Is the Venous Hematocrit Proportional to the Total Circulation Hematocrit?

OSCAR KANNER AND EDGAR A. HINES, JR. (Laboratory and Radioisotope Services, Veterans Administration Hospital, Oteen, North Carolina).

This investigation deals with the ratio of the total circulation hematocrit to the venous hematocrit. Knowledge of this ratio is important for blood volume determinations with one label only. The results support the following:

1. The data regarding the hematocrit ratio found in previous literature do not permit a distinction between experimental error and individual variation.
2. Improved methods and application of the calculus of errors show that real individual differences commonly exist.
3. Rapid changes of the hematocrit ratio may occur in one and the same individual and can be induced by postural changes and by electro-shock. These changes are due to redistribution of the circulating blood between large and small vessels.
4. Theoretical considerations make it certain that if the hematocrit ratio is constant the plasmatocrit ratio must be variable, dependent on the hematocrit, and vice versa. None is privileged over the other and therefore it shouldn't be assumed that either is constant.
5. The experimental work on which the foregoing conclusions are based led to technical improvements and to a simplified method of blood volume determination with increased precision and accuracy.

Cardiovascular Effects Following Gamma Irradiation of the Heart

V. S. BISHOP AND H. L. STONE (Department of Physiology and Biophysics, University of Mississippi Medical Center, Jackson).

Either the right or left ventricle in 9 closed chest dogs were exposed to 20,000 R of Co-60. Measurements of right and left atrial pressures, arterial pressure, pulse rate, body weight and blood volume were made before and after irradiation. The right and left atrial pressures rose progressively until death in 3 animals irradiated on the right side. In 6 animals irradiated on the left side, the left atrial pressure rose progressively, but the right atrial pressures either did not rise or rose only during the latter stage of heart failure. In both groups a declining arterial pressure and an increasing pulse rate were observed in the terminal stages. An increase in blood volume was observed particularly in the animals irradiated on the left side. The pathological report showed 70 per cent—100 per cent of the right ventricle muscle was damaged in dogs irradiated on the right side and 40 per cent—70 per cent of the left ventricle in dogs irradiated on the left side.

In another group of dogs in which the right ventricle was exposed, cardiac output was determined by chronically implanted electromagnetic flow probes. The resting cardiac output was found to be relatively constant until 4 days before death when a rapid decline was observed. Thus, although the heart muscle was known to be damaged, the resting cardiac output remained almost normal. In another instance several animals were exercised before and following irradiation to the right ventricle. Right and left atrial pressures and cardiac output were measured continually during the exercise. Only a slight decline in the ability of the animals to exercise was observed until just prior to death.

Ventricular Function in Conscious Animals Following Heart Irradiation

H. L. STONE, V. S. BISHOP, AND A. C. GUYTON (Department of Physiology and Biophysics, University of Mississippi Medical Center, Jackson).

The evaluation of the pumping ability of the heart can best be determined with ventricular function curves. This means that if the atrial pressure was raised the cardiac output would

also increase. If this rise in cardiac output were plotted against increasing atrial pressure, a curve could be obtained having a definite plateau. This plateau represents the maximum pumping ability of the heart. Ventricular function curves were obtained in conscious mongrel dogs before and after 20,000 R Co-60 irradiation to the right heart. Arterial, right atrial, and left atrial pressures were recorded simultaneously as well as cardiac output and heart rate. Atrial pressures were elevated by infusion of Tyrode's solution into the left jugular vein. Cardiac output was recorded utilizing a sine wave electromagnetic flow probe chronically implanted around either the root of the aorta or the pulmonary artery.

Repeated ventricular function curves were obtained in the normal animals prior to irradiation. The average cardiac output at the plateau of the function curves was found to be 340 cc/min/kg body weight ($\pm$ 20 cc/min/kg standard error of the mean). The plateau level remained approximately normal for seven days post-irradiation. At this time a continuing reduction in the plateau occurred, until the death of the animals approximately 27 days post irradiation. The plateau value was an average of 60 per cent of normal prior to death. The resting cardiac output remained normal until a few day prior to death, but the maximum ventricular function began to decline 7-12 days following irradiation indicating that the pumping ability of the heart was decreased even though the resting state was maintained.
[1]Supported by grants-in-aid from A. E. C. and N. I. H.

Radioactive Pharmaceuticals **HENRY N. WAGNER, JR. (Johns Hopkins Hospital, Baltimore).**

Diagnostic radiopharmaceuticals are administered to provide information rather than to induce pharmacologic response. Therefore one cannot translate pharmacologic principles established for stable compounds directly to radioactive compounds. Radiation detection instruments must be sensitive enough to yield statistically significant data with small doses of radiopharmaceuticals. Radionuclides with a rapid rate of physical decay are preferred, although, if a radioactive material is excreted rapidly and completely, the exposure to radiation may be low despite long physical half-life. It is important to use radioactive isotopes with no beta radiations, or with low energy beta radiations. Because scintillation detectors which effectively measure only gamma radiation are most often used, beta radiation contributes to radiation dosage but provides no data. Special pharmaceutical problems associated with radiopharmaceuticals are: (1) problems of carrier-free state, *i.e.*, those arising because of the extremely small chemical quantities; (2) problems of self-decomposition, produced by the effect of radiation on the compound itself or on its solvent; (3) problems resulting from isotope effect *i.e.*, difference in reaction rates that sometimes result from differences in atomic weight of isotopes; and (4) problems resulting from chemical differences between labelled and naturally occurring compounds.

New radiopharmaceuticals include the use of I^{125} for thyroid scanning, aggregated albumin for liver scanning, mercuri-hydroxypropane for spleen scanning, technetium 99m pertechnetate for brain scanning, strontium-87m and fluorine-18 for bone scanning, and macroaggregated albumin for lung scanning. The use of C-14 labelled compounds in human beings is increasing and radioactive gases, particularly xenon-133, are now in use in many institutions.

Basic Considerations in Calculating Permissible Exposure Levels **KARL Z. MORGAN, Oak Ridge National Laboratory, Oak Ridge, Tennessee.**

Calculation of the internal doses from internally administered radionuclides are based upon certain basic assumptions. Such parameters as Relative Biological Effectiveness, Relative Damage Factor, Build-up, Effective Energy, Effective Half-Life and the standard man will be discussed.

Radiation Dose Considerations in Clinical Practice **HENRY N. WAGNER, JR., The Johns Hopkins Hospital, Baltimore, Maryland.**

When radionuclides are employed in clinical applications the optimal quantities of the doses administered may be affected by selective concentration of the radioactive material in certain tissues, the sensitivity of critical tissues to radiation damage, and the life time of the material in various locations in the body as well as the characteristics of the radiation instruments used in diagnostic scanning or other measurements. Those problems peculiar to clinical uses of radionuclides will be discussed.

The Determination of Average "Beta Ray" Energies and Gamma-Ray Dose Parameters in Electron Capture Processes. **C. C. HARRIS (Oak Ridge National Laboratory, Oak Ridge, Tennessee).**

To accurately determine the radiation dose due to the radiations from those radionuclides which decay by electron capture and subsequent gamma-ray emission (isomeric decay) requires a strict accounting procedure taking into account x-ray transition probabilities, fluorescent yields, electron capture probabilities and other considerations. Some values of radiation dose parameters now in print appear to be in error; some are not established to a degree of certainty that is desirable. A direct approach to the determination of radiation dose constants will be presented.

Pitfalls in Brain Scanning **W. LAMAR HARRELL, JOSEPH L. IZENSTARK, AND H. S. WEENS (Department of Radiology, Grady Memorial Hospital and Emory University School of Medicine, Atlanta).**

In recent years brain scanning has caught the physician and lay public's imagination. It offers a new screening method for the detection of cerebral and cerebellar lesions. Several reports have attested to the usefullness of the brain scan. Inasmuch as this procedure has found widespread application, it is important to be aware of the potential errors. This paper reviews our experience with selected cases and illustrates common and unusual errors in brain scanning.

Analysis of Mercury Brain Scan Patterns **C. H. SMITH, J. BRYLSKI, AND J. L. IZENSTARK (Departments of Radiology and Neurology, Grady Memorial Hospital and Emory University School of Medicine, Atlanta).**

Mercury brain scanning is frequently employed as a screening procedure for brain pathology. Retrospective and prospective review of our first 200 scans is presented. Evaluation seeking to relate accuracy of interpretation by examiners at various levels of experience is considered. Correlation with other diagnostic central nervous system studies and pathological finding is presented. Patterns of tumors and vascular lesions are analyzed.

Brain Scanning in Non-neoplastic Intracranial Lesions **ALBERT J. GILSON (Division of Nuclear Medicine, University of Miami School of Medicine, Miami).**

Scanning is an important modality in the evaluation of patients with cranial-cerebral trauma. Its usefulness in the diagnosis of cerebral neoplasia has gained wide acceptance. However, the potential value of this procedure has not been fully exploited in the mass screening of patients sustaining trauma to the head. The systematic use of routine brain scanning in our clinic has been of major importance in detecting intracranial lesions of non-neoplastic etiology. A series of representative scans demonstrating the classic findings portrayed by brain scanning in lesions of non-neoplastic origin will be presented.

A Comparison of Mercury^{197} and Mercury^{203} Chlormerodrin in Clinical Brain Scanning MARVIN C. OVERTON, III, WILLIAM K. OTTE, LUCAS B. BEENTJES, AND THOMAS P. HAYNIE (Department of Neurosurgery, Nuclear Medicine Service, and Department of Radiology, University of Texas Medical Center, Galveston).

During the past two years, we have employed Hg^{203} and Hg^{197} chlormerodrin in an active brain scanning program. The results of this clinical experience have been analyzed in an effort to determine if results are comparable with these two agents. The overall rate of positivity in neoplastic lesions revealed very little difference between Hg^{203} (82%) and Hg^{197} (88%). In non-neoplastic lesions, results with Hg^{197} (75% positive) appeared superior to Hg^{203} (50% positive) but the cause of this discrepancy is not clear at the present time. We have observed some attentuation of the softer gamma ray of Hg^{197} in some instances where the tumor is distant from the detector, but have not found this to constitute a major problem in clinical practice.

We agree that the search for better and safer brain scanning agents should continue. Hopefully, new agents will offer practical as well as theoretical advantages. Hg^{197} chlormerodrin in our experience has given results comparable to those obtained with Hg^{203} chlormerodrin with the advantage of a lower radiation dose to the patient.

The Digital Autofluoroscope MERRILL A. BENDER AND MONTE BLAU (Department of Nuclear Medicine, Roswell Park Memorial Institute, Buffalo, New York).

The detector of the digital autofluoroscope consists of 260, 2 inch thick, ¾ inch diameter NaI (Tl) crystals packed in 20 files and 13 ranks in a 6 × 9 inch array. Each of the 260 crystals is optically coupled to two plexiglas light pipes with the 20 light pipes from a given rank going to one phototube and the 13 light pipes from a given file going to another phototube. A pair of pulses occurring simultaneously in a rank phototube and a file phototube uniquely identifies the crystal in which an interaction occurres. Increased resolution and efficiency results as the position signal derived from the phototube array is independent of pulse height and anticoincidence circuits reject those simultaneous pulses arising from a Compton interaction followed by the absorption of the scattered radiation in an adjacent crystal.

The digital nature of the light pipe system permits the use of magnetic core storage with subsequent non-destructive continuous readout on a full size CRT and numerical printout for quantitative compartmental analysis.

I. H.S.A.—Studies of Rheumatoid Knees* WILLIAM S. MAXFIELD, THOMAS E. WEISS, PAUL J. MURISON, AND JOHN U. HIDALGO (Ochsner Clinic, Radiology Department, New Orleans).

The study of normals and of patients with rheumatoid arthritis by external counting and by scanning demonstrates that following an intravenous injection of I.*H.S.A. there is an increased localization of the I.*H.S.A. in the rheumatoid joint. The I.*H.S.A. dose employed is 25μc / 10 lbs. of body weight after first blocking the thyroid with Lugol's solution.

The pattern of I.*H.S.A. localization in the knee joint is checked relative to time by external counting at from 1 to 72 hrs. In the normal patient these curves show a different pattern between the counts over the knee joint and counts over the thigh taken as a control for I.*H.S.A. Activity in the vascular bed and in the soft tissue. Counts over rheumatoid knees have a pattern similar to that of the normal knee but the count rate is greater. The degree of I.*H.S.A. localization appears to correlate with the patient's symptoms and with the clinical assessment of the activity of the rheumatoid process in the joint.

The distribution of I.*H.S.A. scans show that in the rheumatoid knee there may be either a diffuse localization of fairly uniform activity or a pattern of definite hot and cold areas.

Evaluation of the localization pattern of I.*H.S.A. in other types of arthritis is in progress. The application of other tracer materials is also being investigated.

A Collimator for Scanning with Low-energy Photons C. C. Harris, J. C. Jordan, M. M. Satterfield, and J. K. Goodrich (Oak Ridge National Laboratory, Oak Ridge, and University of Mississippi Medical Center, Jackson).

Collimators furnished with commercial scanners are usually designed for the 280-410 kev energy range, and have unnecessarily low transmission when used for gamma rays from 25 to 80 kev. In addition, their spatial resolutions are poor compared to that easily obtainable at very low energies.

To obtain improved performance at 30 kev with a commercial scanner, we devised a high transmission collimator made by assembling tubes of lead foil. The tapered hexagonal tubes were made by forming 0.005 inch lead foil around a mold pin for a 61-hole 3 inch collimator. These were then glued together to make a collimator of approximately 110 holes.

Laboratory testing of this collimator using point and phantom sources of iodine-125 indicate resolution similar to that of a 61-hole collimator, but with about twice the geometrical counting efficiency.

Since the collimator, made for adapting an existing scanner to low-energy studies, was unnecessarily long, it was also tested on mercury-197 (67-78 kev). The results indicate satisfactory clinical use with this nuclide.

The quickly-devised construction technique requires a minimum of equipment, and should lend itself to other special experimental collimator designs.

Clinical Applications of Low Energy-High Transmission Collimator Jack K. Goodrich, H. L. Stone, Rebecca W. Hill, and C. C. Harris (University of Mississippi Medical Center, Jackson, Division of Biodynamics, Brooks Air Force Base, Texas, and Oak Ridge National Laboratory, Oak Ridge).

In recent years a definite trend toward in vivo use of low energy emitting nuclides has developed. This has been stimulated by the long recognized need to reduce radiation dose to whole body and target organ. While reducing this radiation dose the low energy emitters have raised new problems of measuring and recording. This came to focus when Cs^{131} Acetate was proposed for myocardial scanning. An endeavor to scan the dog heart using Cs^{131} and standard scanning instrumentation was made only to find that the 19 hole collimator, while giving excellent count rates, yielded no usable image patterns. The 37 hole collimator gave a more desir-image presentation but reduced counting rates to marginal levels. To reach some solution to this dilemma a thin lead foil multi hex holed collimator was produced at ORNL and applied to our standard scanning detector. Early results of scanning the dog myocardium with this modification were gratifying, and human applications are being explored.

The collimator has an added feature of being satisfactorily adapted to scanning the low energy nuclide, Hg^{197} in brain and kidney.

Localization of S^{35} Labeled Sulfanilic Acids of Fluorene in Tumors Francis E. Ray and Krishna C. Agrawal (J. Hillis Miller Health Center, University of Florida, Department of Pharmaceutical Chemistry, Gainesville).

In previous reports we have described the preparation and localization in tumors of radioactive sulfonic acids and sulfonamide derivatives of fluorene. If a compound were obtained that concentrated in tumor tissue to a considerably greater extent than in the vital organs it might be valuable as a diagnostic or therapeutic agent.

In an effort to improve the differential between tumor and normal tissue we have now inserted amino groups into the fluorene nucleus and followed this by sulfonation with S^{35} sulfuric acid. The first compound of this series to be prepared was sodium 2-acetylamino-7-sulfonate-S^{35}. Each tumor-bearing CAF-Jax mouse was injected IP with 0.5 ml containing 5 mg of compound of specific activity 1μc/mg. After varying time intervals the animals were sacrificed and the radioactivity determined in the blood, urine and organs. In passing from 6 hours to 9 hours some decrease in concentration of radioactivity was found in blood, kidney, and

liver; while some increases were found in spleen, stomach and tumor. The ratios of concentration (tumor/organ) were favorable except in liver and GI tract.

At the end of 16 hours the ratio was favorable in all cases. At 40 hours the ratios showed further improvement. This indicates that the compound is eliminated less readily from the tumor than from the vital organs. An interesting feature was the appearance of considerable radioactivity in the stomach despite IP administration and the acidic nature of the substance.

The next step was to insert two amino groups into the fluorene molecule, followed by an S-35 sulfonic acid group. This was a decided improvement. At 8 hours all ratios were favorable: liver, 4.67; kidney, 3.90; spleen, 9.66; muscle, 18.30; blood, 4.61; stomach, 2.52. Here again we are at a loss to account for the considerable amount appearing in the stomach.

Radiation Effects on Tissue Uptake and Protein Incorporation of C^{14}-UL-L-Leucine in the Rat AARON P. SANDERS, GEORGE J. BAYLIN, AND P. J. CAVANAUGH (Radioisotope Laboratory, Department of Radiology, and Radiotherapy Division, Duke University Medical Center, Durham, North Carolina).

The relative response of radiosensitive vs. radioresistant tissue to ionizing radiation is not clearly defined at the cell level. In an effort to delineate possible differences in response to ionizing radiations which occur at the cell level, the present study was initiated. Male Sprague Dawley rats (160-210 grams) were used in all experiments. Normal animals and animals exposed to 1500 r (280 KVP, 1.44mm HVL) whole body irradiation were used in the study. The tissue uptake and protein incorporation of C^{14}-UL-L-Leucine was studied in the controls and in the irradiated animals 3 hrs., 24 hrs., 48 hrs. and 72 hrs. post irradiation. Brain, liver, kidney, spleen and small bowel mucosa were studied.

Two microcuries of C^{14}-UL-L-Leucine (1 micromole were injected into the tail vein of each animal and a 45 minutes incubation period used prior to sacrificing the animal. All tissues were rapidly removed and homogenized in ice cold distilled water. Total tissue C^{14} content per gram of tissue was determined for each tissue. Protein-C^{14}-content per gram of tissue for each tissue was determined by a modified method of Mans and Novelli. The filter paper samples thus obtained were counted in a toluene liquid scintillation mixture in a Packard-tricarb liquid scintillation counter.

The response of each tissue to the whole body irradiation as indicated by changes in tissue uptake and protein incorporation of the C^{14}-UL-L-Leucine is recorded as a function of time post irradiation.

Studies on Retention and Distribution of Diagnostic and Therapeutic Doses of Iodine-131 in Patients with Thyroid Carcinoma FELIX J. PIRCHER AND THOMAS BUFFALO (Duke University Medical Center, Durham, North Carolina).

Metastatic well differentiated thyroid carcinoma has been treated now for over a decade with iodine-131. The doses for a full course of treatment have ranged from 50 to 1,000 millicuries. The dosimetry is purely empirical and few investigators have attempted to determine the doses absorbed by target tissue. Tracer studies are primarily used for the detection and localization of metastases and few attempts have been made to measure directly uptake and effective half-time in these metastases. Furthermore some investigators have presented evidence that the distribution of therapeutic doses may differ from that of diagnostic doses. It seemed desirable to attempt to improve the situation and try to measure uptake and effective half-time in diagnostic studies and to measure absorbed doses in treatments. Since the absorbed dose is a product of energy, concentration and time and since the energy for iodine-131 is known, our efforts were directed towards the development of methods of measuring in vivo the distribution of iodine-131 in patients with thyroid carcinoma. Our experience with the Orins Linear Scanner, designed by Brucer and Ross, suggested that the distribution of the radioisotope may be measured in vivo by moving the patient at a constant speed through a vertical and transverse plane of uniform response divided into individual channels of de-

tection. This was achieved in the whole body scanner described previously (Design and Properties of the Duke Whole Body Scanner and Counter. Presented at the National Meeting of the Society of Nuclear Medicine in 1964 in Berkeley, California.) The instrument uses 10 collimated detectors arranged in 5 channels of detection. The counts are recorded by a typewriter and on tape punch for an average of 100 cross-sections with 5 six digit counts in each. The typewritten data are used for immediate inspection and for the determination of the maximum count. The tape punch record is converted into punch cards which are used for computer analysis to give contour plots in 40 steps of the maximum count. We have so far studied 16 patients with thyroid carcinoma. The majority of them had well differentiated carcinoma. Unfortunately only a minority of the patients had a total thyroidectomy. Most of the patients had diagnostic and therapeutic doses ranging from 500 to 1,000 microcuries and from 100 to 200 millicuries respectively. Several patients had repeated studies. The patients were scanned 2-3 times in regular intervals on the first day after the oral administration of the diagnostic or therapeutic dose in order to determine the value of the administered dose in terms of whole body counts. The whole body retention was determined by repeated examinations at proper time intervals. Areas of concentrations were measured in per cent of the administered dose and the effective half-time determined through repeated examinations. A preliminary review of the results indicate that there is substantial variation in distribution from patient to patient depending upon the amount of residual thyroid tissue and on other factors; some variation in distribution between diagnostic and therapeutic doses; and appreciable high doses to nontarget tissue.

The Use of Spatial Integration in Liver Photoscanning ARTHUR F. DRATZ AND JAMES C. COBERLY (Radioisotope Service, Veterans Administration Hospital, Atlanta).

Using an organ phantom system in evaluating the performance of a recently acquired commercial analog-type photoscanner, we have attempted to determine the optimum instrument parameters for liver scanning at low counting rates. Our experience has convinced us that there is a definite need for additional and specific emphasis on the importance of dot size and shape in photoscanning.

We use a constant total scanning time of 38 minutes per 70 square inch area. Film saturation is avoided and minimal background erase is employed to insure that the maximum amount of useful data is recorded on the scan. Any desired degree of contrast enhancement can be obtained subsequently on Polaroid photographs. We included in the study a wide variety of combinations of scan speed, time constant, spacing, dot configuration and film exposure. We now employ a standard scan speed of 15 inches per minute and a spacing of one-eighth inch between traverses. The scanner's light source, focused at the film plane, is masked to produce a rectangular mark one-eighth inch wide and one-quarter inch long. The long axis is oriented in the direction of traverse. A length of one-quarter inch permits each point on the film to accumulate data for a period of one second. This spatial integration results in a considerable smoothing of statistical variation and permits the use of a fast time constant of 0.1 second, even at low counting rates. One of the major inherent disadvantages of analog scanners is, therefore, overcome.

A Method for Comparing Collimator Systems Applied to External Counting of Cr^{51} in the Spleen BILL M. NELSON, VICHAI POSHYACHINDA, AND MAKUMKRONG WASANASOMSITHI (Oak Ridge Institute of Nuclear Studies, Oak Ridge, and Department of Radiology, Chulalongkorn Hospital, Bangkok, Thailand).

A simple three-dimensional analysis of isoresponse data is used to compare collimator systems for external counting of Cr^{51} in the spleen. The "reproducibility" of *in vivo* counts (neglecting statistical variations) depends mostly on proper positioning of the detector over the

spleen and is only slightly affected by the collimator design, at least for the two collimators chosen for this study. The "sensitivity" of a very short ("no-collimator") system is greater than that of a collimator system designed for thyroid uptake determinations ("flat-field probe"), because the crystal can be placed closer to the spleen. "Specificity," defined as the ratio of the contribution of the spleen to the total net counts, would also seem to be better with a collimator that permits the detector to be close to the spleen. However, because of the activity in the body wall and other tissues about the spleen, a rigorous comparison of the specificity of collimator systems cannot be made by casual inspection or isoresponse data. Arithmetic summation of the three-dimensional contributions of Cr^{51} distributed in appropriate compartments confirms the superiority of the short collimator for spleen counts.

A New Counter for Radioactive Samples WILLIAM D. GIBBS AND C. C. LUSHBAUGH, (Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge).

An instrument was designed to accurately measure the radioactivity in bulky samples of variable shape and size without needing to correct for sample size and shape or for distribution of radioisotope in the sample. Such an assay system was needed particularly for quantitating I^{131} in fecal specimens.

The best design for this purpose was found to consist essentially of two, vertically opposed, 2- × 2-in. NaI crystal detectors, 62.7 cm apart, viewing a chamber shielded with 4 in. of lead. The floor of the chamber is made of ⅛ in. plexiglass and is located 30.9 cm above the face of the lower detector. The two detectors are connected in parallel to one gamma-ray spectrometer. Provision is made for individual calibration of the detectors.

The operation of the instrument is based upon the premise that an energy threshold exists above which the counting rate is almost independent of sample size or isotope distribution. This involves counting a certain amount of scattered radiation. Such a threshold indeed exists and has been determined empirically for a number of radioisotopes for sample sizes from 10 to 500 ml.

The range of sensitivity for this instrument is 0.2 to 200 microcuries for I^{131}.

Because of the relative unimportance of size and spatial configuration of the sample in the counting chamber, whole-body counting of live as well as dead small animals or large tissue or liquid samples can be done with an accuracy of ± 2 per cent.

Scanning of Bone Marrow in Animals GRANVIL C. KYKER AND JOHN RAFTER (Medical Division, Oak Ridge Institute of Nuclear Studies, under contract with the U. S. Atomic Energy Commission, Oak Ridge).

Evaluation of the functional size and distribution of bone marrow has wide potential medical use. The consistent correlation between localization of colloids within marrow and its hematopoietic activity offers a practical approach (1). The properties favoring localization of particles in marrow over other organs—liver, lung, spleen—are only obscurely defined. With similar chemical properties, size is however an important factor (2).

We have compared scans of six colloidal preparations of one rare earth metal, cerium, differing in pH and presumably differing in colloidal size. These were made by titrating acid solutions of cerium citrate containing cerium-144 tracer to pH 3.5, 5.0, and 7.0. A cloud of hydrolytic product varied according to the extent of titration and much of it remained dispersed as a sol. Direct use of these supernatants comprised three of the six preparations and the other three were their corresponding centrifugates (2500 rpm, 5 minutes). In rabbits, each of these six preparations give a clear delineation of the femoral, pelvic, spinal, and other marrow sites. The scan pattern was both quickly evident and persistent (from one hour to a week). The optimal time and sharpness of the scan varied slightly among preparations and correlated with the radioassay data.

After the last serial scan, the animals were killed; and heart, kidney, lung, spleen, liver, marrow, and bone were radioassayed. These preparations at pH 3.5, 5.0, and 7.0 gave mar-

row/liver ratios of 1.8, 1.3, 0.9, 1.7, 1.8 and 1.0, respectively (the underscored values represent the centrifuged supernatants). Similarly, the marrow/bone ratios were 96, 26, 27, 24, 21 and 41. These marrow/liver ratios greatly exceed those for radiocolloidal gold (3) which is presently finding practical use for the clinical scanning of marrow (1) although it largely localizes in liver (90-95%). A short-lived (few hours), low-energy (less than 150 kev), pure-gamma emitter would serve ideally for marrow scanning. Technetium-99m, which is so rapidly gaining medical usefulness (4), has all of these physical characteristics but we have observed poor marrow localization with presently described sols of this isotope (5). The cerium-144 used here has none of these desired physical characteristics but the series of chemically similar rare earth elements includes numerous radioisotopes, some of which do meet these physical criteria.

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Clinical Usefulness of Iodine-130 in Serial Tracer-studies in Patients with Functioning Thyroid Cancer PETER PFANNENSTIEL AND B. W. SITTERSON (Oak Ridge Institute of Nuclear Studies, Medical Division, Oak Ridge).

Cyclotron-produced I^{130} (half-life 12.6 hours) has not found extended clinical use, since it was replaced by reactor-produced I^{131} (half-life 8.04 days). Iodine-130 is available now from Oak Ridge National Laboratory, Produced by Neutron Bombardment of the fission product I-129 (I^{129} (n, α) I^{130}). This preliminary report summarizes its physical data, reports diagnostic counting techniques of its relatively strong α emission and outlines advantages of its short half-life for repeated tracer studies at frequent intervals. Responses of surgically "athyroid" patients with histologically proved thyroid cancer to various exogenous TSH-doses are under study. After thyrotropic stimulation with a total dose of 100 USP units TSH intramuscularly, in a few patients partially treated thyroid cancer we observed a significant increase of I^{130} retention determined through total-body counts or urinary I^{130} excretion. The increased I^{130} retention does not appear to be completely accounted for by the enhanced I^{130} accumulation in remaining functional normal or malignant thyroid tissue, as determined by uptake measurements and area scans, or by output of increased amounts of PBI^{130}. Linear scans give no evidence that other iodide concentrating tissues such as salivary and gastric glands respond to TSH. Two normals with $KClO_4$-blocked thyroid glands did not retain more I^{130} after TSH.

The New Isotope Unit—Problems and Solutions

The chief purpose of the panel is to offer guidance to physicians, administrators and others who are planning to start a new radioisotope unit. The problems which arise are numerous and varied in character. Obviously, all of them cannot be covered in the time available. Attention will be directed specifically to part time noninstitutional radioisotope diagnosticians, with reference to the general problems of equipment, training, scope and economic aspects inherent in small scale programs. Particular attention will be devoted to the "pit-falls" associated with the use of low-energy emmitters. Lastly, some ideas will be presented on how present plans for radioisotope units should be molded in order to fit into the future role of nuclear medicine in hospital and medical school organization.