National Space Biomedical Research Institute
Select Achievements/Earth Applications

Background

The National Space Biomedical Research Institute (NSBRI) was established in 1997 and is a nonprofit academic research consortium, operating under a cooperative agreement with NASA. NSBRI leads a science and technology program to develop countermeasures, or solutions, to the health-related problems and physical and psychological challenges that men and women face on long-duration space flights. The research results and medical technologies developed have impact for similar conditions experienced on Earth, such as osteoporosis, muscle wasting, balance disorders, and other systemic problems, as well as for delivery of medical care. To prepare the next generation of scientists, NSBRI also supports a robust education and outreach program encompassing a variety of activities from kindergarten to independent investigator, including curriculum and teacher professional development, undergraduate and graduate education, and postdoctoral fellowships.

Select Science and Technology Achievements:

Self-Guided Conflict Management
James A. Carter, Ph.D., Harvard Medical School-Beth Israel Deaconess Medical Center, Boston, MA
Unmanaged interpersonal conflicts can threaten the success of long-duration space missions. A conflict management training program has been developed for flight crews as well as for flight and ground control interactions. Input on best practices for managing on-orbit conflicts was obtained from veteran flyers on International Space Station, Mir and Skylab. Formal evaluation of the program is being conducted with current astronauts. This conflict management program is applicable to a wide variety of Earth settings where optimal human performance under demanding, high-stress conditions must be achieved.

Balance and Gait Training
Jacob J. Bloomberg, Ph.D., NASA Johnson Space Center, Houston, TX
Following their return to Earth, astronauts experience disturbances in their ability to walk and maintain balance. This project is developing an in-flight balance and gait training program that will promote recovery of function after long missions. The Gait Adaptability Training Program will be done simultaneously with in-flight treadmill exercise, and will facilitate re-adaptation. Because falls are the leading cause of injury-related visits to the Emergency Room, and a major cause of accidental deaths in persons over the age of 65, this training program has important Earth-based applications to the growing elderly population.

Risk Reduction – Lunar and Mars Dust
G. Kim Prisk, Ph.D., D.Sc., University of California, San Diego, CA
Lunar and Martian dust can be toxic. Because of the lower gravity on the Moon and Mars, dust can penetrate more deeply into the lung, raising the potential for oxidative damage. This project will measure inert aerosols deposited in altered levels of gravity and use sophisticated models to assess exposure levels. The outcome of these studies will aid in setting exposure limits for astronauts. This work will also provide information for assessing Earth-based exposures to particulate matter pollution related to natural disasters, hazardous materials management and groups at high occupational risk, such as those in the mining industry.

Medical Lab in a Suitcase
Richard S. Potember, Ph.D., Johns Hopkins University Applied Physics Laboratory, Laurel, MD
A miniature mass spectrometer has been developed to fit in a small suitcase. This compact medical system allows rapid patient sample monitoring and analysis of tiny levels of chemical and biological substances, and can be used for environmental detection of harmful microbes in air or water. Space medicine applications for the device include determination of markers for bone loss, radiation effects, cardiovascular and muscle alterations, changes in immune function including those associated with infection and altered white blood cell activities, and changes in markers of stress and nutritional status. On Earth, this technology can be applied to rapid medical diagnostics in remote and rural areas, and to screen populations potentially infected by biological agents. A prototype instrument has been used in the Pentagon for detecting Anthrax spores.

Real-Time Radiation Risk Assessment
Vincent L. Pisacane, Ph.D., United States Naval Academy, Annapolis, MD
A rugged, portable, lightweight radiation detection instrument (MIDN) is under development to enable real-time measurement of radiation risk to astronauts. The device measures the three forms of space radiation – solar flares, trapped particle radiation and galactic cosmic rays, and will use the measurements to estimate risk of damage to body tissue. MIDN will also warn of impending radiation events, to permit seeking safe shelter during these periods. NSBRI funds also supported United States Naval Academy midshipmen working on a flight study of a preliminary version of MIDN launched on the MidSTAR-1 satellite. The instrument has important applications on Earth for homeland security and for jobs with high potential of radiation exposure.

Needle-Free Blood and Tissue Measurement
Babs R. Soller, Ph.D., University of Massachusetts Medical School, Worcester, MA
A portable, noninvasive device to assess blood and tissue health is under development, in which measurement of tissue pH, oxygen levels, and red blood cell volume, are made directly on the skin without the use of needles. The monitor can assist first responders in the diagnosis and treatment of critically ill patients. The same monitor can be used to assess physical fitness, in particular muscle weakness and the benefits of exercise countermeasures in space. On Earth, this lightweight instrument can help optimize physical rehabilitation, and can be useful in ambulances and intensive care units and on the battlefield.

Expanding Medical Care
Scott A. Dulchavsky, M.D., Ph.D., Henry Ford Health System, Detroit, MI
Diagnosis and management of health problems in space can be difficult due to limited training and a lack of reference to body changes in microgravity. This project is determining the utility of miniaturized ultrasound in space for health situations with high potential mission impact. Optimized training regimens and computer-based refresher modules allow non-medical personnel to easily perform ultrasound imaging in space. These same techniques are readily transferable to Earth-based medicine, including rural and military applications. Initial diagnostic approaches have been successfully used in athlete health care including professional hockey, baseball, and the United States Olympic Team.

Nutrition/Fitness Countermeasures: Supplements, Exercise and Technology
Joanne R. Lupton, Ph.D., Texas A&M University, College Station, TX
Douglas Paddon-Jones, Ph.D., University of Arkansas for Medical Sciences, Little Rock, AR
In the US, obesity has doubled in adults in the last 30 years and has tripled in children. An amino acid supplement, aided by an associated exercise protocol, has been developed to protect against loss of muscle mass and strength which may occur in space. Additional work targets a supplement of fish oil and pectin as a countermeasure to radiation-enhanced colon cancer, together with a noninvasive companion technology for monitoring genetic changes associated with early detection of colon cancer. The amino acid supplements are currently undergoing clinical trials in burn patients to speed recovery of muscle loss and are also relevant to patients confined to bed. The colon cancer detection procedure is also presently in clinical trials.