Human Analogs

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Overview

- Analogs that support NASA investigations
  - NEEMO
  - Haughton-Mars
  - Antarctica
- Flight Analogs Project Bed Rest Facility
  - Standard Conditions
  - Standard Measures
  - Study Selection Process
NEEMO

- NASA Extreme Environment Mission Operations
  - Located 3.5 miles off of Key Largo, FL

- Facility Operations:
  - National Oceanic & Atmospheric Administration (NOAA)
  - National Undersea Research Center at University of North Carolina, Wilmington (NURC)
NEEMO

- **Aquarius**
  - Underwater habitat - an environment similar to living in space
  - Operating depth 47 feet
  - 11 cubic meters living/lab space, similar to Destiny module of the ISS

- **Application**
  - Isolation/conf confinement
  - Telemedicine
  - Extravehicular activities
  - Simulations of partial gravity
NEEMO

**Investigations**
- Zwart SR, Kala G, Smith SM. *Body iron stores and oxidative damage increased after a 10- to 12-day undersea dive in humans.* J Nutr 139:90-95, 2009.
- PI: D Dinges. *Vigilance, Stress and Sleep/Wake Measurements - NEEMO 13*
- PI: N Kanas. *Effects of High vs Low Autonomy on Space Crewmember Performance -NEEMO 13*
- PI: M. Gernhardt. *Advanced Extravehicular Activity (EVA) Exploration Activities Study to Assess Human Performance Responses in Partial Gravity Environments*

**For more information**
- [http://www.uncw.edu/aquarius](http://www.uncw.edu/aquarius)
Haughton-Mars

- **Location**
  - Site of the Haughton meteorite impact crater
  - Devon Island in the Canadian high arctic

- **Facility Operations**
  - Mars Institute
  - SETI Institute (Search for Extraterrestrial Intelligence)
Haughton-Mars

- Haughton-Mars Project
  - International, interdisciplinary field research project
  - Rocky, polar desert setting provides insights into the evolution of Mars
  - Terrestrial analog for Mars and lunar studies

- Application
  - Human performance
    - physical
    - behavioral
  - Extravehicular activity systems
  - Human factors
Haughton-Mars

- **Investigations**

- **For more information**
  - [http://www.marsonearth.org](http://www.marsonearth.org)
Antarctica

- 64 stations operated by 20 countries
- United States Antarctic Program
  - National Science Foundation, Office of Polar Programs
- 3 year-round research stations
  - Palmer Station
  - Amundsen-Scott South Pole Station
  - McMurdo station
    - Main US station
    - Located on Ross Island
Antarctica

- Antarctic environment
  - Climate, terrain, temperature, isolation and stress parallels that of long-duration space missions

- Application
  - Isolation/confine-ment
  - Physiological stress
  - Disrupted circadian rhythms
  - Telemedicine
Antarctica

- Investigations
  - Smith SM, Gardner KK, Locke J, Zwart SR. Vitamin D supplementation during Antarctic winter. *Am J Clin Nutr (in press).*

- For more information
Involvement in Analogs

- NASA Research Announcement
  - Scientific Review Panels – Scientific Merit
- Directed Studies in collaboration with NASA labs
  - Non-advocate review process – Scientific Merit
- Human Research Program (HRP)
  - prioritizes proposals based upon relevance to the HRP Integrated Research Plan
  - approves and funds relevant protocols
- Proposals integrated as appropriate into analog missions
Involvement in Analogs

- Developing website
  - Detailed analog information
  - Schedules and timelines

- Contact information
  - **Joe Neigut**, Flight Analogs Project Manager
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  - **Jon McFather**, Flight Analogs Deputy Project Manager
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  - **Pamela Baskin**, Mission Coordinator
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Flight Analog

- 6º Head-down Tilt
  - serves as a model for studying the physiological changes that occur during spaceflight under controlled conditions;
  - provides a ground-based platform for comparison to spaceflight;
  - provides a mechanism for testing countermeasures prior to being used in flight.
NASA Flight Analogs Research Unit

University of Texas Medical Branch

Children’s Hospital

Flight Analogs Research Unit
Standard Conditions

- 6º HDT bed rest
- Room Temperature: 70-74º
- Study duration ~87 days
  - 13-15 days pre-bed rest
  - 60 days in bed
  - 14 days recovery
- Sleep/Wake cycle
  - Wake at 0600 hrs
  - Lights out at 2200 hrs
Standard Conditions

- Monitored 24 hrs/day
  - Subject monitors
  - cameras
- Daily Vital signs
  - Blood pressure
  - Heart rate
  - Body temperature
  - Respiratory rate
  - Body weight (bed scale)
- Fluid intake and output is measured
- Psychological support provided
Standard Conditions

- Stretching twice each day
- Physiotherapy (massage therapy)
  - every other day during bed rest
  - daily for 1st week post bed rest
- No exercise permitted
Standard Diet

- Isocaloric diet based on NASA spaceflight nutritional requirements
- Caloric intake 35.7 kcal/kg body weight (2500 calories/70 kg subject)
- Fluid intake 28.5 ml/kg body weight (2000 ml/70 kg subject)
- Carbohydrate:Fat:Protein ratio 55:30:15
- No caffeine, cocoa, chocolate, tea or herbal beverages
- All food must be consumed
- Caloric intake adjusted to maintain weight within 5%
Purpose of Standard Measures

- Characterize human physiological responses to head down tilt bed rest.
- Provide a basis for comparison between bed rest and spaceflight.
  - Many standard measures are medical requirements for long-duration spaceflight
- Provide a mechanism to assess candidate countermeasures in a multidisciplinary manner to determine outcomes on non-targeted systems.
Standard Measures

- **Clinical Laboratory Assessment**
  - Blood and urine studies to monitor subject health

- **Immune Status**
  - General immune status
  - Viral specific immunity
  - Latent Viral Reactivation
  - Physiological stress

- **Nutrition**
  - Nutritional analysis
  - Markers of bone resorption and bone formation
  - Circulating bone and calcium regulatory factors
  - Antioxidants and oxidative damage
Standard Measures

- **Bone Assessment**
  - Dual Energy X-Ray Absorptiometry (DXA) – Bone Density
Standard Measures

- **Physical Fitness**
  - Isokinetic Testing – muscle strength/endurance
  - Cycle Ergometry – maximum aerobic capacity
  - Functional Fitness – strength, endurance, flexibility
Standard Measures

- Functional Neurological Assessment
  - Posturography testing –– standing posture
  - Stretch Reflex –– monosynaptic
Standard Measures

- Cardiovascular
  - Operational Tilt Test – orthostatic tolerance
  - Blood volume – carbon monoxide rebreathing
  - Echocardiography – hemodynamic assessment


Selection of Studies for Bed Rest

- **Review Process**
  - NASA/NSBRI Research Announcement
    - Scientific Review Panels – Scientific Merit
  - Directed Studies in collaboration with NASA labs
    - Non-advocate review process – Scientific Merit
  - Human Research Program (HRP)
    - prioritizes proposals based upon relevance to the HRP Integrated Research Plan;
    - approves relevant protocols;
    - provides protocols to the Flight Analogs Project for implementation.
- Flight Analogs Project operates and maintains the bed rest facility as a service to our PIs and does not directly fund studies.
Protocol Implementation

- Compatible projects are integrated into a campaign.
- Human Use Boards
  - PI provides approved protocol from home institution.
  - FAP coordinates submission of integrated campaign to JSC & UTMB.
- Stand alone studies
- PI works directly with human use boards at JSC & UTMB after obtaining approvals at home institution.
Protocol Implementation

- Subjects recruited/screened through FAP
- FAP monitors day-to-day operations at the Flight Analogs Research Unit
  - Attending physician and nursing staff
  - Medical monitors
  - Coordinators
  - Subject Monitors
- FAP provides the bed rest facility as a service and does not administer PI studies
  - PI supports
    - costs of equipment and testing requirements
    - personnel to run testing, collect/handle samples and data
Protocol Implementation

- FAP develop data management and sharing plans
  - Assist with access to Life Sciences Data Warehouse for data transfer
  - Provide access to standard measures data for use by PIs
Flight Analogs

- Tour of the Flight Analogs Research Unit
  - 1:00, Wednesday, February 4th
  - Sign-up following Plenary Session

- Lunar Analog Session
  - 3:30-5:30, Salons C&F
Contact Information

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