The Lifetime Surveillance of Astronaut Health

NEWSLETTER

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Editor's Note

BY **RONNIE RAFANAN**

Welcome to the April 2023 issue of the Lifetime Surveillance of Astronaut Health (LSAH) Newsletter! Along with the familiar subjects in previous issues, this issue will introduce two new sections: *Clinic Corner,* where Dr. Tim LaVan shares a brief status of the Flight Medicine Clinic, and *Formers Corner,* where we share images and captions submitted by you and your fellow crewmates!

Enjoy!

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In this Issue… *(Cont'd)*

Ask LSAH…

Do you have any questions you would like the LSAH team to answer? We would love to hear from you! Please send your question(s) for us to answer in the upcoming issues of the LSAH Newsletter. Email us at jsc-lsah@mail.nasa.gov and include **"Q&A: Crew Questions"** in the subject line. Looking forward to hearing from you!

LSAH Formers Exams

April 2023 Update

BY **DR. TIM LAVAN**

After the two-year pause in LSAH exams for former astronauts, we were excited to reopen to in-person exams in June of 2022. In the next seven months (through the end of 2022), we were able to complete 80 LSAH exams, including 68 on former astronauts, 4 on payload specialists, and 8 on management astronauts. This included 18 exams completed around the week of the reunion in December. Also, one virtual surveillance exam was conducted to pilot this new process. The entire clinic staff missed seeing all of you in the clinic and are very happy to see everyone coming back for their exams.

If you have called to schedule your annual surveillance exam within the past several months, you will have noted that we have expanded the surveillance exam to include a cognitive and behavioral health screen. For those of you about to call in, expect that this screening will be scheduled along with all the other special surveillance tests (DEXA scans, ultrasound, hearing, etc.) to ensure you can complete all standard screenings in a timely manner. We look forward to evaluating this new and valuable data as it becomes available.

As a reminder, we work on a birth month schedule. We have almost completed a year of birth month physicals, so we are ready to see some of you back for your second exams. For those that are off cycle, if you are already traveling to Houston or JSC and have not had your 2023 exam, we are still offering last minute exams on a "space available" basis; feel free to call the clinic and see if we have any slots still open for the following week or so. If there are remaining gaps in the schedule during those periods, we will work to get you scheduled.

For those unable to travel, but still want to participate in or continue to contribute to the LSAH program, we have formalized the process of virtual surveillance. While we are unable to provide the full comprehensive evaluation that is provided in person, we can still collect bloodwork and biometrics (through local Quest lab facilities), have you complete your history and medication forms by mail or online, then participate in a televisit call with the FMC nurse and physician. This process is currently available, and we plan to continue to expand the scope of virtual surveillance going forward. If you are interested in scheduling a virtual surveillance encounter, please feel free to call the FMC and we will help you get it set up.

Flight Medicine Clinic (FMC): (281)483-7999

CLINIC CORNER

BY **DR. TIM LAVAN**

The Flight Medicine and Occupational Medicine clinics are back up and running at their full current scope, having successfully returned to full schedules. We are currently providing full astronaut physicals, flight physicals for military and NASA aviators, occupational health screening (including dive and suited subject physicals), routine acute care for active astronauts, and limited care for families of active astronauts. We are fortunate to have come through COVID with only a small turnover, so you will see many familiar faces when you make it to JSC for your annual exam. However, there are some new staff members, so if you see a new face, feel free to welcome them to the team!

Systematic Assessment of **Astronaut Landing Day Health after Terrestrial Landing in Soyuz Vehicle**

BY **AVALON KABEEL, MPH**

Until May of 2020, NASA crewmembers returned from ISS either on the Space Shuttle or the Russian Soyuz spacecraft. The Soyuz vehicle offers insight into spaceflight deconditioning and its contribution to landing impact tolerance. Spaceflight deconditioning has been shown to cause decrements in bone and muscle, but it is currently unknown how these decrements translate to injury risk due to dynamic loads, such as re-entry and the forceful impact of landings. NASA collects data from crewmembers returning on Soyuz vehicles to catalog injuries that were sustained during impact. Using the injury data obtained from Soyuz landings and predictive modeling methods, NASA can assess the risk of injury to crewmembers and compare the Soyuz occupant protection design to vehicles such as NASA Orion, SpaceX Dragon, and Boeing Starliner capsules.

NASA-STD-3001 requires use of the Brinkley Dynamic Response Criteria (BDRC) [1] to provide an injury risk assessment during dynamic phases of flight for accelerations < 0.5 seconds. The model assumes that crewmembers will be restrained similarly in all landing events and has been adjusted for landing impact after re-entry based on the existing knowledge of physical and physiological deconditioning related to long-term exposure to the microgravity of space. The occupational surveillance team then looks at the BDRC calculated rate of injuries with nominal and off-nominal landing compared to actual rate of injuries to make recommendations for any changes to the risk posture.

As of December 2022, 84 USOS crewmembers landed in a Soyuz vehicle. After examining the various data sources (Figure 1) used to determine Soyuz landing day injuries, approximately one third of crewmembers experience injuries upon landing day (Table 1). Although many of these injuries are minor, they exceed the expected rates based on the models' analysis.

Based on injury analyses, there are still several important questions that NASA is trying to answer to inform the risk of landing injury:

1. What is the potential relationship between spaceflight deconditioning and crewmembers' susceptibility to landing day injuries?
2. The limitations of the BDRC model do not account for suit interactions and age and sex differences. How do these limitations change the rate of expected injuries?
3. What researchers know about Soyuz landing loads is based on capsule drop and airborne tests that included accelerometers on each seat [2]. If the landing load is underestimated, how does that change the rate of expected injuries?

Future work will provide answers to these questions. Spaceflight deconditioning has the potential to reduce impact tolerance, but the area of injury biomechanics requires further study. As more data becomes available through the Commercial Crew Program, vehicles and landing scenarios are developed, and missions' objectives extend to the moon and on to Mars, NASA will continue to identify and minimize the risks to crewmembers both on-orbit and in the return vehicles.

Injury Classification	Number of Crew Injured (N=84)	Injury Rate (%)
Bruising & Abrasions	18	21.4%
Minor Injury	5	6.0%
Moderate Injury	4	4.8%
Total	**27**	**32.1%**

Table 1 – Rates of injury among N=84 crewmembers landing in Soyuz vehicles. Multiple injuries are not reflected in the numbers above, only the highest category of injury for each crew member is shown. The majority in injuries reported were bruising and abrasions with few minor and moderate injuries such as cervical spine soft tissue injuries, and radial nerve palsy respectively.

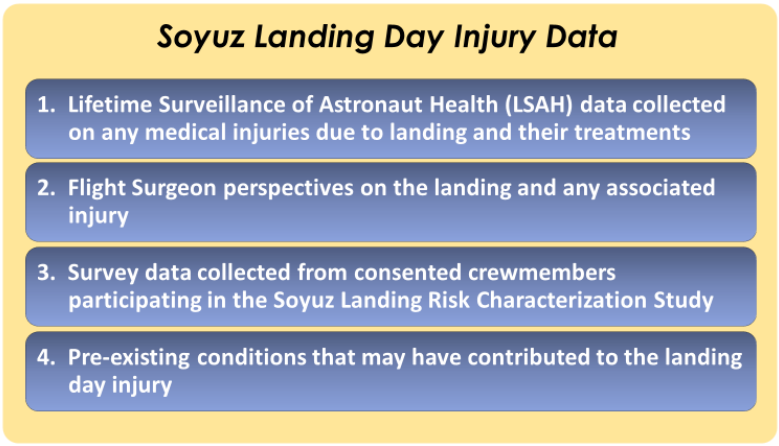

Figure 1- Data sources used to assess Soyuz landing day injuries

References

1. Somers, J.T., D. Gohmert, and J.W. Brinkley, *Application of the Brinkley Dynamic Response Criterion* 2017, NASA/TM-2013-217380-REV1: Houston.
2. Newby, N. J., Greenhalgh, P., & Somers, J. T. (2020). Soyuz Landing Injury Risk Characterization. *SAFE*.

Evaluating NASA Medical Standards for

Atherosclerotic Cardiovascular Disease

BY **JACQUELINE CHARVAT, PHD & DEVAN PETERSEN, MPH**

Astronaut medical standards are periodically reviewed and updated to ensure they align with best clinical practices. On October 28–29, 2022, a Technical Interchange Meeting (TIM) was held at Johnson Space Center to review NASA's procedures for clinical evaluation and prevention of atherosclerotic cardiovascular disease in astronauts. The meeting was led by Drs. James Pavela and Rahul Suresh, operational flight surgeons for NASA. Attendees included subject matter experts (SMEs) such as NASA physicians, civilian and military experts in aerospace and cardiovascular medicine, and two LSAH Epidemiologists: Dr. Jacqueline Charvat and Devan Petersen.

The objectives of the TIM were to understand

1. The risk stratification of astronauts for coronary artery disease during their active career.
2. The appropriate use of screening and prognosis tools for prevalent disease and risk of future cardiac events.
3. Indications for lipid-lowering and anti-platelet therapies.

Discussions during the TIM included

- Using risk calculators such as Astro-CHARM[1,2] and Atherosclerotic Cardiovascular Disease (ASCVD)[3,4] to understand the probability of individual health risk.
- Using specialized screening for determining current levels of disease such as coronary artery calcium screening (CAC Score) and CT angiography, as well as the frequency for conducting this testing.
- Developing thresholds for risk stratification markers such as Astro-CHARM, ASCVD, and CAC scores as well as appropriate testing for low, medium, and high-risk individuals.
- How to treat a potential cardiac event in space should one ever occur. The group discussed items to be included in the medical 8kits carried to space to treat an event such as a heart attack or atrial fibrillation.

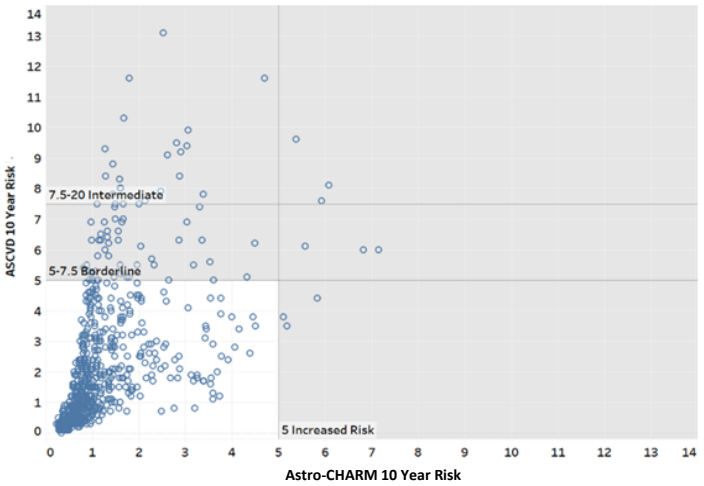

Figure 2. Risk scores from the Astro-CHARM (x-axis) and ASCVD (y-axis) calculators. Each astronaut may be represented multiple times for data collected through July 31, 2022. The maximum risk percentage for ASCVD was 13.3% and 7.3% for Astro-CHARM.

LSAH supported the CVD TIM by providing data and visualizations for active and recently retired astronauts of CVD biomarkers including coronary artery calcium scoring, carotid intima media thickness, exercise stress test, and lipid panels for data collected through July 31, 2022. One visualization (Figure 2) compared the Astro-CHARM (x-axis) and ASCVD (y-axis) calculators, each determining the chance of an atherosclerotic cardiovascular disease event in the next 10 years for each annual exam wherein data is available (each astronaut may appear multiple times based on the number of exams they have). Each risk calculator is comprised of various cardiovascular risk factors (Table 2) to help physicians identify who will be at most risk for a cardiovascular event. These two calculators have similar components; however, the Astro-CHARM calculator adds coronary artery calcium, C-reactive protein, and family history of a heart attack.

The Astro-CHARM risk score has a threshold of 5% for increased risk of an atherosclerotic cardiovascular disease within 10 years. ASCVD (y-axis) has a threshold of 5–7.5% for borderline risk of an event in 10 years and 7.5–20% for intermediate risk (grey shade) of an atherosclerotic

cardiovascular disease within 10 years. The visualization shows that data for most annual exams are clustered at the low end of risk, not surprising as astronauts tend to live healthy lifestyles. The ASVCD scores also tend to be higher than the Astro-CHARM scores, with more individuals being in the borderline and intermediate risk categories than for Astro-CHARM. Both calculators are heavily reliant on the age of the individual: as a person gets older, risk increases for the calculator.

Based on LSAH data and SME input, astronaut medical standards and testing thresholds are currently being evaluated and updated to reflect the best standards in current clinical cardiac care. The recommendations made at this meeting will impact ISS standards as well as future programs.

If you are interested in learning more about your Astro-CHARM or the ASCVD calculator, please contact your NASA physicians.

Astro-CHARM	ASCVD
Age	Age
Sex	Sex
Race	Race
Current smoker	Smoking status
Systolic Blood Pressure	Systolic Blood Pressure
Hypertension Treatment (Yes or No)	Hypertension Treatment (Yes or No)
Diagnosis of Diabetes	Diagnosis of Diabetes
Total cholesterol	Total cholesterol
HDL cholesterol	HDL cholesterol
Family History of Heart Attack in a First Degree Relative	
C-reactive Protein	
Coronary Artery Calcium Scoring	

Table 2. Cardiovascular risk factors included in the Astro-CHARM and ASCVD risk calculators

References

1. Astronaut Cardiovascular Health and Risk Modification (Astro-CHARM) Coronary Calcium Atherosclerotic Cardiovascular Disease Risk Calculator | Circulation (ahajournals.org)
2. User Guide – Astro-CHARM (astrocharm.org)
3. https://www.sciencedirect.com/science/article/pii/S0735109713060312?via%3Dihub
4. ASCVD Risk Estimator + (acc.org)

NASA joins White House *Cancer Moonshot Initiative*

BY **NATHAN CRANFORD**

NASA scientists are working with doctors and researchers across the federal government to help cut the nation's cancer death rate by at least 50% over the next 25 years, a goal of the White House's Cancer Moonshot Initiative.

Supporting scientists are part of the Space Radiation Element within NASA's Human Research Program, which focuses on predicting and managing radiation risks associated with human spaceflight. This group has contributed to cancer studies over the years, from exploring shielding strategies to protect against space radiation exposure, to identifying biomarkers that could serve as early indicators of the disease.

NASA's space radiation team is comprised of 25 people across the agency, universities, industries, and government facilities. Representatives meet periodically with the Presidential Cancer Cabinet, which includes Administrator Nelson, to discuss the status of their research, and brainstorm ideas to further progress and interagency collaboration.

For instance, scientists are seeking to develop and test new screening technologies for specific cancers as only a handful of cancers currently have well-vetted, early-detection protocols. They strive to incorporate these new detection methods into the astronaut health surveillance program, which could help spot certain cancers earlier and make these measures more widely available.

"We want to know: What are those cancers' early 'tells'? And how feasible is it to screen for those tells?" explained Robin Elgart, Space Radiation Element lead scientist at Johnson. "If we could find these early-detection technologies and implement them into the astronaut health surveillance program, collaborations through the Cancer Moonshot could pave the way for broader use and acceptance of these new detection methods."

"NASA support could even help the new technologies to come to market," added Brock Sishc, Space Radiation Element cancer discipline lead at Johnson. "Then we can help not only our astronauts, but also potential cancer patients on Earth."

Scientists are also working to identify medicines and dietary supplements that could help reduce the risk of cancer from radiation exposure. Searching for such compounds requires scrutinizing large groups of people over long durations – something NASA's small set of astronauts can't provide. Using connections forged through the Cancer Moonshot to access and process vast data sets involved with modern drug screening may help. Finding patterns in these data sets could reveal new insights.

"We're not far from having more and more humans in space for long stretches of time, so we need to understand what these risks are and how they're going to impact a larger population," Sishc said. "Not only are we worried about astronauts, but we're also looking forward across the horizon as space becomes more accessible to all."

FORMERS CORNER

Dr. Tom Jones, PhD, flew shuttle missions STS-59, STS-68, STS-80. STS-98 between 1994-2001.
Link to NASA Bio

"Flight Medicine in 2023 was déjà vu all over again: familiar faces, great hospitality, and an efficient and informative exam. The selfie with the shuttle CCT 2 over at the Lone Star Flight Museum dates me, but after my physical I feel ready to shinny down the SkyGenie one more time."

Let us know how you're doing!

How are you spending your retirement? Please feel free to send us any pictures you would like to share, along with a brief description/quote, and we will be happy to publish it here for all your fellow formers to enjoy! Email us at jsc-lsah@mail.nasa.gov and include "**Formers Corner**" in the subject line. Looking forward to hearing from you!

Did you move? New email address? Remember to update us so we can continue to send you the LSAH Newsletter, LSAH invitational physical exam letters, and any other news we may need to share with you. Contact Denise Patterson at 281-244-5195 or denise.a.patterson@nasa.gov.

You may also write us at

Lifetime Surveillance of Astronaut Health (LSAH)
Flight Medicine Clinic/SD3C
NASA Johnson Space Center
2101 NASA Parkway
Houston, TX 77058-3696
Or email us at Jsc-lsah@mail.nasa.gov
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