2013's most compelling International Space Station results announced

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Selecting only four compelling results to highlight from the research performed aboard the International Space Station (ISS) for the third annual ISS Research and Development conference was likely no easy task. Nevertheless, four were recognized June 17, 2014, as awardees in the category of Most Compelling Results from the space station in 2013.

International Space Station Chief Scientist Julie Robinson, Ph.D., moderated the first plenary panel of the conference where the following winners shared their research:

- Carl Carruthers, Jr., Ph.D., of NanoRacks LLC, in recognition of his work with protein crystal growth methods in microgravity.
- Nabarun Chakraborty, M.S., M.B.A., U.S. Army Center for Environmental Health Research, in recognition of his findings on how microgravity alters host immune responses in vitro: multi -omics approach. The term "-omics" referring to collective technologies, such as genomics purposed to study the holistic health of biomolecules.
- Jeffrey Hastings, MD, University of Texas Southwestern Medical Center, on behalf of principal investigators Ben Levine, MD, and Mike Bungo, MD., in recognition of integrated cardiovascular results.
- Matthew Lynch, Ph.D., Procter and Gamble, in recognition of taking consumer product design to entirely new heights.

"These selected awardees are elevating space science to a whole new level, executing tests and demonstrations that show we can improve our understanding of space impacts on the human body and further our space exploration," said Allyson Thorn, NASA ISS Research Integration Office, who was part of the award selection committee.

This year's conference theme is discoveries, applications and opportunities. To be exact, discoveries in microgravity, space and Earth science, as well as engineering and education; applications benefitting Earth, enabling technology and forwarding exploration; and opportunities for use of this innovative laboratory. The conference takes place from June 17 to 19 in Chicago.

Carruthers accepted his award on behalf of the Center for the Advancement of Science in Space (CASIS) for their facilitation of research to study the growth of protein crystals in the microgravity environment as part of Protein Crystal Growth-1 (PCG-1). Aboard the space station, these crystals, which relate to various diseases, viruses and more, grow more perfectly than on Earth. This gives researchers a more precise mapping of the crystals and may reveal the hidden nature of the proteins. This knowledge then can aid in developing pharmaceuticals for treatments.

"This award reinforces CASIS' and NASA's commitment in supporting researchers and companies like NanoRacks that are developing novel microgravity technologies and methods on the space station that could benefit humanity on Earth or for future space exploration," said Carruthers. "Microgravity protein crystal growth is not guaranteed to work for every protein, but there are many examples where it has been an effective technique. NanoRacks now provides researchers the option to try microgravity protein crystal growth with an easy to use, cost effective and expedient method."

Although the pathway from microgravity results to medicine cabinets operates on a decadal scale, Carruthers notes this research has the potential to touch the lives of many on Earth. "Almost everyone at some point of their life will take a prescription medicine, whether it's something for daily aches and pains or if they are battling a life threatening disease," said Carruthers. "The efficacy of these treatments are directly linked with how much we understand, at a molecular level, the manner in which they work, and that kind of knowledge comes directly from high quality structural data. While we understand a lot, we currently have many blind-spots in our comprehension that can possibly be filled with quality structures obtained or supplemented with improved data from microgravity protein crystal growth."

The award Chakraborty was honored with during the plenary highlighted his research for the High Throughput Pan-omic Approaches to Study the Effect of Microgravity on Responses of Skin Endothelial Cells to Insult (STL-MRMC) investigation. This study looked at cell and tissue cultures aboard the space station to examine the host-pathogen relationship and wound healing in space. Humans' healing processes behave differently in this environment where the body's efforts to repair itself are compounded by its compromised defense mechanism and more aggressive pathogen productions.

"In this context, we thought our integrative system biology expertise would be a valuable tool for investigating this multilayered health issue. And, we are elated to see that NASA shares our viewpoints and values our work," said Chakraborty. "This award is a great motivation and will help us remain committed to finding the solutions specific to the extraterrestrial environments. In fact, we are all set to get involved in the upcoming spaceflights purposed for [researching] mouse models (in vivo) and cellular components (in vitro) meeting similar missions."

On Earth, research into wound healing and immunology remains a challenge, according to Chakraborty, making the findings from his work in orbit of particular interest for human health on the ground, given the life-threatening risks infection can carry. "The molecular information mined from the project, particularly from its ground control study, could be significantly beneficial to the terrestrial health research," said Chakraborty. "Present data also suggests some potential biomarkers with clinical significance. Additional studies are underway to better understand the process, to apply the knowledge to other related health issues and to translate the knowledge to the discovery of more viable biomarkers."

The Integrated Cardiovascular (ICV) study looks at cardiac function during long-term exposure to microgravity, specifically atrophy (decrease in the heart's muscle size) diastolic dysfunction, the functional consequences for orthostatic intolerance (symptoms exhibited only while standing), exercise capability and risk for cardiac arrhythmias (heart rate irregularities). By quantifying the extent, time course and clinical significance of cardiac atrophy associated with long duration spaceflight, researchers can identify the mechanisms of this atrophy and the functional consequences for astronauts who spend extended periods of time in space.

"The results for ICV showed that the human heart adapts well to microgravity," said Levine. "Especially early in flight, the heart volume gets smaller, and blood flows a little more slowly into the heart. As the astronauts get into their exercise countermeasure in space, however, they are able to overcome this initial deconditioning response. For some astronauts, especially those who were less fit prior to flight, they actually developed physiological hypertrophy, similar to an athlete's heart."

According to Levine, the research showed that there was nothing magical about microgravity and the heart. The heart adapted to the load that was placed upon it - if the load reduced, the heart would atrophy; but, if the load increased, there was nothing about microgravity that prevented the heart from responding appropriately. In addition, this study showed that spaceflight by itself does not cause cardiac arrhythmias—a problem that had been worrisome for many years. Astronauts who have lots of extra heart beats on Earth, have them also in space, but these do not increase in number or severity, nor are the fundamental electrical properties of the heart altered by spaceflight.

These results have important implications for aging - individuals who keep up their fitness over a lifetime are able to preserve the youthful flexibility of the heart and blood vessels, just like astronauts. In addition, patients with disorders that become prominent in the upright position can reverse the cardiac atrophy that presents in these cases by using a training program designed for astronauts' heart health.

In addition, for the first time, ICV also placed astronauts in the simulated gravity of Mars on the day they returned to Earth after six months on the space station. This confirmed that given the opportunity to apply an aggressive exercise countermeasure, astronauts are very likely to tolerate the gravity of Mars without any difficulties after they arrive on the Martian surface.

The results for Integrated Cardiovascular show that the human heart becomes spherical and smaller in microgravity. According to Levine, this is exactly the same as what happens when people lie down at night and remove the effect of gravity pulling blood (and the heart) down towards the feet. The implications of these findings make the study key to understanding how humans will fare during long duration exploration, such as to Mars or an asteroid. This also may lead to advances in countermeasures and treatments on the ground related to heart health. For instance, the study validated math models that doctors used to predict how the heart would react to working in microgravity, showing the use of the forecasting tool as effective for use on the ground to evaluate how the organ may react to different stress scenarios.

The award presented to Lynch recognized his work with Procter and Gamble to study the behavior of colloids—microscopic particles—suspended in gels and creams and how they separate over time. In microgravity, these mixtures move more slowly for more detailed study of their natural activities. This knowledge, applied to product design, improves shelf life and stability for everyday consumer items like liquid detergents and shampoos. It also has applications for next-generation computer and medical technology and advanced optics.

The specific investigation aboard the space station for this award was the Advanced Colloids Experiment-Microscopy-1 (ACE-M1) study. This investigation was a collaborative effort between Procter and Gamble, Case Western Reserve University, NASA and CASIS. "This research is important and beneficial on two levels," said Lynch. "On one level, the research will help the company design products that will improve the lives of millions of people around the globe. On a second level, the research will add to fundamental scientific knowledge of structure fluids, which will help advance yet unforeseen technologies."

"All the work over the decades to develop and employ the ISS laboratory is having a significant impact on the lives of people and adding unique insights into fundamental scientific knowledge," said Lynch. "This award allows me the chance to highlight the unique opportunities for collaboration and out-of-this-world science with NASA that may spark others to consider such opportunities."

Provided by NASA

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