DEPARTMENT OF HEALTH AND HUMAN SERVICES

NATIONAL INSTITUTES OF HEALTH

Frontiers of Science

Witness appearing before the
Senate Subcommittee on Labor-HHS-Education Appropriations

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Mr. Chairman and Members of the Committee:

I am pleased to present the Fiscal Year (FY) 2008 President's budget request for the National Institute of Biomedical Imaging and Bioengineering (NIBIB). The FY 2008 budget included $300,463,000.

BRIDGING THE PHYSICAL AND LIFE SCIENCES

The mission of the NIBIB is to improve human health by extending the frontiers of biomedical science, through the development and application of innovative biomedical technologies. A major focus of NIBIB is bridging the physical and life sciences in order to develop new biomedical technologies and methodologies that have a profound, positive impact on human health. Translating these technological breakthroughs from the bench to bedside is also a very important aspect of the NIBIB mission, and is demonstrated in some of the examples given below.

TRANSLATING EMERGING TECHNOLOGIES INTO PRACTICE

A Quantum Project to Treat Stroke

Ultimately, NIBIB seeks to translate technological advances into solutions that improve human health by reducing disease burden and enhancing quality of life. To accomplish this goal, NIBIB must be well-positioned to utilize ideas and techniques that are at the cutting edge of science. Also, NIBIB must be bold and far-reaching in generating some of its initiatives in order to more rapidly facilitate discoveries and translate them to clinical practice. NIBIB recently launched the Quantum Grants Program, which supports very high impact, high risk, interdisciplinary and transformative research focused on major biomedical problems. The goal of this program is to solve or dramatically improve a major, previously intractable medical problem through the development and application of new and/or emerging technologies. Interdisciplinary teams of scientists will conduct collaborative research resulting in a prototype product, technology or procedure that promises to solve a significant healthcare problem, and that can be translated into clinical practice in an accelerated time frame. The first grant, awarded in September 2006, aims to develop a novel treatment for stroke, based on implantable units that will lead to neurovascular regeneration of cerebral tissue. This is the first application that has as its target, a treatment for stroke that seeks to *restore functional tissue*.

Seeing and Treating Heart Arrhythmias

Heart arrhythmias are a major health problem. In particular, atrial fibrillation, a disorder found in about 2.2 million Americans, is a significant cause of stroke. This occurs when a blood clot forms in the fibrillating heart chamber and then breaks loose and travels to the brain. Minimally invasive surgery can be used to treat atrial fibrillation. However, the procedure is complicated and lengthy, often lasting many hours. NIBIB investigators are developing new imaging techniques that permit the abnormal electrical activity to be identified and mapped onto a patient-specific image of the heart. This

potentially permits the procedure to be done in one hour instead of six. Beyond the time saving, this approach has the potential for lower cost, decreased exposure to x-rays, greater success rates, and fewer complications. The effort involves collaboration between radiologists, computer scientists, bioengineers, and cardiologists.

Addressing heart diseases of a medically underserved population is the central focus of the Jackson Heart Study. The National Heart, Lung and Blood Institute, the National Center for Minority and Health Disparities, and NIBIB co-fund this study to assess risks factors for cardiovascular diseases, including diet, exercise, and co-morbidity factors such as diabetes and obesity.

Help for the Paralyzed

Paralyzed or ñlocked ï inò individuals who retain normal cognitive function but are unable to move parts of their bodies to communicate now have a means of using the computer, based on an interface technology developed by NIBIB grantees. Brain waves, detected by a skullcap with attached electrodes, are decoded and used to communicate with a computer. By simply thinking of the letters, the user can spell words on the computer. No interaction with a keyboard or mouse is required. Over the past year, a team of neuroscientists has worked intensively to move this system from the laboratory to home use. For one NIH-funded neuroscientist with late-stage amyotrophic lateral sclerosis (ALS, or Lou Gehrigôs Disease), this device has enabled him to continue his research. ñI couldnôt work independently without it,ò he wrote recently for an article posted on the NIBIB web site entitled ñBrain-Computer Interfaces Come Home.ò

NANOTECHNOLOGIES FOR PERSONALIZED AND PREEMPTIVE MEDICINE

Point- of-Care Systems

Empowering clinicians to make decisions at the bedside, or the point-of-care, has the potential to profoundly impact health care delivery and to help address the challenges of health disparities. The success of a potential shift from curative to predictive, personalized, and preemptive medicine will rely in part on the development of portable diagnostic and monitoring devices for near-patient testing. The NIBIB has contributed to advances in this area by funding the development of sensor and platform-based microsystem technologies. These instruments combine multiple analytical functions into self-contained, portable tabletop devices that can be used by non-specialists to rapidly detect and diagnose disease, and can enable the selection of a definitive therapy at the time of the visit to the physician. A prototypic example under development and funded by NIBIB can identify, from a single drop of urine, the DNA of the specific bacteria responsible for a given urinary tract infection. Moreover, this test can be completed in just a few minutes, compared to the 2 days often required by standard culture techniques.

A second example is in the area of improved diabetes control through non-invasive continuous glucose monitoring. Several NIBIB-funded researchers are working to engineer such a device. One has developed a contact lens that changes colors in response to the concentration of glucose in tears. The lens wearer can compare the color of the contact lens to a chart in order to determine his glucose concentration. If indicated,

medications to control blood glucose, such as insulin, can then be administered.

NEXT GENERATION MINIMALLY-INVASIVE TECHNOLOGIES

Restoring Touch in Robot-assisted Surgery

Robot-assisted surgery is expanding the applications and reducing the complications of minimally invasive surgery. Nonetheless, this expansion has been inhibited due in part to the lack of a sense of touch. When surgeons operate on their own, their hands provide important tactile feedback. Although all fields of surgery could benefit from tactile feedback, cardiac surgery is among the fields that have the most to gain. Because of the large number of sutures used, the delicate tissues involved, and the need for precise work, tactile feedback is essential in cardiac surgery. An NIBIB-funded research team is working closely with a cardiac surgeon to create a robotic system that delivers required touch sensitivity. Use of this system could result in fewer broken sutures, more consistent application of force to tissues during surgery, and suture knots with superior ability to stay together. This system is now in development, and it could also serve as an important teaching tool for surgical residents. Rather than the current practice of teaching students exclusively on live patients, new surgeons could obtain more extensive practice in the lab before performing live surgery. Using computer algorithms that recognize motion, a traineeôs movements can also be compared to an expertôs performance and assessed.

Non-Surgical Biopsy through New Approaches to Optical Imaging

The diagnosis of many conditions such as cancer depends on microscopic evaluation of tissue samples. Typically these samples go through a process of fixation and staining before they are looked at under a microscope in the pathology laboratory. NIBIB researchers have made significant progress in developing techniques to image tissue in place without the need for surgical biopsy, fixing, and staining. This new imaging approach makes use of the different fluorescent characteristics of normal and diseased tissue, and offers the potential for examining the tissue at the point of care, in the operating room or medical office. Many potential human applications exist, including imaging tissues that form as a sheet such as the bladder or bowel lining. Physicists, biophysicists, imagers, engineers, biologists and clinicians are working together to advance this technology.

FEEDING AND SUSTAINING THE SCIENTIFIC TALENT PIPELINE

Interdisciplinary Training Programs

An important goal of the NIBIB is to train a new generation of researchers equipped to meet the modern needs of interdisciplinary and transdisciplinary research. The Institute's proactive approach is to develop creative and flexible opportunities that will fill critical gaps in the career continuum while also enhancing the participation of underrepresented populations. As examples, the NIBIB has a program to co-train basic

and clinical investigators, a Residency Supplement Program to provide research experiences to clinical residents and fellows, and postdoctoral support programs for interdisciplinary training to individual postdoctoral fellows.

The NIBIB also supports and participates in a number of programs to address gender and diversity issues in biomedical imaging and bioengineering. The NIBIB partners with the NSF in the University of Maryland, Baltimore County, Meyerhoff Scholarship Program alliance. This has been an exceptionally effective diversity honors program. Eighty-five percent of the 511 students who have graduated since 1993 have earned a science, technology, engineering, or math doctoral degree.

The NIBIB has also partnered with the Howard Hughes Medical Institute to support the HHMI-NIBIB Interfaces Initiative, a program to develop new curricula to train Ph.D.-MD level scientists at the interface of the physical and life sciences and give them the knowledge and skills needed to conduct research. Collectively, these programs will help to train a new generation of researchers equipped to better meet the challenges of the 21st Century.

Once trained, it is critical that we encourage those who aspire to be great scientists to pursue research careers. New investigators are the innovators of the future and their entry into the ranks of independent researchers is essential to the health of the research enterprise. In addition, the recent closure of the Whitaker Foundationð a catalyst in the evolution of bioengineering as a forefront disciplineð has left many in the scientific community concerned about new and early career investigators. For these reasons, the NIBIB is specifically targeting new investigators for special funding consideration. This policy has proved to be successful; in FY 2006 nearly one-third of the NIBIB-funded traditional research grant investigators were new NIH investigators. The NIBIB also participates in the trans-NIH ñPathways to Independenceò program which will support recently trained scientists conducting independent, innovative research.

National Institute of Biomedical Imaging and Bioengineering
Roderic I. Pettigrew

Roderic I. Pettigrew, Ph.D., M.D., is the first Director of the National Institute of Biomedical Imaging and Bioengineering at the NIH. Prior to his appointment at the NIH, he was Professor of Radiology, Medicine (Cardiology) at Emory University and Bioengineering at the Georgia Institute of Technology and Director of the Emory Center for MR Research, Emory University School of Medicine, Atlanta, Georgia.

Dr. Pettigrew is known for his pioneering work at Emory University involving four-dimensional imaging of the heart using magnetic resonance (MRI). Dr. Pettigrew graduated cum laude from Morehouse College with a B.S. in Physics, where he was a Merrill Scholar; has an M.S. in Nuclear Science and Engineering from Rennselear Polytechnic Institute; and a Ph.D. in Applied Radiation Physics from the Massachusetts Institute of Technology, where he was a Whitaker Harvard-MIT Health Sciences Scholar. Subsequently, he received an M.D. from the University of Miami School of Medicine in an accelerated two-year program, did an internship and residency in internal medicine at Emory University and completed a residency in nuclear medicine at the University of California, San Diego. Dr. Pettigrew then spent a year as a clinical research scientist with Picker International, the first manufacturer of MRI equipment. In 1985, he joined Emory as a Robert Wood Johnson Foundation Fellow with an interest in non-invasive cardiac imaging.

Dr. Pettigrewôs awards include membership in Phi Beta Kappa, the Bennie Award (Benjamin E. Mays) for Achievement, and being named the Most Distinguished Alumnus of the University of Miami. In 1989, when the Radiological Society of North America celebrated its 75th Diamond anniversary scientific meeting, it selected Dr. Pettigrew to give the keynote Eugene P. Pendergrass New Horizons Lecture. He has also served as chairman of the Diagnostic Radiology Study Section, Center for Scientific Review, NIH.

Department of Health and Human Services
Office of Budget
Richard J. Turman

Mr. Turman is the Deputy Assistant Secretary for Budget, HHS. He joined federal service as a Presidential Management Intern in 1987 at the Office of Management and Budget, where he worked as a Budget Examiner and later as a Branch Chief. He has worked as a Legislative Assistant in the Senate, as the Director of Federal Relations for an association of research universities, and as the Associate Director for Budget of the National Institutes of Health. He received a Bachelorôs Degree from the University of California, Santa Cruz, and a Masters in Public Policy from the University of California, Berkeley