A SUMMARY OF PRINCIPAL INVESTIGATORS' 180-DAY REPORTS

SLS-1 Flight Experiments Preliminary Significant Results

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NASA SPACELAB LIFE SCIENCES 1

(NASA-TM-108033) SLS-1 FLIGHT EXPERIMENTS PRELIMINARY SIGNIFICANT RESULTS (NASA) 39 p

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ORIGINAL PAGE COLOR PHOTOGRAPH

492933
SLS-1 CREW

Clockwise from back left:
O'Connor, Jernigan, Hughes-Fulford,
Guiterrez, Seddon, Bagian, Gaffney

Spacelab Life Sciences 1
The 16 experiments selected for flight on SLS-1 investigated the cardiopulmonary/cardiovascular, neurological, muscularkeletal, and neuropsychology disciplines in both human and rodent models. Preliminary results gave insight to mechanisms involved in the adaptation to the microgravity environment and readaptation when returning to Earth. The experimental results will be used to promote health and safety for future long duration space flights and, as in the past, will be applied to many biomedical problems encountered here on Earth.

The integrated experiments to determine the underlying mechanisms responsible for the observed phenomona. Early missions led to the formulation of several hypotheses from the physiological effects observed during subsequent readaptation to gravity (1 G). Hypotheses to investigate the mechanisms involved in the physiological adaptation to weightlessness and the first of a series dedicated life sciences Special lab Life Sciences 1 (SLS-1) is the first of a series
Spacelab provides the capability to perform life sciences research in space
Space Life Sciences 1

Spacelab Life Sciences 1 Mission Goals

- Test the validity of using rodents as human models
- Investigate the consequences of the body's adaptive responses to weightlessness and readjustment to 1 G
- Study the mechanisms, magnitudes, and time courses of physiological changes that occur during space flight
- Acquire fundamental scientific knowledge concerning space biological sciences
- Ensure the health, safety, and productivity of humans in space
SLS-1 was launched on June 5, 1991.
Special Life Sciences

Mission Profile

Research was conducted in the following disciplines:

- Neuroscience
- Musculoskeletal
- Regulatory Physiology
- Cardiovascular/Respiratory

Team consisting of 17 principal investigators and 35 co-investigators from 4 countries:

- 1 utilized jellyfish
- 7 utilized rodents
- 10 utilized human subjects

The primary payload consisted of 16 investigations:

Crew:
- 4 Payload crewmembers
- 3 Orbiter crewmembers

Duration: 9 days

Launch: June 5, 1991

United States
Switzerland
Canada
Australia
and blood pressure
and cardiac baroreflex receptors that control heart rate
and weightlessness to pulmonary function during exercise
cardiac dimensions at rest and during exercise
weightlessness affects the CV/CP response to stress
To determine how acute and prolonged exposure to
adaptation and readaptation to 1 G.

To quantify CV/CP decoupling by examining the
weightlessness to pulmonary function at 1 G
To compare pulmonary function during orthostatic intolerance.

To investigate the mechanisms contributing to the CV/CP
increase in heart rate and blood pressure, a decrease in
changes observed in previous space flights include an
Space flight has been shown to cause changes in the

EXPERIMENT OBJECTIVES

CARDIOVASCULAR/CARDIOPULMONARY

OVERVIEW
CV/CP measurements were made before and during exercise.
Special Life Sciences

Prior theory is unlikely, suggesting that interstitial pulmonary edema, contrary to monoxide, and the membrane-diffusing capacity. This capillary blood volume, the diffusing capacity of carbon increases were observed during light in the pulmonary RESPIRATORY SYSTEM.

Prelight levels within 7 days. Exercise capability had nearly returned to decreasing in stroke volume, cardiac output, and oxygen exercise levels was reduced after light due to the exercise capability, for both moderate and maximum.

EXERCISE CAPABILITY

RESULTS OF CARDIOVASCULAR/PULMONARY INVESTIGATIONS
Echocardiography was performed to study heart function.
Orthostatic intolerance affects human arterial function during light and contributes to exposure to weightlessness leads to a degradation of decreased cardiac output. By an increased heart rate response, resulting in a decrease in stroke volume, only partially compensated. This intolerance was characterized by a larger postural.

A postural orthostatic intolerance was observed.

Central venous pressure fell below preflight levels during light, stroke volume increased and heart rate remained unchanged, allowing cardiac output to remain unchanged, allowing central venous pressure to remain.

Concluded.

Results of Cardiovascular/Cardiopulmonary Investigations

Central Venous Pressure

Orthostatic Intolerance
Regulatory Physiology

Overview

Regulatory Physiology discipline consists of the
renal/endoctrine, the circulatory, and the immunological
systems. Changes that occur during early space flight
include a headward fluid shift and a decrease in total
body fluid, red blood cell (RBC) mass, and circulating
mass and plasma volume in human subjects and
To determine if the decrease in RBC mass is due to
adaptation to weightlessness are not completely
understood.

Various systems of the Regulatory Physiology discipline:
Five experiments on the SLS-1 mission investigated the
time of onset of the physiological response, and the
mechanisms causing the changes.

Renal/Endocrine System
To investigate the acute and adaptive changes in the
renal/endoctrine system, the circulatory, and the immunological
systems.

Circulatory System
To examine the reduction in the circulating RBC
RBC to 0 G
To determine if the decrease in RBC mass is due to
mass and plasma volume in human subjects and

Immunological System/Biotechnology
Rodents

Activation and proliferation
To study the effect of weightlessness on lymphocytes

Special Life Sciences
Samples were collected to study fluid volume regulation mechanisms.
Figure 2. Total Body Water

Figure 1. Renal Filtration

Results of Regulatory Physiology Investigations
The regulation of red blood cell production was studied in humans and rodents.
Special Life Sciences

T-lymphocytes.

by macrophages and not the lack of adhesion of
This was due to the decrease of interleukin-2 production
of microcarriers, activation was depressed 50 percent.
compared to the T-G controls, whereas in the absence
Presence of microcarriers was increased 100 percent.
indicate that T-lymphocyte activation at 0 G in the
these studies
indicate that T-lymphocyte activation studies in vitro. These studies
the use of microcarriers are available to conduct
With advances in biotechnology, applications such as

T-lymphocyte Production

IMMUNOLOGICAL SYSTEM/BIOENGINEERING

RBCs. Indicating a suppression of RBC production.
After high RBC incorporation of iron decreased in
remained constant, while reticulocyte levels increased in the
in humans during high RBC incorporation, the serum levels of iron
Iron Kinetics

unchanged in both humans and rodents.

ground control rodents, the RBC survival remained
decreased relative to body mass and RBC mass of
expression of erythropoietins. In rodents RBC mass
in human subjects RBC mass decreased, indicating a

Red Blood Cell Mass
differential during higher.

competent to differentiate into mature RBCs, failed to
The RBC precursor cells of rodents, which were

Regulation of Erythropoiesis

CIRCULATORY SYSTEM

(Concluded)

RESULTS OF REGULATORY PHYSIOLOGY INVESTIGATIONS
Musculoskeletal System

To study protein metabolism by measuring protein synthesis and breakdown rates and nitrogen balance

Muscular System

Experimemt Objectives

Six experiments on the SLS-1 mission investigated the effects of countermeasures to reduce or halt possible adverse musculoskeletal alterations critical for developing space. An understanding of the mechanisms causing which may affect how long humans can safely remain in physical fitness and a decrease in skeletal strength, muscle loss or muscle tissue and bone mineral during space

Overview
Changes in skeletal muscle function, structure, and biochemistry were investigated.
Bone loss

Skeletal System

Recovered immediately after injury.

Energy utilization

Aggravated by postinjury refeeding in 1 G.

Muscles show an atrophy-related vulnerability to muscle fiber and microvascular damage. These changes are not associated with a term-space injury. This increase in protein syntheses occurs during short-term response and not a ground-based bed rest.

Results of Musculoskeletal Investigations

Characteristics, making them less efficient for weight-bearing during early phases of recovery.

The slow-witch muscles acquired fast-witch muscle twitch muscles recovered a greater portion of mass than the fast-witch muscles. After injury the slow-witch when during injury more atrophy occurred in the slow-witch muscle mass occurs.

A significant decrease in rodent muscle mass occurs during injury and is partially replaced by 9 days after injury.
Three experiments were conducted in the Neuroscience discipline.

1. A role in altered sensory perception. The experiments suggested that structural changes in sensory organs may play a role in interpreting sensory perception. It has been hypothesized that adaptation also includes learning to interpret altered sensory perception. Researchers are critical in improving crew efficiency. The same principles discovered in the investigations of the visual, vestibular, and proprioceptive systems on a spatial orientation and adaptation to microgravity and subsequent readaptation to normal gravity are being studied. The stimulus is the same, but the stimuli are used by the systems to interpret the sensory information. Symptoms are similar to early motion sickness symptoms experienced by a large percentage of astronauts. SBS is sensory perception conflict. Early in flight SBS is a mussy to overcome space motion sickness (SMS) and weightlessness.

**EXPERIMENT OBJECTIVES**

**OVERVIEW**

**NEUROSCIENCE**
Measurements were made to study how the vestibular system relies on visual cues.
Special Life Sciences

Transient postural instability appears to be
caused by a combination of afferent muscle and
vestibular functions.

HUMAN VESTIBULAR EXPERIMENT

RESULTS OF NEUROSCIENCE INVESTIGATIONS
The development and function of jellyfish gravity receptors were studied.
Behavior
Jellifish Development and Swimming

(Concluded)

Results of Neuroscience Investigations
The intravenous fluid pump test was one of the hardware verification tests conducted in preparation for extended duration space flight.
Special Life Sciences test results indicated the particulate mass concentration influenced significantly by the air cleaning system or the animal cages. The results indicated the particulate mass concentration did not significantly increase with time and was not validated by the containment capabilities of the CD3, CD, and CD (CD) tests.

**Particulate Containment Demonstration**

Specimens drawn on SLS-1.

**Bioprocess Sharing Plan**

Experiments proved to be operationally successful. The Space Acceleration Measurement System (SAMS), which was used to measure the acceleration level effect on the devices, was developed for use as a medical restraint system (MRS), evaluated for use as a medical restraint system (MRS).

**Interavenous Fluid Pump**

A prototype of an intravenous (IV) fluid pump for the Space Station.
The results of the SLS-1 mission will pave the way for ensuring the health, safety, and productivity of humans in space.
Special life sciences

SLS-1 is to be launched in mid-1993.
SLS-1 will provide the opportunity to test animal
and future missions.

SLS-2 will provide science enhancement and
life sciences research that will be continued on SLS-2.

The Biospecimen Sharing Program of SLS-1 provided

animal experimentation on future life sciences
handling and maintenance hardware for in-flight
missions.

SLS-2 payload and future SLS missions.

Lessons learned from SLS-1, both scientific and
future long-duration space flight missions.

Data collected will contribute to the preparation of
adaptation to weightlessness.

Information necessary to understand physiological
data collected on SLS-1 are providing background

SLS-1 CONTRIBUTIONS TO FUTURE SPACE FLIGHT
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MUSCULOSKELETAL

CARDOVAUCULAR/CARDIOPULMONARY

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