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SECY-1407

April 23, 1971

PROPOSED WORK FOR NIH-NHLI AT ARGONNE CANCER RESEARCH HOSPITAL

Note by the Secretary

The General Manager has requested that the attached memorandum of April 22, 1971 from the Director of Biology and Medicine, with enclosure, be circulated for the information of the Commission.

Secy 1407

W. B. McCool

Secretary of the Commission

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UNITED STATES
ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

APR 22 1971

R. E. Hollingsworth
General Manager
THRU: S. G. English, AGMRD

PROPOSED WORK FOR NHLI AT ARGONNE CANCER RESEARCH HOSPITAL

Enclosed, for your information, is a proposal entitled, "Myocardial Imaging" for a five-year, $737,780 program that was submitted by Argonne Cancer Research Hospital to the National Heart and Lung Institute - NIH.

The proposed studies concern the imaging of the heart muscle by means of a radioisotope scanning technique for the early recognition of lesions as they occur in coronary artery disease. Early detection of these lesions is essential since prognosis of the disease significantly benefits from early treatment. The immediate goals of the studies are the selection of an appropriate radioisotope, the development of portable imaging equipment and the preliminary clinical evaluation of myocardial imaging in patients with myocardial infarctions.

The proposed studies have been reviewed by the Division of Biology and Medicine and are considered highly programmatic and of joint interest to the AEC and the National Heart and Lung Institute. If approved and funded by NIH, it is the intention of the Division of Biology and Medicine to process the proposal through AEC Headquarters as an Interagency Agreement.

W. W. Burr, Jr. for
John R. Totter, Director
Division of Biology and Medicine

Enclosure:
As stated

[redacted]

Signature Page

Title: Myocardial Imaging

University of Chicago, Division of Biological Sciences and
Pritzker School of Medicine

Paul V. Harper, M.D.	Principal Investigator Professor of Surgery; Research Associate (Professor) Department of Radiology	Phone
Robert Moseley, M.D.	Chairman, Department of Radiology	Phone
Cornelius W. Vermeulen, M.D.	Deputy Dean for the Clincal Sciences Division of Biological Sciences and the Pritzker School of Medicine	Phone
Cedric L. Chernick, Ph.D.	Assistant Vice President for Programs and Projects	Phone

TITLE PAGE - PROPOSAL SUMMARY DATA SHEET

Date: March 2, 1971

1. NHLI RFP No.: NHLI-71-10
2. NHLI RFP Title: Quantifying the Size of Ischemic, Infarcted, and/or Scarred Myocardium - Methods Suitable for Use in Living Man
3. Name of Offeror: University of Chicago
4. Title of Proposal: Myocardial Imaging
5. Principal Investigator(s) and Senior Scientists

Name	Telephone Number	% of Time or Hrs. weekly	Social Security Number
Paul V. Harper		20	
Leon Resnekov		10	

7. Total estimated time required to complete project: 5 years

8. Total estimated costs:

First year	$155,280
Second year	$143,600
Third year	$133,900
Fourth year	$146,000
Fifth year	$159,000

9. Type of contract proposed:

Cost-Reimbursement	X	Cost-Plus-Fixed-Fee	
Cost-Sharing		Fixed-Price	
Other			

10. Individual(s) authorized to negotiate:

Cedric L. Chernick, Asst. Vice President for Programs and Projects
Phone: 753-3051

Herbert W. Boyd, Grants Administrator, Phone: 753-3047

11. Individual(s) authorized to execute and sign contracts:

William B. Cannon, Vice President for Programs and Projects,
Phone: 753-3045

Cedric L. Chernick, Asst. Vice President for Programs and Projects,
Phone: 753-3051

12. Subcontractor Information: (Furnish name and location of organization, description of services, basis for selection, responsible person employed by subcontractor and cost information.)

None

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Table of Contents

Introductory Summary

Myocardial imaging with radioactive potassium or one of its analogues is a well known procedure. If it could be perfected so that early recognition of the presence and extent of large areas of infarcted heart muscle were possible, it would provide indications (which are not at present available to the physician) for early vigorous forms of therapy. The technique is non-invasive and with portable imaging equipment could be used harmlessly and repeatedly without disturbing the patient. Prospects for accomplishing this are encouraging. The compact medical cyclotron at the Argonne Cancer Research Hospital is available for producing a variety of radioactive materials (K^+, Rb^+, Cs^+, Tl^+) which localize in the myocardium. There is likewise in the Department of Radiology and in the Argonne Cancer Research Hospital an interested and experienced group involved in the development of new radiopharmaceuticals, new imaging procedures and equipment, and the manipulation of image data by analogue and digital methods. A portable imaging device is under development by the Harshaw Chemical Co. which appears suitable for this application and is available for field trial. The MIRU group at the University of Chicago Hospital is deeply involved in the planning and support of this project. Initial efforts would be directed toward improvement of production methods for the most suitable agents. Feasibility studies on imaging of realistic phantoms have already been carried out and are encouraging. The principal difficulties lie in the imaging procedures in man so that little would be gained from animal studies, where the imaging parameters differ markedly from man. Initial clinical studies would be undertaken on volunteers and patients with small infarcts. If the method proves clinically feasible, its value should be immediately apparent and final formal assessment of its true worth would be made by correlation with clinical and pathological data.

Technical Proposal

1. Title: Myocardial Imaging
2. Principal Investigator: Paul V. Harper, M.D.
3. Other Professional Personnel: L. Resnekov, K.A. Lathrop, R.N. Beck, C.B. Charleston, P. Hoffer, C.E. Metz, H. Brooks, H. Krizek, C. Athanassopoulos, C.J. Umbarger

4. Overall Goals:

To investigate the feasibility of myocardial imaging by potassium radioisotopes or their analogues in measuring the extent of an acute myocardial infarct. The early recognition and extent of large areas of infarcted heart muscle would provide indications for early vigorous forms of therapy and, in addition, would give the clinician information which at present he is not able to obtain. Furthermore, it is hoped that myocardial imaging would also be used serially to diagnose extension of the lesion following the acute episode.

5. Specific Short-Term Goals:

1) To delineate which of the available nuclides would be the most appropriate for the study.

2) To perfect myocardial imaging using mobile apparatus suitable for the investigation of the acutely ill patient at his bedside.

3) To study 15 patients admitted within the coming year to the MIRU with acute myocardial infarctions to determine the usefulness of the technique and to correlate myocardial imaging with the clinical and hemodynamic parameters obtained and with any pathology studies undertaken.

6. Methods of Procedure.

1) Nuclide: The following nuclides will be available (at no cost to the contract):

Nuclide	$T_{1/2}$	Principal Radiations β	γ	Yield μc/μah	Production Reaction
^{43}K	22 h	β^-	85% .373; 81% .619	40†	$^{40}A(\alpha,p)$
^{38}K	8 min	100% β^+	100% 2.2	~5200*	$^{40}Ca(d,\alpha)$
^{81}Rb	4.7 h	13% β^+, EC	.253; .450; 1.1	35**	$^{79}Br(^3He,n$
^{127}Cs	6.2 h	3.5% β^+, EC	10% .125; 72% .406	43**	$^{127}I(^3He,3n$
^{130}Cs	30 min	46% β^+, EC	-	~560*	$^{127}I(\alpha,n)$
$^{198-202}Tl$	2 h-12 d	EC	high-energy mixt.	~3000*	Hg(p,xn)

*ACRH
†Hammersmith
**Sloan-Kettering Institute

Work has already commenced and will continue to delineate which nuclide would be most appropriate for myocardial imaging. The 10 day reactor produced ^{131}Cs has been studied extensively (1,2) and is probably the most convenient agent for animal studies but the low energy of its radiations (30 KEV) precludes its use for imaging any but the superficial regions of the human heart, and the long half-life and slow excretion prevent repeated examinations. ^{129}Cs (3) and ^{43}K (4) have been used for myocardial imaging. These agents have relatively long half-lives, 32 and 22 hrs respectively, which would make repeated examinations difficult. In addition, ^{129}Cs requires a larger cyclotron for its production than is readily available for this project.

Radiations from ^{43}K, ^{81}Rb, ^{38}K and the mixture of thallium isotopes (5) include abundant high energy gammas which make imaging difficult. This leaves 6.2 hr ^{127}Cs and 30 min. ^{130}Cs as probably the most favorable candidates for the present study if adequate amounts can be produced.

Production of ^{127}Cs and ^{130}Cs both involve bombardment of targets of iodine (as an iodide salt) with $^3He^{++}$ and alphas respectively. In order to obtain a reasonable yield large beam currents must be used (40 - 50 μa). This means that 400 - 500 watts of power must be dissipated as heat in a 200 - 300 mg target. This may be accomplished by spreading the target over a wide area and either defocussing or scanning the beam. Protecting the machine from vapors arising from decomposition of the heated target requires either very efficient cooling of the target which is difficult or interposition of a cooled foil window between the target and the machine which degrades the beam energy and reduces the yield. The extensive experience of Dr. Umbarger in this area will prove invaluable.

If production problems for these materials prove to be insoluable, potassium-43 is probably the next best candidate. An argon gas target should present no problem in cooling, though harvesting the ^{43}K from the target chamber may be difficult to carry out efficiently.

Production of 8 min. ^{30}K is very simple and efficient with deuterons on ^{40}Ca but the 2.2 MEV gamma accompanying the β^+ decay renders imaging extremely difficult.

Production of ^{81}Rb is fraught with difficulties similar to the cesium isotopes, i.e., a bromide target, and it emits high energy radiations which interfere with efficient imaging.

The thallium isotope mixture is produced easily from proton bombardment of mercury. When fresh, it contains many species emitting high energy gammas. After a week or ten days of aging the mixture contains largely ^{201}Tl and ^{202}Tl. These emit 70 KEV mercury x-rays and the ^{204}Tl emits an abundant 439 KEV gamma which may be used for imaging. Here the principal difficulty is the 12 day half-life which precludes repeated examinations. It is not clear at the present time which of these nuclides will provide the most useful agent in our situation.

Target processing presents few serious problems. The rubidium and cesium isotopes may be separated easily by ion exchange on Biorex-40. ^{38}K may be separated from a metallic calcium target by solution in acid and precipitation of the calcium as the carbonate. ^{43}K has been harvested from an argon target by recirculating the gas rapidly through a glass filter although much of the activity sticks to the walls of the target chamber. Carrier free thallium is easily separated from the mercury target by solution in acidified acetone. Radiopharmaceuticals containing these materials present no production difficulties.

2. Myocardial Imaging

The basis for myocardial imaging is the localization of 5 - 10% of the injected dose of radioactivity in the heart and its rapid disappearance from the blood. These numbers are based on animal studies and clinical observations appear to bear them out. The choice of nuclide is intimately dependent on the available imaging devices. Collimation and shielding of the detector in most commercial devices are usually limited to an upper range of 300 - 400 KEV gamma energy. Accessories for imaging high energy radiations up to 500 KEV may be obtained for some devices. Geometrical resolution of such high energy devices is usually poor as they are designed for bone scanning with ^{18}F or ^{85}Se.

An additional requirement in the present project is that the device must be portable and suitable for use in the Myocardial Infarct Research Unit. A commercial device (the "Quantascope") which meets many of the requirements for myocardial imaging using high energy emitters is under development at the Harshaw Chemical Co. and is at present undergoing field trials. This instrument is an external energy conversion image intensifier device. At the front end an array of 2500 1/8" x 5/8" CsI(Tl) extruded scintillation crystals are directly coupled optically to a RCA light amplifier tube. In a second stage the amplified image is viewed on an output phosphor by a photo multiplier tube. Since the signal on the output phosphor is proportional to the energy of the photon absorbed in the scintillator, pulse height analysis may be carried out in this way to reject scattered radiation. When a pulse from the photomultiplier enters a preset window, the electron signal beam is deflected onto a second output phosphor where it is recorded by a camera. Thus pulse height analysis is carried out on the leading edge of the electron beam signal and the tail is recorded in the image. This system has advantages and disadvantages The pulse height resolution is very poor compared to conventional equipment. However, the resolution is independent of energy unlike the Anger camera, and the thicker, denser, higher Z crystals have a greater detection efficiency than the Anger camera, although escape of the compton photon reduces the photopeak efficiency.

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Coincident photons may be recorded in the final image at high count rates since the beam is deflected for about 5 μseconds for each recorded pulse and during this interval unanalyzed signals may get through. Since the light output is proportional to the gamma energy, pulses from gammas above the desired range make excessively bright spots in the record. Low energy scattered photons have a lower light output and hence cause little difficulty under these conditions. This effect may be minimized by shortening the time the window is open to about 1 μsecond with consequent loss of light in the output. A third stage light amplifier may be used to increase the light output without degrading the image appreciably.

The collimator design is such that each collimator hole is 1/8" in diameter and looks at one crystal. The crystals are separated at the tube face by 3/16 on centers. For high energies thicker collimators are used. For the highest energy, Tungsten liners in each hole reduce the septal penetration so that the calculated value at 600 KEV of the penetration fraction is 5 - 10%. This is a very remarkable result. The image intensifier tube input window has a spherical surface to which the crystal array and collimator conform. This has a half angle of 25°, so that the collimator is moderately divergent.

In looking at low and moderate energy gammas the scatter rejection is poor even with the good pulse height resolution of conventional NaI detectors, and is worse than poor with the Quantascope. At high energies this is no longer true. Compton scatter is degraded in energy much more with higher primary energy and the marginal pulse height analysis is more effective in this range, Crude testing at 393 KEV indicated that sine wave pattern of 2.5 cycles per centimeter were visually resolvable in the photographic record 3½ inches from the collimator face. With 3 inches of lucite scattering material introduced between the object and the collimator the resolution was degraded to 1.5 cycles/cm. This is still far better than is attainable with conventional scanning equipment. Under these conditions the sensitivity was about 50% of that of the Anger camera with a 3 inch 1000 hole collimator and a 20% window.

The Quantascope thus appears potentially capable of giving improved spatial resolution at high gamma energies with little sacrifice of sensitivity under realistic conditions. One of the greatest

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weaknesses at the present time is the difficulty in obtaining absolutely uniform optical coupling between the 2500 crystals and the light amplifier tube face. When dry coupling is used this is a small problem. The spatial resolution of the light amplifier system is such that individual crystals may be seen. This is accomplished at the cost of a 50% reduction in light output so that the pulse height analysis is further degraded. Using a silicone optical coupling oil improves the light collection but results in a substantial variation in the uniformity which makes the device almost unuseable. Substitution of sodium activated CsI for the thallium activated material increases the light output by a factor of two and permits dry coupling without loss of energy resolution. Another option which is effective is to rock the imaging system slightly about its horizontal support axis while maintaining the position of the image on the output phosphor fixed by servo regulated electrical bias on the deflector. This has the effect of averaging out irregularities in the front end response without degrading the spatial resolution. Well understood solutions thus appear to be available for the principal developmental problems of the Quantascope and there appear to be no serious obstacles to its use as a portable and effective imaging device in the present project.

Preliminary studies using a realistic heart phantom made from plastic and wax castings of a fixed pathological specimen indicate clearly that even under ideal conditions, i.e., no activity in the infarct and no activity in the surrounding medium, myocardial images will be low contrast. Under these conditions it is necessary to collect many counts to reduce the statistical noise in the picture so that it can be subjected to edge enhancement procedures better to outline the infarcts. Since one of the requirements of the request for contract proposal was to attempt to map realistically regions of normal, ischemic, and dead myocardium, analogue methods of contrast enhancement (while being effective in presenting interpretable visual images) would sacrifice the opportunity to reduce the images to numerical data. To accomplish this it seems desirable to digitize the output of the Quantascope. This may be accomplished for count rates contemplated in the proposal (500 - 1000 cps) by simple videcon methods. A comprehensive data acquisition system and computer interface is under construction at the present time at the Argonne Cancer Research Hospital and would be available for use with this project.

If cardiac motion appears to degrade the image significantly, it is very simple to gate the Quantascope on and off with the ECG.

3) Patient Studies

The clinical application of the techniques outlined will follow the preliminary studies to define;

1) choice of nuclide
2) apparatus suitable for the investigation of the acutely ill patient at his bedside.

Studies will be carried out in the two-bed Myocardial Infarction Research Unit. It is anticipated that 15 patients will be studied in the first year as follows:

Complete clinical and electrocardiographic assessment - as detailed in the attached clinical and ECG protocol (Appendix).

Hemodynamic characterization - see attached care protocol

The circulatory characterization of the severity of the lesion will be carried out as soon as feasible following admission to hospital using techniques suitable for the investigation of potentially acutely ill patients and allowing the facility for long-term hemodynamic monitoring as deemed necessary. On the completion of this initial hemodynamic characterization an intravenous injection of the chosen nuclide will be made and myocardial images obtained.

A careful correlation will be made between the size and location of the infarcted area as demonstrated by myocardial imaging and the
1) clinical
2) electrocardiographic
3) hemodynamic

assessments.

Serial imaging will continue daily with the clinical ECG and hemodynamic investigations to determine whether myocardial imaging is of use in detecting
1) extension
2) regression

of the initial lesion.

A careful post mortem assessment will be made in any patient who dies according to the MIRU Pathology Protocol (Drs. Robert Wissler, Seymour Glagov) to determine the anatomical correlation of myocardial imaging.

References

1. Carr, E.A., G. Gleason, J. Shaw, B. Kroutz. The Direct Diagnosis of Myocardial Infarction by Photoscanning After Administration of Cs-131. Am. Heart J. 68:627-636, 1964

2. Rejali, A. H. Friedell, and E. Gredd. Radioisotope Method of Regional Myocardial Blood Supply. Progress in Radiology, Rome, 1967, Vol 2:1208 - 1212

3. Yano, Y., D. van Dyke, T. Budinger, H.O. Anger. Myocardial Uptake Studies with ^{129}Cs and the Scintillation Camera. J. Nucl. Med. 11:663-668, 1970

4. Cooper, M., P. Hurley, R. Reba, K. Poppenberg and H. Wagner. ^{43}K as a Myocardial Scanning Agent. J. Nucl. Med. 11:310, 1970.

5. Kawana, M., H. Krizek, K. Lathrop, D. Charleston and P.V. Harper. Use of ^{199}Tl as a Potassium Analogue in Scanning. J. Nucl. Med. 11:333, 1970 (Abstract)

Statement of Work

Clearly, as indicated in the technical proposal, the problems of isotope production must be worked out so that an adequate supply of nuclide of whichever species finally chosen will be available at short notice. Conceivably 6 hr ^{127}Cs will be better for detailed images, ^{130}Cs might be better for repeated studies.

Concurrently with these efforts imaging studies with the Quantascope will be carried out on phantoms and volunteers to determine the best imaging parameters and to iron out any technical problem with the device.

A short series of patients with myocardial infarcts will then be studied using the direct images from the machine. Processing these by analogue means already in existence should then permit serious consideration of the gains to be achieved by digital processing. If it appears feasible and desirable it will be implemented in the second year of the program where it will fit in with concurrent developments in the data acquisition equipment in the nearby medicine laboratory.

Subsequent efforts will be directed toward correlation studies to assess the worth of the procedure over a period of several years.

Facilities and Resources

The exisiting facilities have all been alluded to in the technica proposal.

1) The ACRH Cyclotron Facility

During the past 18 months at the Argonne Cancer Research Hospital a compact medical cyclotron (Cyclotron Corporation, Berkeley, Cal., Mod. CS-15) has been in operation. This machine produces 15 MEV protons, 8 MEV deuterons, 20 MEV ^{3}He and 15 MEV α beams. An external beam of 50 μa is useable. Operation durin the past year has been with trivial down time. Machine development and maintenance has been under Lester Skaggs, Ph.D., Professor of Medical Physics, and his engineering staff. Machine operation has been under Dr. Paul Harper who personally for the first year carried the major load of operation, target design and experimentation. An experimental physicist with substantial experience is vitally needed in this area as indicated in the technical proposal, and we are attempting to recruit Dr. Umbarger for this position.

2) Radiochemistry Facilities

Facilties for handling and processing cyclotron targets and handling major quantities of radioactivity exist in close proxinity to the cyclotron vault. These include laboratory space with counting facilities, a multi-channel analyzer for spectral measurements, a single-channel analyzer and multiscaler for decay measurements. Solid state detectors are available for special studies requiring high energy resolution. Handling and storage facilities include two high velocity flow hoods, a hooded muffle furnace and a shielded cave with remote manipulators capable of handling 10 Ci of ^{60}Co for 40 hrs a week. This operation is in charge of Helen Krizek, Ph.D., a chemist.

3) Radiopharmaceutical Development Facilities

This includes laboratories with adequate work space, counting facilities, ion chamber equipment for radiation measurements, five high low hoods and bacteriologic incibator and small animal scanning equipment. This facility is in charge of K.A. Lathrop, M.S.

4) Machine Shop

This is a completely equipped machine shop operated by a foreman with a draftsman and five skilled machinists. It occupies approximately one third of the first floor of the Argonne Cancer Research Hospital.

5) Electronic Instrument Development Shop.

This facility is adjacent to the machine shop. It employs three electronic technicians and two engineers and is operated by D.B. Charleston. This group makes their own circuit boards, handle moderately complex digital equipment as well as the usual run of electronic development and maintenance problems.

6) <u>The Clinical Nuclear Medicine Operation</u>.

This operation in the Department of Radiology was developed by Dr. A. Gottschalk and is operated at the present by Dr. Paul Hoffer. This is a highly sophisticated group deeply involved in making use of the new imaging methods developed by the Argonne group such as new radiopharmaceuticals, equipment and other approaches such as fluorescent imaging of the iodine in the thyroid developed by Dr Hoffer. The nuclear medicine facility is near the MIRU unit, and the digital data acquisition equipment under development in the electronics shop will be housed there ultimately with remote terminals in the MIRU and radiopharmaceutical laboratory.

7) <u>The Image Analysis Group</u>

In collaboration with the electronic group whose primary interest is the development of analogue image processing methods, the image analysis group which includes Dr. Metz's and Mr. Beck's operations will study and set up the operational procedures for the data acquisition equipment and subsequent data manipulation with the 360-65 computer at the University of Chicago Computation Center.

8) <u>Facilities of the Myocardial Infarction Research Unit</u>.

The clinical facility of the MIRU is a specially designed two-bed area within the Coronary Care Unit of the University Medical Center and is equipped with monitoring apparatus to permit investigations at the bedside and the collection and analysis of data over days or hours as needed. The area is provided with two dedicated computers for the clinical evaluation, hemodynamic assessment and ECG analysis on a 24-hour basis. A mobile image intesification x-ray unit permits fluoroscopy in the radiolucent beds in which the patients are nursed. In close proximity is a well-equipped analytic laboratory for the routine analysis of the blood samples, expired air and urine samples. The clinical area is staffed by Drs. Resnekov, Lipp, Gambetta and Brooks, supported by Drs. Yanowitz and Fozzard and by two cardiac fellows. There is in addition a resident and intern staff attached to the

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cardiology service and nursing care is under the direction of Miss Joanne Perner. Technical help is provided by Miss Sheila King and a staff of four.

The relationship of all these facilities to the proposed research projects is direct and functional as indicated in the technical proposal.

Equipment

A major part of the technical proposal is a discussion of the quantascope. This is the major request for support under the contract. The Harshaw engineering staff is most cooperative and already much fruitful collaboration has taken place in the development. In the second year of the project approximately $25,000 will be required to implement the digital interface and display system relevant to myocardial imaging.

Patient Availability

There is no problem with this in view of the existence of the MIRU at the University of Chicago Hospitals. This proposal was in fact initiated by the MIRU group.

Organization and Administration.

The cyclotron operation is directly under Dr. Paul V. Harper. This is in the Argonne Cancer Research Hospital operated by the University of Chicago for the United States Atomic Anergy Commission. The Director, Dr. A. Gottschalk, has expressed warm enthusiasm for this project.

Supporting personnel and facilities in the Argonne Hospital as mentioned above, include H. Krizek, Ph.D., in charge of the radiochemical processing, K.A. Lathrop, in charge of the radiopharmaceutical development; R.N. Beck, in charge of scanning

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and collimator design; D.B. Charleston, in charge of electronic engineering , and C. Metz, in charge of image analysis and processing. This is a heterogenous and cooperative group in the Department of Radiology for the most part in the Section of Radiologic Sciences under Dr. Kurt Rossmann, Ph.D. The contract would be administered under the direction of the Department of Radiology, R.D. Moseley, Chairman. The imaging procedures would be supervised by the section of Nuclear Medicine under P. Hoffer, M.D., in the Department of Radiology, and the patient responsibility would be carried out through MIRU under Drs. Resnekov and Brooks. Drs. Harper and Resnekov would be the prime planners for this research.

Support for Related Work.

Much of this has been described in the technical proposal as supporting the contract effort rather than seeking support. The proposal is clearly along a line of effort to which we are already deeply committed, and the contract support will accelerate progress of the work immensely.

Facilities supported in the Argonne Cancer Research Hospital under contract AT(11-1)-69 between the University and the Atomic Energy Commission, Division of Biology and Medicine, are as follows:

	Direct Cost	Indirect Cost	Total
ACRH Project 22 Cyclotron and Radiochemistry	70,000	97,000	167,000
ACRH Project 11 Radiopharmaceutical Development	50,000	69,000	119,000
ACRH Project 5 and part of Project 29, Imaging Group	62,000	85,000	147,000
ACRH Machine Shop	102,000	included in indirect co	
ACRH Electronics Shop	125,000		

The Nuclear Medicine Facility is part of the University of Chicago Hospital patient operation and is self-supporting.

[redacted]

The Myocardial Research Unit is supported by Contract #PH 43-68-1334 from National Institutes of Health.

	Direct Costs	Indirect Costs	Total
Present Year	365,038	41,915	406,953

Support for the ACRH Projects will continue at approximately the same level.

Support has been requested for the MIRU at a total figure of $297,365 for next year and this figure will be subject to negotiation.

Under the MIRU contract, 25% support for the Quantscope purchase has been requested (Project 1, Subproject 11).

A Radiology Center Grant application to include all aspects of radiologic and radioisotope imaging has been proposed to the Natioanl Institute of General Medical Sciences. The grant proposed is in preparation and will be submitted within the near future.

Under the present proposal we are requesting only support which will be completely committed to myocardial imaging by augmentation of the capabilities of existing facilities.

Additional Institutional Resources.

The University Computation Center has IBM 7094 and IBM 360/65 computation equipment. A remote job entry facility (IBM 360/20) plus an IBM 1401 Biomedical Computer Facility is in close proximity to the MIRU and Nuclear Medicine Facilities.

Future and Alternative Funding.

The funding indicated by the ACRH supported operations will continue at about the same level. Application has been made under the MIRU Contract Renewal Contract No. PH 43-68-1334, Project 1, Subproject 11, for 25% of the cost of the Quantascope. This request will be withdrawn if the present contract (RFP NHLI-71-10) is awarded.

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Application is in preparation for a Radiology Center Grant to the National Institute of General Medical Sciences which will include the major items requested in this contract. It is anticipated that these items may be picked up by the Center Grant if it is awarded when the mission of this contract is fulfilled.

[redacted]

The Use of Human Subjects

This project has been submitted to the Clinical Investigation Committee of the Division of Biological Sciences of the University of Chicago for review and approval, and will be carried out in accordance with the Institutional Assurance filed with NIH by the University of Chicago concerning the use of human subjects.

Radiation Dose Estimates

For the various radionuclides radiation dose estimates are indicated in the following table. These are computed using the absorbed fraction method assuming complete retention and complete decay. The target organ with these nuclides is the kidney which is assumed to contain 5% of the injected dose. The kidney radiation dose is estimated to be 5 to 10 times higher than the total body dose depending on which zone in the kidney medulla is assumed as the site of localization.

Nuclide	Total Body Dose rads/mCi
^{38}K	.011
^{43}K	.90
^{81}Rb	decay scheme not available
^{127}Cs	.041
^{130}Cs	.008
Tl (fresh mixture)	.12

[redacted]

BUDGET - 1ST YEAR

Professional	Position	% Effort	$ Salary	$ Fringe	$ Total
Harper, P.V.	Professor of Surgery and Radiology	20			
Resnekov, L.	Associate Professor of Medicine	10			
Lathrop, K.A.	Associate Professor of Radiology	5			
Beck, R.N.	Associate Professor of Radiology	5			
Charleston, D.C.	Associate Professor of Radiology	10			
Hoffer, P.B.	Assistant Professor of Radiology	5			
Brooks, H.	Assistant Professor of Medicine	5			
Metz, C.E.	Instructor in Radiology	5			
Krizek, H.	Research Associate, Medicine	25			
Umbarger, C.J.	Research Associate, Radiology	100			
Athanassopoulos, C.	Research Associate, Cardiology	50			
-	Instructor in Radiology	50			
Technical					
	Senior Technician	100			
Equipment					
	Quantascope Model 1070, complete with special high energy collimator and 3rd stage light amplifier				54,800
Supplies					5,000
Travel					1,500
Publication Costs					1,500
Overhead					28,468
Total					115,280

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