is found to be the most useful information for the diagnoses of the disease. It has been known that some of the other neurological disorders, such as generalized cerebral atrophy and presenile dimentia, show similar pattern of radioisotope intrathecal encephalographic results as the normal pressure hydrocephalus. The visualization of spatial distribution of the tracer in the cerebrospinal fluid compartments was found to be inadequate to differentiate this problem and it is necessary to obtain additional information to solve this problem.

In order to investigate the dynamics in relation to the absorption of the tracer from various compartments following the intrathecal injection of the tracer, we have examined the dynamic behavior of radioactivity in ventricular system, parasagittal subarachnoid space as well as the blood radioactivity.

Since this study requires up to 72 hr following the intrathecal injection of radioisotope, the long half-life radiopharmaceutical, ^{131}I-labeled human serum albumin, was used. High specific activity $^{131}IHSA$ was administered intrathecally into the lower lumbar subarachnoid space. Using Picker Dynacamera, serial scintiphotos were taken up to 72 hr after injection of the tracer. Simultaneously, the information was stored on the videotape, using Sony videotape recorder. The radioactivity of serial blood samples was measured in a well scintillation counter.

The videotape stored information was played back and reviewed. A fixed volume of the selected area in ventricular system and parasagittal areas were chosen for each case and the amount of radioactivity in these compartments and the percent changes in each compartment as a function of time were studied.

Relationship of the uptake turnover rate in each compartment in every case was examined. The results of these findings will be discussed.

^{133}Xe Ventilation and Perfusion Scintiphotography in Infants BY VINCENT SGROI, University Hospital, San Diego, Calif.

During the past 5 years, ^{133}Xe $\dot{V}/\dot{Q}$ scanning techniques have played an important role in more clearly defining the pathophysiology of pulmonary disorders. Because the technique is simple and noninvasive, it is suited for the functional evaluation of the pediatric age group.

When presented with pulmonary disease the pediatrician has been limited in the number of methods available to assess pulmonary function. The routine roentgenogram outlines the anatomical features of the lung; however, it fails to indicate regional function. Furthermore, standard pulmonary function tests require cooperation not available in children.

This paper is concerned with the methodology used in performing ^{133}Xe $\dot{V}/\dot{Q}$ scans on infants. Three infants proposed for pulmonary resection were studied by this technique to provide functional data. Due to their size and lack of cooperation, a modified system for ventilation was employed. The design and problems encountered in the use of this system will be discussed .In addition, the physiologic information obtained from these studies will be presented.

Patient Positioning for Hepatic Scintiphotography BY S. J. SWANN, C. L. BOYCE, V. M. HARDIN, A. E. JONES, AND G. S. JOHNSTON, National Institutes of Health, Bethesda, Md.

Variations in patient positioning for liver imaging with the gamma camera can produce apparent differences in that organ's location, lobe size, shape, and in labeling characteristics. These variations may be a problem in scintiphoto interpretation unless their cause is recognized. On the other hand, they can be an aid in the diagnosis of hepatic fibrosis and in defining liver defects.

Patients with suspected liver disease were studied 15 min following intravenous injection of 1.5 mCi of ^{99m}Tc-sulfur colloid. Initially, anterior, posterior, and both lateral images were obtained with the patient reclining. The patient then either stood or sat up and these four views were repeated.

Comparison of the scintiphotos obtained with the patient recumbent and upright showed differences in every instance which varied from slight to marked. Patients without liver disease demonstrated the greatest variation in liver shape and apparent size. Those with widespread liver disease had the least amount of variation. Space-occupying lesions were better delineated with the upright than with the recumbent liver views.

Since the liver is normally a relatively pliable organ, it is reasonable to expect variations in size, shape, and location with changes in body positioning. Most experience with liver imaging has been acquired with the patient supine; therefore, the appearance of views obtained in an upright position may be confusing. The left hepatic lobe is usually

small and triangular in the supine position. Changing to the upright position alters the normal appearance of the left lobe to a larger, more lobular structure often associated with hepatic disease. Apparently this is because the normal left lobe tends to sag in the upright position and to contract upon itself in the supine position. In the presence of congestion, edema, fibrosis, or extensive tumor involvement, the left lobe remains abnormally extended in the supine position and does not change with the patient in the upright position. In addition, liver space-occupying defects are frequently more clearly seen in upright than in reclining views, possibly because the surrounding, relatively normal, flexible liver tends to fall away from a rigid area of tumor involvement.

These studies suggest that hepatic imaging should be performed in a standard way with the patient recumbent. However, in the presence of suspected abnormality, upright views should be obtained, preferably with the patient standing, to confirm the impression of abnormal liver rigidity.

Experimental Animal Scintigraphy BY SYBIL J. SWANN, A. ERIC JONES, AND GERALD S. JOHNSTON, National Institutes of Health, Bethesda, Md.

The small size of experimental animals frequently results in scintigraphic images too small for accurate interpretation. Comparative organ imaging of rhesus monkeys was performed using a rectilinear scanner and a gamma scintillation camera to select the most applicable among several imaging methods. Approximately 50 imaging studies were obtained including $^{99m}TcO_4^-$ brain, ^{99m}Tc-sulfur colloid liver, and ^{67}Ga-citrate whole-body images.

A 5-in. detector crystal with either a low-energy or medium-energy focused collimator was used for rectilinear views. For scintillation camera imaging, either a 4,000 parallel-hole, low-energy collimator or a pinhole collimator with low-energy insert was used.

Although rectilinear scans were superior to parallel-hole collimator camera studies, both of these techniques provided images that were too small for meaningful interpretation. The best images were obtained with the pinhole collimator and the scintillation camera. This latter technique provided adequate resolution for defining the supraorbital ridges and transverse sinuses when the head of the rhesus monkey was placed 2 cm from the pinhole. This position adjusted the image so as to occupy most of the crystal surface thereby providing a presentation comparable in size to an adult human. Cerebral blood-flow distribution studies are possible and provide detail comparable to human studies.

The combination of pinhole collimator and gamma scintillation camera provides high-resolution images with magnification of the subject and permits the addition of dynamic flow studies in experimental animals. The method could be adapted to pediatric scintigraphy.

Transmission-Emission Imaging in Heart and Mediastinal Disease BY SYBIL J. SWANN, A. ERIC JONES, AND GERALD S. JOHNSTON, National Institutes of Health, Bethesda, Md.

Transmission imaging of the mediastinal region was combined with emission heart-blood pool scintiphotography to enhance diagnostic information in a variety of mediastinal abnormalities. A transmission image of the mediastinum and cardiac shadow was simply and reliably obtained employing a disk with a 16-in. diam × ¼-in. i.d. containing 20–30 mCi of $^{99m}TcO_4^-$. The disk, covered by a 4,000-hole, low-energy collimator, was placed on the imaging table beneath the patient for the 120 sec required to obtain the 300,000-count image. Sealed source markers containing ^{57}Co were placed over the xyphoid and suprasternal notch to aid in orientation. The collimator disk was then removed and the mediastinal blood pool was imaged using 2 mCi of ^{99m}Tc human serum albumin administered intravenously. The two studies are recorded separately and then superimposed for comparison. Four illustrative cases are presented to show the appearance of cardiac dilatation, pericardial effusion, hemopericardium, and bronchogenic carcinoma. This technique has provided an excellent substitute for the chest x-ray as a transmission image with which to compare chest blood-pool emission images. It is applicable with images obtained on 11 × 14-in. x-ray film or with polaroid or 35-mm transparencies. The routine use of transmission radionuclide imaging is recommended as an adjunct to mediastinal scintiphotography.

Evaluation of the Effective Thyroxin Ratio (ETR) Test BY K. VANAGS, B. KOVALESKI, AND J. FRANCO, O'Connor Hospital Medical Center, San Jose, Calif.

Over the past few years a number of in vitro tests have been advocated as the ultimate thyroid function test. Our practice has been to evaluate such tests by comparison with our thyroid workup.

Our thyroid workup consists of a brief thyroid oriented history, clinical evaluation by the Nuclear Medicine physician, a 24-hr ^{131}I uptake, T_3 and T_4 by competitive binding.

The ETR test is an ingenious combination of the T_3 and T_4 wherein the patient's serum T_4 concentration is determined and expressed as a fraction of the serum T_4 concentration determined in normal control serum. The ratio so obtained is supposed to provide a precise measure of thyroid status irrespective of serum binding protein concentration. The manufacturer's directions need to be followed completely in order to obtain consistent results. At the end of the procedure the counts per minute remaining in each solution vial are determined. The counts per minute in the patient's solution vial are divided into counts per minute in the standard serum solution vial to obtain the effective thyroxin ratio. Euthyroid values are reported to be between 0.86 and 1.13. Hypothyroid levels are less than 0.86 and hyperthyroid values are greater than 1.13. A number of points require special attention. One is the rotation speed. We compared different rotators and found that it didn't make much difference in the final count which rotator one used but a more important variable was the handling of the standard serum which is supplied in dry form. To this serum one adds 2.0 ml of distilled water. Mixing has to be gentle as vigorous shaking will give rise to erroneous results.

In order to evaluate the performance of this new test we simply added it to our thyroid workup. Eighty-eight patients were so studied. Clinical diagnoses were as follows: 7 hypothyroid, 3 hyperthyroid, 1 early hyperthyroidism, and 77 euthyroid patients. The ETR values were in the hypothyroid range in each of the seven hypothyroid patients. The three patients with clinical hyperthyroidism were easily identified by all four tests including the ETR. In the group of 77 euthyroid patients, 3 had ETR values above 1.13. One other patient suspected of having early hyperthyroidism had borderline high values for the 24-hr uptake which did not suppress after triiodothyronine administration. In this patient the ETR was in the normal range. Two of three patients who were on Synthroid (R) replacement therapy had elevated ETR values. The sera of 3 of 23 pregnant patients referred for T_3, T_4 and ETR gave values below 0.86 for the ETR. From this limited experience it would appear that the ETR test is probably superior to the isolated T_3 or T_4 determination.

It may however give misleading results in a number of cases. For this reason a patient whose ETR test is abnormal probably should have a thyroid workup; in cases of clinically suspected hypothyroidism or hyperthyroidism the ETR by itself might not be enough to exclude such diagnostic possibility. On the other hand, routine testing of the patient who is thought to be euthyroid could probably easily be done by the ETR test alone.