REPORT

BIOMEDICAL APPLICATIONS OF AEROSPACE-GENERATED TECHNOLOGY

QUARTERLY REPORT NO. 3
1 December 1968 - 28 February 1969

Contract No. NSR 26-002-083

MRI Project No. 3217-E(A)

For

National Aeronautics and Space Administration
Office of Technology Utilization
Technology Utilization Division
Washington, D.C. 20546

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by

David Bendersky
Wilbur E. Goll
Donald Roberson

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PREFACE

This report covers the activities of the Midwest Research Institute Biomedical Applications Team during the period from 1 December 1968 to 28 February 1969. The MRI BA Team is concerned with the application of aerospace-generated technology to problems in the nonaerospace biomedical field. This work is being conducted for the National Aeronautics and Space Administration, under the technical direction of NASA's Office of Technology Utilization, Technology Utilization Division, Washington, D.C.

The MRI BA Team is directed by David Bendersky, Principal Engineer, under the supervision of Paul C. Constant, Jr., Assistant Director of the Engineering Sciences Division, and Manager of Technology Utilization. Other MRI technical staff members who contributed to the activities reported herein are: Edward T. Fago, Senior Engineer; Wilbur E. Goll, Associate Engineer; and Donald E. Roberson, Assistant Engineer.

The coordinators at the participating medical institutions are: Dr. John W. Trank, University of Kansas Medical Center, Kansas City, Kansas; Drs. Robert H. Schwartz and Harry Ludwig, University of Wisconsin, Madison, Wisconsin; Dr. William G. Kubicek, University of Minnesota, Minneapolis, Minnesota; Blair A. Rowley, University of Missouri, Columbia, Missouri; and Dr. Marshall P. Reich, Fitzsimon's General Hospital, Denver, Colorado.

The all-important contributions of the biomedical investigators at the participating medical institutions, whose names are given in the text, are gratefully acknowledged.

Approved for:

MIDWEST RESEARCH INSTITUTE

Harold L. Stout

Harold L. Stout, Director
Engineering Sciences Division

14 March 1969

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SUMMARY

During the period from 1 December 1968 to 28 February 1969, the MRI Biomedical Applicaticns Team was active on 38 biomedical problems. Four actual and 14 potential transfers of technology resulted from the team's activities on these problems. Twenty-two new biomedical problems were obtained from the participating institutions during this period.

Seven reports, papers and presentations were prepared by the team. Outside inquiries were handled as well as a variety of other miscellaneous project activities.

I. INTRODUCTION

The MRI Biomedical Applications Team was established in 1965, under the sponsorship of the NASA Office of Technology Utilization, to assist in the transfer of aerospace-generated technology to the non-aerospace biomedical field. The MRI BA Team is a multi-disciplinary group consisting of personnel with training and experience in biology, computer technology, electrical engineering, medicine, mechanical engineering, pharmacology, and physiology.

The procedure being used to transfer aerospace-generated technology to biomedical applications consists of five basic steps. The first step is to define specific biomedical problems. The problems are obtained from the research staffs at participating biomedical institutions. The second step is to identify potential solutions to the biomedical problems. The identification of potential solutions is done through computerized and manual literature searches, circulation of problem abstracts to the NASA research centers and aerospace contractors, and personal contacts. The third step is to modify the original technology, when required, to adapt it to the biomedical problem. The fourth step is the evaluation of the technology by the biomedical researcher who submitted the problem. The final step is to document and disseminate information on successful transfers.

Five biomedical institutions are presently participating in the MRI BA Team program. These are the University of Kansas Medical Center, Kansas City, Kansas; the University of Wisconsin, Madison, Wisconsin; the University of Missouri, Columbia, Missouri; University of Minnesota, Minneapolis, Minnesota; and Fitzsimons General Hospital, Denver, Colorado.

II. ACTIVITIES ON BIOMEDICAL PROBLEMS

A. University of Missouri Biomedical Problems

X-Ray Photograph Enhancement, Problem No. MU-8; Biomedical Investigators, Dr. Peter L. Reichertz and Dr. Samuel Dwyer, III: (Transfer)

Drs. Reichertz and Dwyer are engaged in a research project to eliminate noise, correct distortions and enhance contrast in X-ray photographs. The ultimate goal of the project is to provide improved X-rays and computerized processing and analysis of X-rays for diagnosis. Dr. Dwyer, a member of the Electrical Engineering Department, is now in the process of assembling apparatus for computerized X-ray enhancement based on the system developed at the Jet Propulsion Laboratory.[1] Information on the JPL X-ray enhancement system had been furnished to Dr. Reichertz by the MRI BA Team.

Hardware developed by Dr. Dwyer has progressed to an operational, but still experimental stage. Presently a simulated X-ray is scanned by an image dissector camera producing 200 scan lines per image generating an analog signal representing image intensity. The signal is filtered to remove noise, converted to digital data (201 data points per scan line), and stored on digital tape. An IBM 360/50 computer will apply the enhancement processing techniques, and store the enhanced X-ray on digital tape. The software for the enhancement process is not yet available. Reconstruction is accomplished on an oscilloscope by converting the data to analog signals to modulate the intensity of a raster generated on the oscilloscope screen. Several improvements are required to produce better pictures, especially in eliminating noise and reconstructing the image.

Four reports[2-5], previously sent by the MRI Team for evaluation, were reviewed by Dr. Reichertz. He stated that a radiographic image amplifier described in a report[2] and NASA Tech Brief (B68-10363) was only remotely related to his research problems. The technique could possibly be used as a preamplification device for film scanning. He reported that the report on the NASA spatial technique filtering[3] "might be a very important tool in reprocessing data for computer analysis." The article on pseudo-color processing[4] was of no use for his research program. The report on facsimile video enhancement[5] describes a simple and inexpensive technique for video enhancement. The device utilizes a nonlinear amplifier whose gain characteristic can be altered by the selection of different nonlinear feedback networks. One drawback is that enhancement of black areas reduced contrast in the white area and vice versa. The system is designed for slow scan, 240 line raster per minute, facsimile. Presently, Dr. Reichertz has no plans to use this material.

Electrocardiogram Electrodes, Problem No. MU-9; Biomedical Investigator, Dr. Peter L. Reichertz (Potential Transfer)

Small electrodes for electrocardiograms are needed which are satisfactory over comparatively long periods, are not affected by movement of the patient, and must not cause bedsores even when attached for long periods to the back of motionless lying patients. These electrodes are to be connected to a central computer network in hospital coronary care units being developed at the University of Missouri under the Federal Regional Medical Program.

Dr. Reichertz is evaluating several potential solutions previously sent to him by the MRI BA Team.[6,7,8] References describe long-term testing of several types of electrodes. He reported that the material could possibly be valuable in the development of inert long-term monitoring electrodes.

Cardiac Output Measurement, Problem No. MU-12; Biomedical Investigators, Dr. P. L. Reichertz and Dr. R. H. Martin (Potential Transfer)

A method is needed to evaluate the amount of blood being pumped by the heart through peripheral measurements. This type of measurement is particularly required for critically ill patients.

Two reports on an impedance cardiographic technique to measure cardiac output[9,10] were sent to Dr. Martin. Dr. W. G. Kubicek et al., at the University of Minnesota have been developing the impedance cardiograph method of measuring cardiac output under a NASA contract.

Pulmonary and Metabolic Measurement Instrumentation, Problem No. MU-13; Biomedical Investigator, David W. Douglas (Potential Transfer)

In connection with the Federal Regional Medical Program at the University of Missouri, there is a need for instrumentation for obtaining pulmonary function and metabolic data in mass screening. Present instrumentation is not satisfactory for mass screening, because of their slow response and lack of flexibility.

The Westinghouse Electric Corporation produces a Pulmonary Function Oxygen Monitor, Model 211. Literature describing this instrument was sent to Mr. Douglas by the MRI BA Team. The unit boasts 30 ms. response allowing breath-to-breath measurements, oxygen concentration measurement within 0.5 percent accuracy, and rectilinear strip chart readout. Sample flow rate is adjustable from 100 cc/min to approximately 400 cc/min. Mr. Douglas reports that he plans to arrange for a demonstration of the instrument.

Simultaneous Electrocardiograph Measurements, Problem No. MU-19; Biomedical Investigator, David W. Douglas (Potential Transfer)

The conventional procedure for obtaining electrocardiograms from electrodes attached to the limbs is to respectively switch to each set of electrodes, called multiplexing. Consequently, the electrocardiogram from each set of electrodes is not a continuous record. For multi-phase testing being developed at the University of Missouri, wherein a number of physiological functions are monitored at the same time, it is desired to measure all six sets of electrodes simultaneously. There is some concern whether electrocardiograms collected simultaneously are comparable with electrocardiograms collected by multiplexing.

As the result of a computerized literature search, nine reports[11-19] were sent to Mr. Douglas for his evaluation. One report[12] described a technique for triggering the cardiotachometer with which he plans to experiment. The report on magnetocardiograms,[18] which measure the magnetic field associated with cellular electrical phenomena in cardiac tissue, is pertinent to his problem. He plans to contact the authors of the report. He reported that five reports[11,13,15,17,19] were not applicable to his project but referred three of them[11,13,19] to other investigators.

Torso Position Effects on the Electrocardiogram, Problem No. MU-21; Biomedical Investigator, Blair A. Rowley (Potential Transfer)

In the University of Missouri's Federal Regional Medical Program, it is planned to take electrocardiograms with the subject in a reclining chair. The MRI BA Team was asked to furnish data on the effects of body positions on electrocardiograms.

A computer search of NASA literature revealed four pertinent Italian documents[20-23] which Mr. Rowley is having translated. A manual search of other literature uncovered five articles[24-28] which he evaluated. He reported that one article[24] may be useful, but the others had no apparent application to his problem.

Speed Reducer for Heart Pump Drive, Problem No. MU-22; Biomedical Investigator, Alan H. Purdy (Potential Transfer)

This is a new problem submitted during this report period.

An important problem in developing an artificial implanted heart is supplying the energy to power the pump. The investigator proposes that the energy source be outside the body, and that energy be transported as electromagnetic energy through the intact tissue wall to an implanted pump drive. To attain a large power-to-weight ratio and high efficiency, a high speed electric motor would be used as the prime mover. The radio frequency energy would be converted to dc to power the motor.

The speed reducer must be highly efficient to maximize energy transport and minimize heat generation. It must be small and lightweight, and encapsulated in an inert and impervious material. Lubrication for life is an important consideration.

A computerized search of NASA literature tapes revealed fifteen citations. However, none of the citations was useful. The investigator requested a search of helicopter transmission mechanisms and lubricants. A manual search of NASA literature turned up seven reports; the investigator requested four.[29-32] A copy of "Solid Lubricants"[33], NASA SP-5059, was sent to Mr. Purdy.

Implanted Transducers and Telemetry System for the Ovary Ducts of Small Animals, Problem No. MU-23; Biomedical Investigator, Saul D. Larks, Ph.D. (Potential Transfer)

This is a new problem submitted during this report period.

The investigator wishes to implant a small package in the ovary ducts of small animals to measure cyclic changes which may occur. The package should contain transducers to measure one or more of the following parameters: pH, electrical potentials, pressure, and chemicals. Telemetry must be by radio; life span should be 60 - 90 days.

Information on a pressure telemetry system, developed in connection with a NASA program by the Electro-Optical Company, will be sent to the investigator. A computerized search of NASA documents will be conducted to locate small transducers and radio telemetry units.

Detection of Embryonic Low Level Mechanical Movements, Problem MU-24; Biomedical Investigator, Saul D. Larks, Ph.D. (Potential Transfer)

This is a new problem submitted during this reporting period.

The investigator wishes to detect embryonic heart activity as early as possible and obtain some information about its mechanical activity. ECG recordings may be obtained quite early but information of a mechanical nature is scarce. A means of detecting the low level mechanical movements of the embryo's heartbeat from the surface of the maternal skin is needed.

The MRI muscle accelerometer[54] offers a potential solution to this problem. Information on this accelerometer will be furnished to the investigator for evaluation. A literature search of the NASA data bank will also be conducted.

Remote Station Signaling, Problem No. MU-27; Biomedical Investigator, Gail Bank

This is a new problem submitted during this reporting period.

The investigator has a medical communications telephone network which is used for continuing education and medical problem solving. Normally, one point originates the program. At the end of the program questions are accepted from other points. At present, there is no method employed to electronically signal the originating point that one or more of the other points has a question. Hence, the system tends to become saturated with voice requests.

A method is needed for allowing many individual locations on a single voice grade telephone circuit to individually signal a signal main point. The signal must register in the presence of voice noise, regardless of the number of locations on the circuit.

Digital Signal Enhancement Software, Problem No. MU-28; Biomedical Investigator, Alan H. Purdy

This is a new problem submitted during this reporting period.

Biological signals are recorded by F.M. tape recording. These signals contain low frequency noise (base line drift) and high frequency noise. In order to use these signals for analytical applications, the noise must be removed. The tape is played back through an A-D converter into a digital computer. Software is needed to filter the signals and generate analytical functions which will describe the signals.

A search of the NASA computer data bank (COSMIC) will be conducted to locate computer programs to solve this problem.

Glucose Electrode, Problem MU-31; Biomedical Investigator, David M. Klachko, M.D. (Potential Transfer)

This is a new problem submitted during this reporting period.

The investigator seeks an electrode sensitive to glucose in a water base solution, such as blood, suitable for ascertaining the concentration of glucose.

An investigator at the University of Wisconsin, S. J. Updike, M.D., is developing such an electrode (in connection with Problem No. UW-20). A copy of a paper by Dr. Updike[34], was sent to Dr. Klachko. He was referred to Dr. Updike for further details.

Blood Vacuum Pressure Monitor, Problem MU-29; Biomedical Investigator, David M. Klachko, M.D.

This is a new problem presented during this reporting period.

Continuous on-line monitoring of blood glucose is being done at the University of Missouri Medical Center. Blood is drawn from a vein via very small tubing (I.D. = 0.027) utilizing a roller pump at 10 ml. per hr. It is necessary to know if the tube blocks so it may be cleared or the run terminated without loss of data in the line. In the current monitoring technique the vacuum pressure is measured with a manometer at the pump located about 12 ft. from the vein. This location results in an undesirable time lag.

A new monitor located at the site of the vein puncture is needed to overcome these difficulties. Not more than 1/2 ml. of fluid should be contained in the monitor. The vacuum pressure should be adjustable over an operating range of 1 mm. mercury to a maximum of 760 mm. mercury. The unit should occupy a space no more than 1-1/2 cubic in.

Blood Sample Catheter, Problem No. MU-30; Biomedical Investigator, David M. Klachko, M.D.

This is a new problem submitted during this reporting period.

To make a continuous sampling of blood a very small tube (0.042 in. I.D., 0.054 in. O.D.) is inserted in a vein. Because of tube flexibility, patient motion, etc., the tip has a tendency to approach the wall and be drawn to it by the suction in the tube. The tube is actually two tubes, one within another. The inner tube draws the blood while the outer tube supplies a small volume of anticoagulant. A method is needed to prevent the end of the catheter from obstructing itself against the walls of the vein.

B. University of Kansas Biomedical Problems

The following new problems were recently submitted by investigators at the University of Kansas Medical Center. These problems are in the process of being defined.

KU-31: EKG electrodes for use during surgery and anesthesia

KU-32: Oxygen partial pressure monitoring during surgical anesthesia

KU-33: Continuous measurement of water partial pressure in a gas anesthetic mixture

KU-34: Respiration monitor by measuring changes in thoracic volume

KU-35: Continuous respiration volume flowmeter to monitor volume moved per breath and total accumulated volume

KU-36: Remote monitoring of radial arterial blood pressure, systolic, and average

KU-37: Reliable monitoring of electrocardiogram during anesthesia and surgery

KU-38: A one person interaction simulator for clinical training in speech pathology

C. University of Wisconsin Biomedical Problems

Eyeblink Measurement, Problem No. UW-2; Biomedical Investigator, Prof. L. E. Ross (Potential Transfer)

The eyeblink response has been used extensively to study classical condition, or learning, in adult subjects, and it offers many advantages for work with infants. However, infants and mentally retarded children will not tolerate the attachment of devices to the eyelid. A noncontacting type of sensor is, therefore, required.

An infrared sight switch described in NASA Tech Brief 65-10079[35] is considered to be a potential solution for this problem. Past efforts to procure an infrared sight switch for clinical evaluation have been unsuccessful. Further attempts were made to obtain this item for evaluation. The Technology Utilization Officer at the Marshall Space Flight Center informed the MRI BA Team that (1) there are no switches available from NASA and (2) the Hayes International Corporation is licensed to manufacture and sell the device. Prior attempts to get one of those switches from Hayes were unsuccessful; however, further attempts are now being made.

Apparatus for Learning Research, Problem No. UW-5; Medical Investigator, Dr. R. Heber (Transfer)

For research and training of mentally retarded children, there is a need for a functionally flexible apparatus for experiments on visual learning, memory and other performance characteristics. This apparatus must be compact and portable so that it can be readily moved from school to school.

Since a search of available equipment did not reveal an appropriate apparatus, a proposal to develop the apparatus was prepared by MRI and submitted to Dr. Heber. Dr. Heber has advised the MRI BA Team that he will know shortly whether his new budget for 1969-1970 will provide funds to proceed with the development of the proposed learning machine.

Temperature Telemetry for Internal Organs, Problem No. UW-10, Biomedical Investigator, Dr. R. K. Meyer (Transfer)

Endocrinology research on monkeys, being conducted by Dr. Meyer, requires a method for monitoring the internal body temperature on a continuous basis. Such an instrument must be able to detect temperature changes as small as 0.02°F, and must remain operative inside the animal for several months without adverse reaction to the animal.

A computer search of NASA literature indicated that a temperature telemetry system developed at the NASA Ames Research Center[36], and subsequently commercialized by Electro-Optical Systems[37], was a solution for this problem. One of the telemetry units has been implanted in an ovariectomized monkey since May 1968, with no apparent tissue reaction. Considerable data have already been accumulated on diurnal temperature changes in response to a controlled light/dark (day/night) environment. Some temperature changes due to drug reactions have also been noted. The second unit is still being tested *in vitro* and will soon be implanted in a monkey having a normal menstrual cycle.

Enzyme Electrode Amplifier and Telemetry System, Problem No. UW-20, Biomedical Investigator, Dr. S. J. Updike

Dr. Updike has developed a special enzyme electrode which he intends to use for the continuous monitoring of oxygen and glucose concentrations in living animal tissues. He needs a very stable, high-impedance amplifier in order that changes in the amplifier will not mask the signal he is attempting to measure.

Fabrication of an amplifier[38] per information previously supplied by the MRI BA Team indicates that temperature drift and linearity are still major problems. A commercial amplifier was tried which also has similar problems of stability. Effort is now being expended by Dr. Updike to develop his own special circuitry.

D University of Minnesota Biomedical Problems

Foot Support Devices, Problem No. UM-17, Biomedical Investigator, Prof. John D. Allison (Potential Transfer)

Correction of certain foot disorders in children requires that inserts be placed in the patient's shoe to support the base structure in proper position during growth. Due to frequent changes required, because of the constant growth and corrective action taking place, new inserts must be fabricated several times a year at a cost of approximately $50 per pair. It is desired that some material and/or fabrication technique be found to reduce the present costs.

Based on a review of the literature search[39] previously supplied by the MRI BA Team, the investigator has requested four documents[40-43] for further evaluation. These documents are on order and will be forwarded when received. Information on an electronic shoe fitting device previously sent to the investigator, was not deemed relevant, since data will be obtained from serial casts of the foot, rather than measuring progressive changes in total length or metatarsal width.

Distortion of Visual Perception, Problem No. UM-26, Biomedical Investigator, Dr. A. S. Marrazzi

Dr. Marrazzi is investigating the behavioral consequence involved with patients having disturbed cerebral functions, when they look into a seven foot open-ended room through a set of distorting lenses. The resulting distortion of visual perception appears as a slope in the wall of the test chamber. The extent of the slope can then be accentuated in a quantitative, diagnostic fashion by small test doses of drugs which have no recognizable overt effect, but which can be readily followed instrumentally. In order to increase the capability of the research project, a miniaturized version of the system is needed for field use.

A computer search of the NASA data bank has been conducted and the results have been sent to the investigator for evaluation.

Electrical Sensor for Bacteria Detection, Problem UM-28, Biomedical Investigator, Professor Grace Mary Ederer (Transfer)

Professor Ederer desires to make a clinical application of the aerospace methodology for monitoring the bacterial content of water supplies for space craft.

Information contained in documents reviewed by the investigator[44,45] indicates that work performed by Hazleton Laboratories[46] for the Aerospace Medical Research Laboratories is applicable to this problem. Past attempts to locate the Hazleton equipment were not successful. However, during a recent tour of the Life Detection Laboratory at the Goddard Space flight Center, a member of the BA Team recognized the equipment which was developed by Hazleton for Wright-Patterson AFB. Additional reports[47,48] were obtained on similar work done by Hazleton for Goddard Space Flight Center. Arrangements are now being made to borrow the unit from Goddard for use by the investigator.

Cool Suit for Metabolic Studies, Problem No. UM-35, Biomedical Investigator, Dr. Henry L. Taylor (Potential Transfer)

This is a new problem submitted during this report period. Dr. Taylor is engaged in the development of methods for evaluating the capacity of the cardiovascular system to provide an adequate oxygen supply to the heart during stress conditions. The reliable interpretation of electrocardiograms taken before and after stress requires precise control of the myocardial oxygen consumption, a condition which is not now available.

It is proposed to explore the problem by studying the relationship of skin temperature, as controlled by a "cool suit," to pulse rate and blood pressure under standardized conditions of work. It is expected that data will also be obtained, which will provide insights into the use of "cool suits" for the purpose of studying peripheral circulation. A follow-on course of investigation will involve the degree of cardiovascular stress produced by the effect of heating the subject via the heat exchange mechanism of the "cool suit."

A member of the BA Team, having prior knowledge of space suit technology, suggested that a water-cooled garment developed for NASA by United Aircraft Corporation[49] and commercialized by B. Welson and Company, Inc.[50] would be an appropriate solution to this problem. The investigator is now interested in having the use of a NASA "cool suit" for a 6-12 month period of investigation and efforts are now under way to procure one through NASA.

Miniature Power Sources, Problem No. UM-36, Biomedical Investigator, Dr. John Tester and Mr. David Gilmer

This is a new problem submitted during this report period.

Mr. Gilmer is working on a NIH project which involves the "radio tracking" of small animals and birds, particularly ducks. Power sources, weighing some 4.5 to 12 grams, are needed to supply miniature telemetry equipment (see Problem UM-37) which will be either attached to or implanted in the test subjects.

Additional information is now being gathered to provide a more complete definition of the problem. A computer search of the NASA data bank will then be made.

Miniature Telemetry Equipment, Problem No. UM-37, Biomedical Investigator, Dr. John Tester and Mr. David Gilmer

This is a new problem submitted during this report period.

Dr. Tester and Mr. Gilmer are working on a NIH project which involves the "radio tracking" of small animals and birds, particularly ducks. Due to size of the animals and birds involved, extremely compact, lightweight telemetry equipment is needed. Information is desired on miniaturized state-of-the-art construction information. A computerized literature search of the NASA data is being conducted.

Telemetry Recording Devices, Problem No. UM-38, Biomedical Investigators, Dr. John Tester and Mr. David Gilmer

This is a new problem submitted during this report period.

Dr. Tester and Mr. Gilmer is working on a NIH project which involves the "radio tracking" of small animals and birds, particularly ducks. Information on equipment capable of receiving the very weak telemetry signal and recording the desired data is needed.

Additional information has been requested from the investigators in order to more clearly define the type of signal information to be recorded. A computerized literature search will be made when the problem definition is completed.

E. Fitzsimons Army Hospital Biomedical Problems

Bloodless Perfusion, Problem No. FH-1, Medical Investigator, Dr. Marshal P. Reich (Transfer)

Captain Reich is engaged in a long-range research program on limb implantation. The ultimate goal of this program is to develop techniques for grafting human arms and legs to soldiers who have lost limbs in combat. Good results have been obtained with dogs, wherein the animal's leg was amputated and immediately replanted. At the present time, the amputated limb is being kept in a hyperbaric chamber for various time periods prior to replantation. During the storage of the limb in the hyperbaric chamber, a mixture of blood and dextrin solution is continuously circulated through the vascular system to assist in keeping the limb viable. It is desired to avoid the use of blood in the perfusate because of problems related to the artificial circulation of blood, such as deterioration of the red cells. A bloodless perfusate which will be capable of keeping the amputated limb viable is desired.

A Medlars search on perfusion was initiated by the MRI BA Team. The search resulted in 651 citations, which were sent to the investigator. The investigator reported that the search was extremely comprehensive and that 12 articles are pertinent to his problem.

Determination of Nerve Viability, Problem No. FH-3, Biomedical Investigator, Dr. Marshall P. Reich (Potential Transfer)

A reliable technique is needed to determine the viability of nerves in an umputated limb. At the present, the viability of the nerves in the limb is determined by observing the actions of the leg after replantation. If a reliable method was available for determining the viability of the nerves in the amputated limb prior to replantation it would avoid the work required for replantation of a limb in which the nerves were not viable.

The pertinent reports[51,52], which were revealed in a search of the NASA literature tapes and requested by Dr. Reich, were obtained by the MRI BA Team and sent to Dr. Reich.

Monitoring of pH, PO_2, PCO_2, Problem Nos. FH-4 and FH-5, Biomedical Investigator, Capt. Marshall P. Reich (Potential Transfer)

The pH, partial pressure of oxygen, and partial pressure of carbon dioxide in the perfusate as it is circulated through the amputated limb, and

the partial pressure of the tissue of the amputated limb are important parameters in the study of limb preservation. Convenient and accurate methods for making these measurements are, therefore, urgently needed. Some commercial equipment is available, but tests have shown this equipment to be inconvenient and/or inaccurate.

Dr. Reich has asked the MRI BA Team to advise him with regard to difficulties he has had with a commercial PCO_2 probe. Inspection of the probe revealed that the membrane was loose with respect to the underlying metal structure. It was recommended that the probe be returned to the manufacturer for repair.

Information on a new commercial machine for measuring PO_2, PCO_2 and pH[53] was obtained by the MRI BA Team and sent to Dr. Reich for evaluation.

III. OTHER ACTIVITIES

A. Reports, Papers and Presentations

1. Quarterly Report No. 2, covering the activities of the MRI Biomedical Applications Team during the period from 1 September to 30 November 1968 was prepared and distributed.

2. David Bendersky, Director of the MRI Biomedical Applications Team, gave a presentation on the NASA Biomedical Applications Program to the Kansas City Section of the Institute of Electrical and Electronics Engineers, Kansas City, Missouri, 2 January 1969.

3. The galley proofs of the paper entitled "Evaluating Aerospace Technology in the Medical Setting," by David Bendersky, were checked and returned to the publisher. This paper is to be published in the March 1969 issue of the Journal of the Association for the Advancement of Medical Instrumentation.

4. Wilbur Goll, MRI BA Team, spoke before the professional women's service organization, Zonta International (Kansas City, Missouri Chapter) on 22 January 1969. The history and purpose of NASA's Biomedical Application Teams was given as well as several examples of technology transfers.

5. David Bendersky, Director of the MRI Biomedical Applications Team, presented an invited lecture on the NASA Biomedical Applications Program at Bradley University, Peoria, Illinois, on 11 February 1969. The lecture was sponsored by the Bradley University College of Engineering and the Illinois Valley Chapter of the Institute of Electrical and Electronics Engineers.

6. A paper, entitled "Recent Successes in Utilizing Aerospace Technology", by David Bendersky, has been accepted for publication in the Journal of the Association for the Advancement of Medical Instrumentation.

7. Wilbur Goll, MRI BA Team, was the luncheon speaker for the North Kansas City Chapter of Kiwanis International on 19 February 1969. The talk concerned NASA's Technology Utilization Program and, particularly, the Biomedical Application Team's role in applying aerospace-generated technology as solutions to medical research problems. Types of current problems as well as successful transfer solutions were described. The potentialities of industrial participation were also mentioned and the talk was concluded with a question and answer period.

B. Meetings

5 February 1969: Donald Roberson, MRI BA Team member, visited the University of Missouri, Columbia, Missouri, and met with five biomedical investigators who had submitted problems. Discussed in these meetings were status of current problems, new problems, and hardware development, which are presented elsewhere in this report.

13 February 1969: Dave Bendersky and Wilbur Goll attended the SRS/NASA Interagency Conference at the Goddard Space Flight Center in Greenbelt, Maryland. Representatives from participating rehabilitation centers, SRS, HEW, NASA, George Washington University, and the three Biomedical Applications Teams discussed ways and means for improving the Interagency effort. The Goddard clean room facility and Life Detection Lab were also toured. This tour proved very interesting and fruitful because information and equipment relevant to a current medical problem (Problem No. UW-28) was located.

C. Biomedical Research Staff Mailing

A mailing to the medical research staff at the University of Missouri was made to stimulate the inflow of new problems to the MRI BA Team. As a result of the mailing, 15 new problems have been submitted by biomedical investigators at the University.

D. Inquiries

1. Dr. S. J. Updike, The University of Wisconsin, Madison, Wisconsin, requested information regarding NASA spray-on electrocardiogram electrodes. Information sent 5 February 1969.

2. Dr. John G. Webster, The University of Wisconsin, Madison, Wisconsin, requested that he be added to the distribution list for receiving BA Team reports. Dr. Webster has appointments with both the Electrical Engineering Department and the Instrumentation Systems Center and is responsible for supervision of graduate students working with medical investigators.

3. Dr. A. A. Siebens, The University of Wisconsin, Madison, Wisconsin, expressed the need for information in the following areas:

a. Muscle accelerometer
b. Voice controlled orthotic devices
c. High efficiency D.C. motors
d. Constant force solenoid
e. Damping device for arm movements

Information concerning item (a) has been sent. Items (b) thru (e) will be written up as new problems when detailed information is available.

4. Dr. F. E. Russell, O'Fallon, Missouri, requested general information on the NASA Biomedical Applications Program. The requested information was sent to Dr. Pussell.

5. James E. Freeman, Denver Research Institute, Denver, Colorado, requested information on the relationship between the MRI BA Team and the user institutions. The information was prepared and sent to Mr. Freeman.

6. Mr. Vargo, NASA Lewis Research Center, Cleveland, Ohio, inquired concerning the status of the X-ray enhancement system being developed at the University of Missouri (Problem No. MU-81). He requested the information on behalf of a Cleveland hospital which is interested in this equipment.

7. Mr. B. Rowley, University of Missouri, Columbia, Missouri, requested information on manufacturers of reproduction equipment. A list of reproduction equipment manufacturers was assembled and sent to Mr. Rowley.

E. Miscellaneous

1. A copy of a literature search on Continuous Measurement of pH, PO_2, and PCO_2, which had been assembled in connection with Problem No. UM-31, was sent to Dr. Ray Ware, Southwest Research Institute, for possible application to his Problem No. RNV-15.

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