



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 spaceflights. 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. Cartreine, 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.

Optimized Lighting: Combating Sleep Loss and Shift Work Problems

George C. Brainard, Ph.D., Jefferson Medical College of Thomas Jefferson University, Philadelphia, PA

Risk factors for the health and safety of astronauts include sleep loss and disturbed circadian rhythms that can result in decrements in alertness and performance. The research goal is to determine the best combination of wavelengths for use as a lighting countermeasure for sleep and circadian disruption during spaceflight. Prototype lighting systems enriched in the blue portion of the spectrum are currently being tested. If the prototypes are effective, they may be useful in space exploration as well as for treating sleep disruption in civilians with problems related to shift work and intercontinental jet travel.

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.

Objective Self Test to Measure Fatigue

David F. Dinges, Ph.D., University of Pennsylvania School of Medicine, Philadelphia, PA

Fatigue from high workload and sleep loss is a common risk to astronauts. This team has developed a brief, valid, reliable, objective measure of fatigue for use by astronauts on the International Space Station, based on psychomotor vigilance test (PVT) performance. The 3-minute PVT Self Test can determine the extent to which fatigue has altered nervous system speed and accuracy relative to sustained attention. Unaffected by aptitude or practice, the test rapidly informs astronauts of the need for fatigue countermeasures. The test has wide application to any group that must operate remotely at high levels of alertness, such as first responders, Homeland Security personnel, flight crews, special military operations, police and firefighters.

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.

Ultrasound Technology for Assessment of Bone Loss and Acceleration of Fracture Healing

Yi-Xian Qin, Ph.D., Stony Brook University, Stony Brook, NY

Bone loss represents a key health problem and is associated with aging, osteoporosis and long-term space missions. Loss of bone diminishes both the structure and strength of bone, which can significantly reduce the bone's ability to resist fracture. This project team is developing a new, integrated ultrasound technology called Scanning Confocal Acoustic Navigation, or SCAN. The SCAN technology can assess bone parameters beyond mineral density, namely bone qualities such as strength, structure and stiffness. The device can also be beneficial for guided fracture healing with ultrasound. The team expects to develop a noninvasive, small, mobile SCAN device that would be easy to use in clinics and during space missions.