NASA Life Sciences Data Repositories: Tools for Retrospective Analysis and Future Planning

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Data Repository Goals

• Enable combination of medical and research data where applicable to reduce astronaut spaceflight health and performance risks
  – Support operational and health care analyses
  – Support NASA research objectives

• Improve dissemination of and access to NASA life sciences data and information
Providing Data and Information to the Research and Operations Communities

Life Sciences Data Archive URL: http://lsda.jsc.nasa.gov
Online Searchable Catalog: Current Research Projects

Archived non-attributable data can be downloaded directly from the public website.

<table>
<thead>
<tr>
<th>Data Set Name</th>
<th>Resting Gas Exchange in ISS Crewmembers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Set Description</td>
<td>Pulmonary function tests were performed on eight crewmembers (7 male, 1 female) of the International Space Station who performed a total of 15 extravehicular activities (EVAs) and who followed disinfection procedures approved for EVA from the International Space Station. Of these EVAs, nine were performed using the Russian Orlan suits and six were performed using the US Extravehicular Mobility Unit (EMU). Source: Fridk GK, Fink JM, Cooper TK, and West JB. Pulmonary gas exchange is not impaired 24 h after extravehicular activity. J Appl Physiol 2005;99:2259-2266.</td>
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<td>Level of Processing</td>
<td>Analyzed - Microsoft Excel Spreadsheet</td>
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<tr>
<td>Data Files [Available online]</td>
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<tr>
<td>Measurements</td>
<td>Alveolar dead space (VDAIV)</td>
</tr>
<tr>
<td></td>
<td>Alveolar ventilation (VA)</td>
</tr>
<tr>
<td></td>
<td>Average inspiratory flow rate (VT/TI)</td>
</tr>
<tr>
<td></td>
<td>Breathing frequency (fB)</td>
</tr>
<tr>
<td></td>
<td>Cabin pressure</td>
</tr>
<tr>
<td></td>
<td>Carbon dioxide production (VO2)</td>
</tr>
</tbody>
</table>
Online Searchable Catalog: Completed Research Projects

A significant addition to the archive content is the Detailed Supplemental Objectives data

Shuttle Detailed Supplementary Objectives (DSO)

Conducted aboard the Space Shuttle, Detailed Supplementary Objectives (DSO) were medical investigations supplementary to the primary Shuttle payload performed voluntarily by the crewmembers. DSOs flown on Shuttle missions were designed to require minimal crew time, power and stowage. DSOs focused on studying adaptation to microgravity (specifically, space motion sickness) as well as cardiovascular deconditioning, muscle loss, changes in coordination and balance strategies, radiation exposure, pharmacokinetics and changes in the body's biochemistry.

Related Experiments

- Acceleration Detection Sensitivity (DSO 465)
- Adaptation to Linear Acceleration After Space Flight (DSO 207)
- Air Monitoring and Atmosphere Characterization (DSO 611)
- Ambulatory Monitoring (DSO 416)
- Anatomical Observation (DSO 422)
- Animal Enclosure Module In-flight Test (DSO 421)
- Assessment of Circadian Shifting in Astronauts by Bright Light (DSO 484)
- Assessment of Human Factors (DSO 304)
Research Publications: Electronic Books

Links are provided to related websites

<table>
<thead>
<tr>
<th>CURRENT NASA PROJECTS:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human Research Program (HRP)</strong></td>
</tr>
<tr>
<td><strong>Lifetime Surveillance of Astronaut Health (LSAH)</strong></td>
</tr>
<tr>
<td><strong>Medical Operations</strong></td>
</tr>
<tr>
<td><strong>IIASA Technical Reports Server</strong></td>
</tr>
</tbody>
</table>

**Complete NASA Projects:**

- **Project Mercury**
  - Space Medicine in Project Mercury

- **Gemini Program**
  - Gemini Mid-Program Conference

- **Apollo Program**
  - Biomedical Results of Apollo

- **Apollo-Soyuz Test Project**
  - Medical Report

- **Skylab Program**
  - Biomedical Results of Skylab
  - Recent publications: The Skylab Medical Operations Project: Recommendations to Improve Crew Health and Performance for Future Exploration Missions

- **Shuttle Program**
  - The Neurolab Spacelab Mission: Neuroscience Research in Space Extended Duration Orbiter Medical Project - Final Report

- **Lunar Mars Life Support Test Project (LMLSTP)**
  - Isolation: NASA Experiments in Closed Environment Living + Whole book + Each chapter

- **Fundamental Biology/Animal and Plant Research**
  - Life Info: Space, Volumes 1, 2 and 3 - Fundamental Biology

Research program publications can be read online or downloaded

3/25/2011

18th IAA Humans in Space Conference 2011
Animal Research Data: Biospecimen Sharing Program

- Animal biospecimens include organisms that have flown in space and subjects of related ground control studies
  - Available samples are surplus (unassigned) biospecimens
- Applicants may submit proposals specifically for analysis of materials obtained from this program or as a supplementary component of an experiment proposal in another research area

The search term “Muscular” returns the following result:

<table>
<thead>
<tr>
<th>Name</th>
<th>ID</th>
<th>Species</th>
<th>Collection Phase</th>
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<td>Rat</td>
<td>Postflight</td>
<td>Flight</td>
</tr>
<tr>
<td>Adductor longus</td>
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<td>Rat</td>
<td>Preflight</td>
<td>Basal</td>
</tr>
<tr>
<td>Adductor longus</td>
<td>4824</td>
<td>Rat</td>
<td>Postflight</td>
<td>Flight control</td>
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<tr>
<td>Adductor longus</td>
<td>4825</td>
<td>Rat</td>
<td>Postflight</td>
<td>Ground control</td>
</tr>
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</table>
Clinical Data: Lifetime Surveillance of Astronaut Health

• The Longitudinal Study of Astronaut Health was closed out and control subjects were released in May 2010.
• The new LSAH program will continue to examine the incidence of acute & chronic morbidity and mortality of astronauts, and define the risks of morbidity and mortality associated with the occupational exposures encountered by astronauts.
• All astronauts selected into the US space program will be monitored throughout their NASA career and retirement from the astronaut corps.
• The major goals of the new program are:
  - Develop and Provide a Comprehensive Annual Medical Exam for each LSAH Participant
  - Conduct Occupational Surveillance
  - Improve Communication, Data Accessibility, Integrity and Storage
  - Support Operational and Health Care Analyses
  - Support NASA Research Objectives
Clinical Data: Medical Tests Performed

Medical Operations

The Space Medicine Division mission is to optimize the health, fitness, and well-being of flight crews.

Astronaut medical data are collected per requirements detailed in the Medical Requirements Integration Documents (MRIDs). Data collected during these medical tests are generally housed in the Lifetime Surveillance of Astronaut Health (LSAH) repository. These test protocols are divided into areas as shown below. Each MRID will give an indication of the type of testing performed as well as the frequency of such tests.

Annual medical exam & flight-related medical requirements

Other data from tests performed for clinical purposes may also be available

<table>
<thead>
<tr>
<th>Discipline</th>
<th>MRID#</th>
<th>MEDB#</th>
<th>Medical Requirement Title</th>
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<td>+ Pre- and Postflight Physical Exam for Long Duration Crews</td>
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<td>Therapeutics and Clinical Care</td>
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<td>+ Pre- and Postflight Physical Exam for Short Duration Crews</td>
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<tr>
<td>Therapeutics and Clinical Care</td>
<td>MR010L</td>
<td></td>
<td>+ Clinical Laboratory Assessment for Long Duration Flights</td>
</tr>
<tr>
<td>Therapeutics and Clinical Care</td>
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<td>MEDB 1.6</td>
<td>+ Clinical Laboratory Assessment for Shuttle</td>
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<tr>
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<td>MR011L</td>
<td>MEDB 1.9</td>
<td>+ Dental Examination</td>
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<td>+ Audiometry for ISS</td>
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<tr>
<td>Therapeutics and Clinical Care</td>
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<td>+ Audiometry for Shuttle Crews</td>
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<td>MEDB 1.10</td>
<td>+ Ophthalmology Examination</td>
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<td>Therapeutics and Clinical Care</td>
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<td></td>
<td>+ Pre- and Postflight Ophthalmology Examination for Short Duration Flights</td>
</tr>
<tr>
<td>Therapeutics and Clinical Care</td>
<td>MR015L</td>
<td>MEDB 1.12</td>
<td>+ Ultrasound Imaging (Sonography)</td>
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</tbody>
</table>
Clinical Data: Access to LSAH Findings

- Disseminate results of surveillance to participants, stakeholders, the research community, and the public
  - The LSAH newsletter is published semi-annually as a communication vehicle for results gained through the surveillance process and changes to the program.
  - Surveillance results are also published in official NASA technical papers, books, and in peer-reviewed scientific journals.
  - Other vehicles for communication of surveillance results are under development.
The portal provides guidance to researchers on requesting data from the LSDA and LSAH repositories.
Online Data Request Form

*One request form for all repositories
(LSDA, LSAH, and Animal Biospecimens)
Data Request Fulfillment

Data Request Clearinghouse

LSAH Data

LSDA Data

Confirm with Requester

Data Availability Check

Retrieval missing data

Mission Medical Records
LSDA Archive
Training Records
Clinic/LSAH Records
Vehicle Environmental Data
Biospecimen Data
Research Study/Laboratory Data
Questionnaires/Surveys

Assimilate Data from Various Sources

Request Approval Process:

- Request purpose?
- Merit established?
- Attributable data?
- Consent necessary?

Request approved

Request not approved

Requester notified of anticipated schedule; signs data use agreement

Data sent to Requester

Notify requester; modify request

Perform Data Quality Assurance

Obtain more info

Automated email to requester
Team Approach to Fulfilling Data Requests

57 data requests completed October 1, 2010 through March 3, 2011

• Provide data in response to Data Requests
  – Data requests from flight surgeons, NASA management, subject matter experts, and researchers will be processed and dispositioned in an integrated manner.
  – Data requests will be processed jointly by LSAH and LSDA personnel to assure the requester is provided access to all available and relevant data
  – LSDA and LSAH will partner with each requester to understand their needs & provide the most relevant data, whether medical, research, or a combination of both.
  – Data requests in support of NRAs and RFPs

• Sample uses of LSAH and LSDA data and information:
  – Astronaut fracture incidence rates for current flight experiment background information
  – Incidence of corneal abrasion in Apollo crew due to lunar dust exposure to evaluate animal model
  – Interest in ISSMP Intravenous Fluid Generation (IVGEN) study for military application
  – Technical documentation on ISS treadmill and cycle ergometer vibration isolation systems
  – Intraocular Pressure Data – historical LSAH/LSDA data to understand evolving issue
  – Medical event data to populate a Space Medicine Exploration Medical Condition List
  – Integration of Evidence Base into a Probabilistic Risk Assessment (“Integrated Medical Model”)
Plans for the Future

• **LSDA Content Expansion:**
  – Historical Detailed Supplemental Objectives (almost complete)
  – Historical Detailed Technical Objectives (in progress)
  – HRP Directed Research (in progress)
  – Flight Analog Extramural Studies (ongoing)
  – Future Desired Content
    • NSBRI Ground-based Studies
    • International Partner Studies

• **LSAH Occupational Surveillance Data:**
  – Develop individual exposure profiles, additional annual screening tests
  – Increased surveillance for spaceflight medical events, associated health trends
  – Conduct operational investigations (e.g., shoulder injury; intraocular pressure)

• **Early involvement in NRA and CPHS processes to facilitate data availability**

• **Consent astronauts for future uses of data**
  – LSAH: use of medical data for research purposes
  – LSDA: use of existing research data for future research studies
Backup Slides
Data Analysis Timeline Example: Cancer Morbidity

Year 1: Predominantly Data Analysis
Year 2: Predominantly Dissemination of Findings, Follow-Up Analyses and Board Approvals

Legend: Black=Reports & presentations, Green=Data cleaning, Purple=Statistical analysis, Blue=Manuscript preparation
Data Processing Workflow

1. Confirm case definitions, parameters required, and statistical analysis plan with requester
2. Identify data sources
   - EMR, LSAH, BDRA or MMR database
   - SKYSF Lab database
   - LSDA database
   - MedOps Flight Surgeon Records
   - Hardcopy Records
3. Extract data
   - Request data
   - Request data
   - Contact Flight Surgeon
4. Data is obtained from various sources in multiple formats
5. Clean data sets
   - Convert test data to discrete analyzable components
   - Check data for outliers, invalid values, internal integrity, and other indicators of accuracy
   - Merge data from multiple sources into usable data file(s)
6. Transfer cleaned and verified data to requestor
7. Conduct statistical analysis per a priori plan
   - Summarize and interpret results of statistical analysis
8. Correct original source databases
9. Provide summary results/report to requestor
Abstract

As NASA transitions from the Space Shuttle era into the next phase of space exploration, the need to ensure the capture, analysis, and application of its research and medical data is of greater urgency than at any other previous time. In this era of limited resources and challenging schedules, the Human Research Program (HRP) based at NASA’s Johnson Space Center (JSC) recognizes the need to extract the greatest possible amount of information from the data already captured, as well as focus current and future research funding on addressing the HRP goal to provide human health and performance countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration. To this end, the Science Management Office and the Medical Informatics and Health Care Systems Branch within the HRP and the Space Medicine Division have been working to make both research data and clinical data more accessible to the user community.
Abstract (continued)

• The Life Sciences Data Archive (LSDA), the research repository housing data and information regarding the physiologic effects of microgravity, and the Lifetime Surveillance of Astronaut Health (LSAH-R), the clinical repository housing astronaut data, have joined forces to achieve this goal. The task of both repositories is to acquire, preserve, and distribute data and information both within the NASA community and to the science community at large. This is accomplished via the LSDA’s public website (http://lsda.jsc.nasa.gov), which allows access to experiment descriptions including hardware, datasets, key personnel, mission descriptions and a mechanism for researchers to request additional data, research and clinical, that is not accessible from the public website. This will result in making the work of NASA and its partners available to the wider sciences community, both domestic and international. The desired outcome is the use of these data for knowledge discovery, retrospective analysis, and planning of future research studies.