National Aeronautics and Space Administration

# *Recognition of Excellence in Aging Research*
# *Gerontological Society of America*
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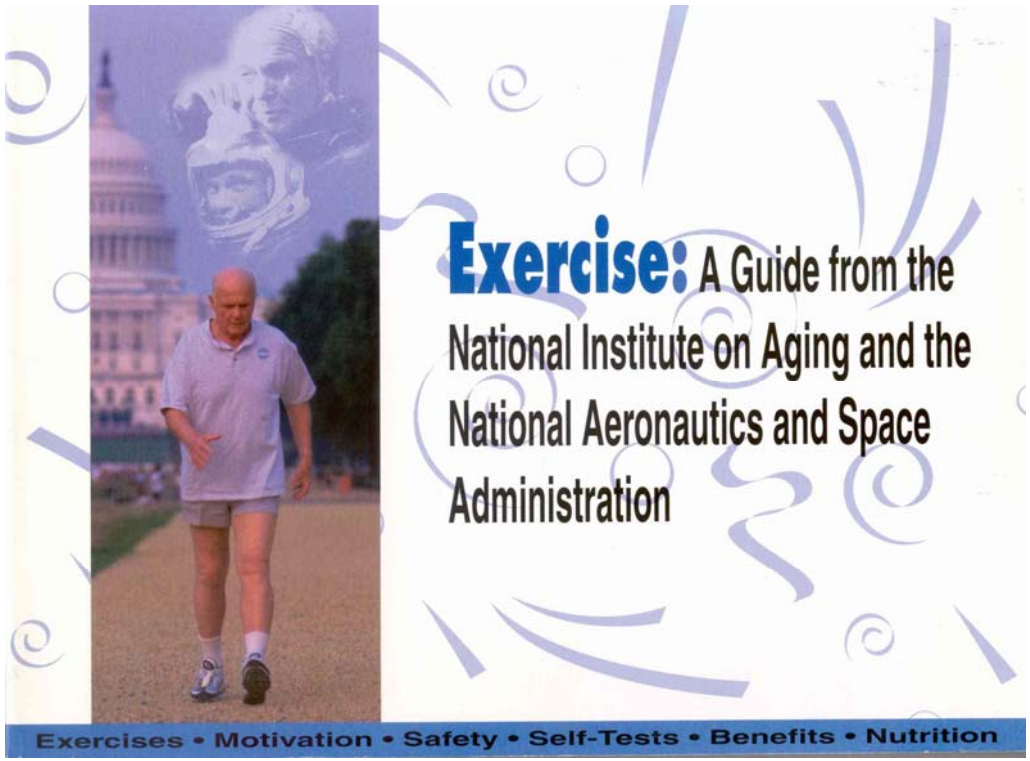
# *Human Research Program and Aging Research*

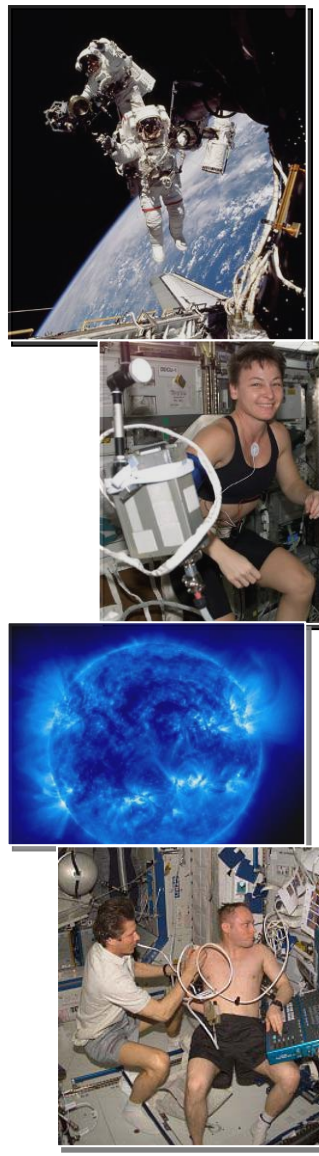
- **NASA's Human Research Program undertakes biomedical research and develops technologies to assure human health, safety, and performance during space exploration missions to the moon and Mars**
  - Because some of the effects of space flight on astronauts have similarities to the effects of human aging, NASA's research on astronaut health may offer significant utility for treatment of the elderly.

- **NASA and NIH/NIA Cooperation**
  - Many of NASA researchers are also NIH researchers
    - NASA leverages off the National biomedical infrastructure
    - NASA returns contributions from its research activities and technology development
  - STS-95
    - Balance Studies
    - Cardiovascular Deconditioning
    - Exercise Guide



# Human Research Program Investment Areas

- **Space Radiation:** Human health effects, limiting factors for vehicle environments and crew selection; computational shielding modeling; measurement and warning technologies
- **Exploration Medical Capability:** Medical care and crew health maintenance technologies; medical data management; probabilistic risk assessment
- **Human Health Countermeasures:** Integrated physiological, pharmacological, and nutritional countermeasures suite; Lunar Extra-Vehicular Activity (EVA) related physiology research
- **Behavioral Health & Performance:** Behavioral health selection, assessment, and training capabilities; intervention and communication techniques
- **Space Human Factors & Habitability:** Anthropometry, display/control, cognition, habitability, lighting, ergonomics; advanced food development; lunar dust toxicological testing
- **ISS Medical Project:** ISS research integration and operations, including Human Research Facility Racks 1 & 2
- **National Space Biomedical Research Institute (NSBRI):** Cooperative agreement funding that supports investigators at more than 70 institutions across the United States in 22 states working on crew health risks associated with exploration missions



# Evidence/Risk-based Management Approach

Human Research Program Architecture: Evidence Risks Gaps Tasks Deliverables

## SHFH Risks

Risk of Error Due to Inadequate Information

Risk Associated with Poor Task Design

Risk of Adverse Health Affects from Lunar Dust Exposure

Risk Factor of Inadequate/Inefficient Food System

Risk of Reduced Safety and Efficiency Due to Poor Human Factors Design

## BHP Risks

Risk of Behavioral and Psychiatric Conditions

Risk of Performance Errors Due to Sleep Loss, Circadian Desynchronization, Fatigue and Work Overload

Risk of Performance Errors Due to Poor Team Cohesion and Performance, Inadequate Selection/Team Composition, Inadequate Training, and Poor Psychosocial Adaptation

## Space Radiation Risks

Risk of Radiation Carcinogenesis

Risk of Acute Radiation Syndromes Due to Solar Particle Events

Risk of Acute or Late Central Nervous System Effects from Radiation Exposure

Risk of Degenerative Tissue or other Health Effects from Radiation Exposure

## ExMC Risks

Risk of Inability to Adequately Treat and Ill or Injured Crew Member

## HHC Risks

Risk of Accelerated Osteoporosis

Risk of Orthostatic Intolerance During Re-Exposure to Gravity

Risk of Inaccurate Assessment of Cardiovascular Performance

Risk Factor of Inadequate Nutrition

Risk of Compromised EVA Performance and Crew Health Due to Inadequate EVA Suit Systems

Risk of Impaired Performance Due to Reduced Muscle Mass, Strength and Endurance

Risk of Operational Impact of Prolonged Daily Required Exercise

Risk of Bone Fracture

Risk of Invertebral Disc Damage

Risk of Renal Stone Formation

Risk of Cardiac Rhythm Problems

Risk of Reduced Physical Performance Capabilities Due to Reduced Aerobic Capacity

Risk of Crew Adverse Health Event Due to Altered Immune Response

Risk of Impaired Ability to Maintain Control of Vehicles and Other Complex Systems

Risk of Therapeutic Failure Due to Ineffectiveness of Medicine

# *Human Research Program and Aging Research*

- **Balance and Gait Control**
  - Falls in astronauts and the elderly can be caused by problems with the sense of balance. Astronaut's nervous systems adapt to weightlessness in ways that disturb balance and gait when they return to Earth or land on another planet.
  - The human nervous system has evolved components that optimize body movements and posture control under Earth's gravity. Both space flight and aging affect the performance of the components. NASA is investigating ways to help astronauts "learn how to learn" to adapt to new gravitational environments. This involves techniques that systematically test and challenge the balance and gait control systems.

- **Orthostatic Hypotension**
  - The decrease of blood pressure while standing upright may lead to fainting, falls and thus injuries in astronauts and the elderly. Astronauts' orthostatic hypotension has been shown to be related to dehydration and blunted functioning of the cardiovascular control system, and there is evidence of similar mechanisms in elderly hypotensive patients.
  - NASA's work in understanding this problem in astronauts has suggested treatments ranging from mechanical support, to oral rehydration, to a medication named Midodrine that augments the nervous system's control of the circulation.

- **Osteoporosis and Bone Fracture Risk**
  - The injuries from falls in the elderly are often manifested in bone fractures, which are also a significant risk to astronauts if they occur during stressful missions on another planet, at a great distance from definitive medical care on Earth.
  - Osteoporosis is perceived as a disease of the elderly because the inevitable loss of bone mass with aging occurs by a slow, chronic process that does not display symptoms until a low-trauma fracture occurs. But loss of bone strength happens in young, fit astronauts at a much faster rate than in the elderly, in a process that NASA calls premature osteoporosis. This is a long-term health risk to astronauts after a space flight, as well as a risk during the mission.

# *Human Research Program and Aging Research*

- **Impaired Nutrition and Vitamin D Metabolism**
  - Many of NASA's nutritional biochemistry efforts have important applications to the elderly, foremost among them NASA's vitamin D research.
  - This involves astronauts in spaceflight, scientists in the Antarctic, and the self-neglecting elderly. NASA collaborated with the Surgeon General's Office in 2004 and 2005 in conferences titled "Vitamin D and Bone Health Conference: An Update from Earth and Outer Space."

- **Reduced Immunological Response**
  - Innate immunity, the first line response to bacterial infections, is diminished in up to 20% of adults over age 65 who do not develop fevers in response to infections. Immunity has been found to be altered during and following space flight.
  - In particular, the reversible nature of the space flight effects offers hope for slowing or even reversing the effects of aging. Specifically, astronauts have exhibited altered number and function of immune cells and reactivation of latent herpesviruses.

- **Noninvasive Behavioral Health Techniques**
  - There are neurobehavioral and psychosocial factors that influence both the elderly and astronauts including risk of depression, sleep disorders, and cognitive function changes that can benefit from noninvasive techniques.
  - These noninvasive behavioral health techniques can aid physicians to provide treatments for individuals at risk, to enable them to continue leading productive and healthy lives, whether in space or on Earth.

# *ISS Increment 18: Aging Related Research*

- **TMA-13 (17S), launched October 12, 2008** at 3:01:38am EDT carrying ISS-18 CDR Michael Fincke (first American to launch twice on a Soyuz), Soyuz CDR/ISS-18 FE-1 Yuri Lonchakov, and SFP/VC15 Richard Garriott.
  - **Increment 18 ISS crew members are participating in the following HRP studies:**
    - **Integrated Immune** (Validation of Procedures for Monitoring Crew Member Immune Function): Collect and analyze blood, urine and saliva samples from crewmembers before, during and after space flight to monitor changes in the immune system.
    - **Bisphosphonates (**Bisphosphonates as a Countermeasure to Space Flight Induced Bone Loss) will determine whether anti-resorptive agents in conjunction with the routine in-flight exercise program, will protect ISS crew members from the bone loss documented on previous missions. Cooperative activity with JAXA
    - **Sleep** (Sleep-Wake Actigraphy and Light Exposure During Spaceflight-Long) will examine the effects of spaceflight on the sleep-wake cycles of the crew members during long-duration stays on the ISS.
    - **Nutrition** (Nutritional Status Assessment) is NASA's most comprehensive in-flight study to date of human physiologic changes during long-duration spaceflight. This study will impact both the definition of nutritional requirements and development of food systems for future space exploration missions to the moon and beyond. This experiment also will help researchers understand the impact of countermeasures, such as exercise and pharmaceuticals, on nutritional status and nutrient requirements for astronauts.

# *Technologies Under Development*

- **Orthopedic implant decontamination**
  - NASA's research on low Earth orbital atomic oxygen and materials testing, developed a process for removal of biologically active contaminants from the surfaces of orthopedic implants.
  - Most orthopedic implants have endotoxins on their surfaces, which cause inflammation and pain. Such responses can lead to joint loosening and implant failure. Implant surface exposure to atomic oxygen has been demonstrated to fully remove all endotoxins thus minimizing the chances of inflammation in the patient after surgery.

- **Biomedical Wireless and Ambulatory Telemetry for Crew Health (BioWATCH)**
  - Wireless biometric monitoring system originally designed to monitor astronaut health in space. It can measure heart rate, blood pressure, glucose, temperature, joint angle, ECG, and blood oxygenation, and then send the information to doctors on Earth in real time.
  - Commercial version of BioWATCH transmits data to doctors wirelessly via cell phone, wireless internet or Bluetooth. It can be configured to monitor various conditions, which makes it ideal for post-surgery patients, participants in clinical drug trials, and home healthcare patients.

- **Remote Medical Capability**
  - Ultrasound has been utilized as a non-invasive imaging tool, and NASA researchers and the medical community continue to improve the capability to use this tool for telemedicine assessment and enhanced care delivery.
  - NASA supported efforts developing procedures and training for remote guided ultrasound has increased the utility of this technique for potential use in emergency vehicles, rural care, assisted living facilities, military conflicts, and third world medicine on Earth.