

AN APPLICATION FOR FUNDS

FOR CONSTRUCTION

of

SCINTILLATION COUNTERS

TO ACCOMMODATE

(1) The Entire Human Being

(2) Small Animals

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by

David M. Gould, M.D. and Horace N. Marvin, Ph.D.

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INTRODUCTION

This is an application for funds from the Atomic Energy Commission to build a 4 pi whole body counter for human subjects, and purchase of a whole body counter for small animals. Although the application is being formulated primarily by Dr. David M. Gould and Dr. Horace N. Marvin, a number of departments and people are included in the application.

REASONS FOR REQUEST FOR FUNDS

Funds are not available from institutional budgets for this purpose, although space and maintenance can be provided.

JUSTIFICATION FOR, AND USE OF, SUCH EQUIPMENT

Some of the studies, listed below, can be carried out in part by analysis of small samples with the usual type of detector. Complete resolution of the problems requires equipment able to determine the isotope activity of the entire body in a short period of time.

A. Large Whole Body Counter

1. Department of Radiology (Drs. Gould and Mauderli).

- a. A complete study would be made of the physical characteristics of the detector and electronics including such properties as geometry, sensitivity, resolution collimation, reproductivity and calibration. Information of this nature is available for several other such counters, but each detector will, however, have its own special characteristics, and these statistics will be necessary for valid interpretation of results.

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- b. As a corollary to the above study, the possibility of obtaining radial section activity will be studied. By proper wiring each ring of photomultiplier tubes can be summated through the counter. Providing collimation is adequate, the activity of a radial section, and the organs contained therein, could be obtained. To our knowledge such a modified use of the body counter has not been attempted.
- c. A survey of the activity (particularly ^{40}K and ^{137}Cs) of the people of Arkansas and suitable food products would be carried out.
- Particular reference to residents of the Hot Springs area should be made. Here both the soil and subsurface water contain a good deal more radioactivity than the rest of the state. Correlations may be possible between bodily activity and incidence of disease (blood dyscrasias).
- d. As a related project on a long term program, changes in $^{137}\text{Cs} / ^{40}\text{K}$ ratios may give useful information concerning significance of fall-out.
- e. Personnel monitoring would be carried out to detect gamma emitting isotopes contaminating people involved in the use of such materials.
- f. An air base of the Strategic Air Command is located within twenty miles of the Medical Center. In the event of the use of atomic weapons, a whole body counter would be of assistance in rapidly screening personnel for exposure to neutron radiation, and recovery therefrom.

2. Department of Medicine (Dr. Ross)

- a. An attempt would be made to develop a method for evaluating the activity of the reticuloendothelial (RE) system. Preliminary work on animals using a small 4 pi counter by one of us (H.N.M.) makes this project feasible.
- b. Little is known about the rate at which the remaining RE system is capable of compensating following the removal of the spleen. This should be studied in the patient by determining the proportion of tracer isotopes retained at various times after splenectomy.
- c. In multiple myeloma, the effectiveness of therapeutic agents may be related to retention in the tissues. With appropriate tagging of the compounds, and determination of retention, a rapid screening for effectiveness could be carried out.

B. Small Animal Counter

1. Department of Anatomy (Dr. Marvin)

- a. Simultaneous counting of ^{59}Fe and ^{51}Cr in the entire animal body would lead to a more complete understanding of the red cell survival curves in certain species. With a pulse height analyzer or discriminator in the electronic circuit, the activities of these isotopes could be differentiated and determined. This is a logical extension of work already carried out (H.N.M.)

An investigation of the practicality of including a thin plastic shell containing beta scintillator within the chamber

of such a counter is being carried out elsewhere. If successful this would make possible counting ^{32}P , ^{59}Fe and ^{51}Cr simultaneously on one animal. These three isotopes are all used to tag red cells, but each reveals a different aspect of the survival problem.

- b. The detector would be used to determine the dissociation and diffusion rates of hemoglobin and ^{51}Cr . At the present time the use of the aliquote sampling method is not sufficiently precise. The ability to count rapidly the activity of moderate volumes without opening a dialysis arrangement would increase precision to a practical level.

2. Department of Physiology (Dr. Aulsebrook)

- a. A project is now under way supported by a grant to study the ionic exchange in the inverted gut of the rat, and the effects of adrenal steroids on this exchange. Both ^{22}Na and ^{24}Na are being used in order to follow simultaneously the diffusion in both directions. Due to the short half-life of ^{24}Na it is difficult to obtain adequate data in the presence of ^{22}Na using the aliquote testing procedure. A detector such as being requested, rapidly counting activity in moderate volumes would facilitate this problem.

3. Department of Obstetrics and Gynecology (Dr. Krantz)

- a. A project has been designed and a grant made for a clinical study of the use of ^{198}Au and ^{177}Lu in treating pelvic malignancy. Injection of the colloidal isotopes into lymphatics will introduce these beta emitters into the lymph

nodes containing metastases for the beneficial irradiation effects. The transportation of the isotopes must first be tested in the experimental animal, and it is important to know total amount present, duration of retention, and proportional amounts in organs. These isotopic contents can be determined by the small body counter by virtue of the gamma emission of the isotopes, and use of a pulse height analyzer in the detector circuit.

- b. A project has been considered for sometime pending availability of equipment suitable for the study. Placentae of animals of various species, because of the varying intimacy of uterine contact, differ in permeability to blood-born materials. It is proposed to determine the trans-placental passage of salts and proteins with isotopic labels under controlled culture in vitro. Rapid determinations on moderate volumes of transported materials, as well as placental retention (without damage to tissue) are necessary. The small animal counter appears to be the only practical device for such studies.

4. Department of Radiology (Drs. Gould and Mauderli)

- a. Studies by one of us (H.N.M.) have demonstrated the utility of the small 4 pi detectors for determining the isotopic content of the arm as a proportional measure of body counts when the isotope is blood-born. This principle would be applied in determining the rate of clearance of ^{131}I from the blood in diagnostic tests of thyroid activity. Under usual conditions two ten-second counts give reliable counting statistics. Thus

this part of the iodine uptake picture can be determined in a minimal time and with minimal trauma to patients. Studies on normal and thyroid patients are necessary in order to determine the means and their parameters.

- b. A similar principle and procedure will be applied to explore the use of the small counter to evaluate the cardio-vascular-renal status of patients. Comparisons of arm count decay, urinary excretion, and plasma levels following tracer doses of ^{22}Na or ^{24}Na , whichever is appropriate, will be made. Analysis of biologic decay curves may well be informative in assessing cardiovascular physiology.

5. Department of Biochemistry (Dr. Dinning)

- a. The small animal counter will be used to follow the biologic decay curves of ^{51}Cr - tagged red cells in vitamin E-deficient rats as compared with normals. Blood studies being carried out indicate an extremely rapid loss of ^{51}Cr , but whether this is (1) Poor tagging initially, (2) excessive elution, or (3) excessive red cell loss, can be determined successfully only with whole body counts.

QUALIFICATIONS OF APPLICANTS

It should be stated first that the medical and/or biological qualifications, apart from training and experience with isotopes, are at least adequate in every case. Only the isotope qualifications are, therefore, included here.

A. David M. Gould, M.D.

1. Professor and Head, Department of Radiology
2. Worked with Drs. Asper and Morgan at Johns Hopkins in 1950 using isotopes.
3. Served as lecturer on isotope usage, both theoretical and practical.
4. Directed all the isotope work since June 1956.
5. Holds By-product Materials license for ^{131}I , ^{32}P , ^{198}Au , ^{60}Co , ^{59}Fe , ^{51}Cr , and ^{90}Sr .
6. Licensed for use of isotopes in both animals and human beings.

B. Horace M. Marvin, Ph.D.

1. Associate Professor and Acting Head, Department of Anatomy.
2. On the job training 1954, 1955 with Dr. I. Meschan.
3. Held Radioisotope Procurement Authorization for ^{59}Fe beginning August 1955.
4. Held By-product Materials license for ^{59}Fe , ^{51}Cr and ^{75}Se since then to date.
5. Three months practical experience in Health Research Division, Los Alamos Scientific Laboratory using both the human whole body counter and the small animal counter.

C. Walter Hauderli, D. Sc.

1. Assistant Professor, Isotope Laboratories, Department of Radiology.
2. Doctoral training at Federal Institute of Technology, Zurich.
3. Physicist six years at Neutron and Isotope Laboratory, University of Zurich.

D. James S. Dimming, Ph.D.

1. Associate Professor, Department of Biochemistry.
2. Seven years practical experience with ^{14}C and ^{32}P .
3. Held By-product Materials license 1956 and 1957, and Radioisotope Procurement Authorization for several years prior to that time.

E. S. William Ross, M.D.

1. Associate Professor, Department of Medicine.
2. Practical experience, 1952 and 1953, using ^{131}I -tagged globulin, with Dr. I. Nascher and Dr. Hal Oddi.
3. Clinical use of ^{51}Cr red cell survival studies and $^{60}\text{Co-B}_{12}$ uptake studies for diagnostic purposes 1955, 1956, 1957.

F. Kenneth A. Aulabreck, Ph.D.

1. Assistant Professor, Department of Physiology
2. Course in Radiochemistry, 1953, University of Wisconsin.
3. Practical experience 1952, 1953, 1954 at University of Wisconsin using ^{22}Na , ^{131}I and ^{32}P up to 10mc.
4. Research under a By-product Materials license, 1957 to date, using ^{22}Na up to 1 mc.

G. Kermit E. Krantz

1. Assistant Professor, Department of Obstetrics and Gynecology
2. Casual contact with procedures using ^{51}Cr -tagged red cells to determine red cell volume. Study carried out over period of one year at University of Vermont.

CONSULTANTS

A. Raymond E. Edwards, Ph.D.

1. Director of Graduate Institute of Technology, University of Arkansas.
2. Radio-chemist since 1943.

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B. Dan Mathews, Ph.D.

1. A radio-chemist with dual appointments in the Institute of Science and Technology, and the Medical Center.

OTHER PERSONNEL

A. Louis Muench, Electronic Engineer

1. Three years 1954, 1955, 1956, working on Navy contract with A. R. and T. Electronics Inc. designing electronic missile devices.
2. Five years experience in design, construction and maintenance of scalars, pulse height analyzers and other devices used in isotope laboratories.
3. B. S. degree in electrical engineering.

B. Technicians

Adequate technical help is available for pursuit of the projects listed. All individuals, in addition to practical experience, will be working under the direction of one or more of the investigators listed as applicants.

SPACE AVAILABLE

A. Large Human Body Counter

This is a large device of considerable weight, and requires subfloor space for reservoir tanks. For this reason a permanent installation is mandatory with optimal shielding to reduce background. An area of temperature stability is desirable for best electronic function. Approximately 100 square feet of space is required for the detector, electronics, and accessories such as: work benches, desk, storage, and dressing room and shower.

Such basic facilities are available for this purpose in the Isotope

Laboratories of the Department of Radiology, and can be assigned for this purpose.

B. Small Animal Body Counter

This device can be either permanently installed or constructed on a movable truck. If permanently located, the disadvantage of immobility is partly compensated for by less construction expense. The detector can be mounted in a concrete cubicle, the concrete walls serving as shielding.

If the advantage of mobility is desirable, heavy and expensive shielding is required to keep background at a minimum. It is the plan to construct the mobile detector if funds become available.

AVAILABILITY OF TECHNICAL AND ENGINEERING SERVICES

- A. Blue prints and specifications are available for the Los Alamos models from Dr. Wright H. Langham or for the improved model under construction from Major Kent T. Woodward. In addition costs are available from the latter source.
- B. Dr. Ernest C. Anderson, co-designer of the Los Alamos models, is available for consultation himself, and other personnel at Los Alamos will be able to help as needed.
- C. Mr. R. L. Schuch is now Project Engineer with William Johnston Associates. He was formerly at Los Alamos where he made significant contributions to the design and construction of their models. He is now consultant on the Walter Reed project. His services, either as a consultant or supervising engineer, would be available for a project here in Little Rock.

D. Dr. Raymond Edwards located here in Little Rock would be of help during this phase of the project, as well as in the operation of the completed facilities.

TOTAL FUNDS REQUESTED, AND BUDGET

The following schedule of costs have been taken from information supplied by Major Woodward, since no other recent cost schedules were available to us.

Human Body Counter

Complete set of detailed drawings	\$ 2,500.00
Shop fabrication, test set-up, field assembly, Checkout	35,000.00
Toluene Storage tank, fill and vent system	1,500.00
Milled, rolled steel shield	7,500.00
Photomultiplier tubes and mountings.....	5,500.00
Electronics--scalers, discriminators, amplifiers, high voltage panel, coincidence circuits.....	8,000.00
Chemicals--toluene, terphenyl and POFOP	<u>750.00</u>
TOTAL	\$60,750.00

Small Animal Counter

Fabrication, shield, photomultiplier tubes, toluene, scintillator	\$ 4,000.00
Electronics--scaler, discriminator, high voltage panel, amplifier	<u>5,000.00</u>
TOTAL	\$ 9,000.00

Total funds requested for both instruments **\$69,750.00**

Signed: David M. Gould
David M. Gould, M.D.

Signed: Horace H. Marvin
Horace H. Marvin, Ph.D.