NEW DEVELOPMENTS IN NASA'S RODENT RESEARCH HARDWARE FOR CONDUCTING LONG DURATION BIOMEDICAL AND BASIC RESEARCH IN SPACE

Abstract

Animal models, particularly rodents, are the foundation of pre-clinical research to understand human diseases and evaluate new therapeutics, and play key roles in biomedical discoveries both on Earth and in space. The National Research Council's Decadal survey emphasized the importance of expanding NASA's life sciences research to perform long duration, rodent experiments on the International Space Station (ISS). To accomplish this objective, flight hardware, operations, and science capabilities were developed at NASA Ames Research Center (ARC) to enhance science return for both commercial (CASIS) and government-sponsored rodent research. The Rodent Research program at NASA ARC has pioneered new research capabilities on the International Space Station and has progressed toward translating research to the ISS utilizing commercial rockets, collaborating with academica and science industry, while training crewmembers to assist in performing research on orbit.

Starting with a validation mission in 2014, the Rodent Research team has successfully completed four missions to the International Space Station (ISS). In collaboration with commercial, academic, and government entities, the Rodent Research team has been able to perform long duration experiments on the ISS. This paper will focus on the development of the Rodent Research system, highlighting the enablement of live animal return for mission return of tissues and the development of methods for bioresource storage and preservation.

Introduction

Animal studies are valuable translational models because they facilitate extensive experimentation and application of techniques that cannot be applied to human subjects (e.g., extensive tissue sampling).

To better understand how mammals adapt to long duration habitation in space, a system for performing rodent experiments on the ISS has been validated by the RR-1 mission and expanded in 4 subsequent missions that included on-orbit animal support and tissue preservation.

To maximize science return, we developed methods to recover multiple tissue types from frozen carcasses following prolonged storage of carcasses that are now being applied to multi ISS missions.

Materials

Rodent Transporter
- transport mice from Earth (KSC) to ISS
- accommodates up to 10 adult mice in each of the 2 compartments

Animal Access Unit
- crewed by move mice between: Transporter and Habitat OR Habitat and Microgravity Science Glove Box for on-orbit operations, including euthanasia and dissection

Rodent Habitat
- houses mice long-term on the ISS
- accommodates up to 5 adult mice in each of the 2 compartments
- continuously records humidity, temperature, video capability to monitor health and behavior

Mouse Transfer Box
- used to transport mice between: Transporter and Habitat OR Habitats and Microgravity Glove Box for on-orbit operations including injection, food bar changes, dissection, and other activities requiring temporary changeouts between: habitats

• Samples recovered on orbit dissection or after return of frozen carcasses post-euthanasia, then distributed to PI retained in via Life Sciences Data Archive for later distribution to and additional investigators (Russian BIOM, academic and government scientists).

Approach

Live Animal Return: Concept of Operations

Transfer from habitat to Transporter NET 36 hours Dragon hatch

Transplant

Transporter

Live Animal Return

RR5 Mission in progress

On-orbit video collection
- 5 mice per compartment, 10 per Habitat
- Storing on all video
- Air flow to eow waste in filters
- Blood supplied in from others
- Water supply (not in image)
- Lighting (dark-light cycle)
- Video cameras (infrared)

Summary & Conclusions

Comparison of results between the experimental group (Flight) and various other possible control groups (basal, vivarium, ground control) facilitates interpretation of which independent variable accounts for differences observed.

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