Canadian Space Health Research Symposium

2022 Scientific Abstracts: The First Canadian Space Health Research Symposium

November 17-18, 2022

Poster Presenters
All posters have been numbered in this document.

Poster presenters with odd-numbered abstracts will present during the lunch session on day one (Nov 17).
Poster presenters with even-numbered abstracts will present during the lunch session on day two (Nov 18).

In addition to the sessions indicated above, all poster presenters (odd and even-numbered abstracts) will also have the option (not required) to present their poster during the social reception on day one (Nov 17).

Table of Contents

#1 Transcriptomic response of bioengineered human cartilage to parabolic flight microgravity is sex-dependent

Aissiou AK, Jha S, Dhunnoo K, Ma Z, Li DX, Ravin R, Kunze M, Wong K, Adesida AB

Spaceflight and simulated spaceflight microgravity induced osteoarthritic-like alterations at the transcriptomic and proteomic levels in the articular and meniscal cartilages of rodents. But little is known about the effect of spaceflight or simulated spaceflight microgravity on the transcriptome of tissue-engineered cartilage developed from human cells. In this study, we investigate the effect of simulated spaceflight microgravity facilitated by parabolic flights on tissue-engineered cartilage developed from chondrogenically differentiated human bone marrow mesenchymal stem cells obtained from age-matched female and male donors. Our bulk transcriptome data via RNA sequencing demonstrated that the engineered tissues responded to parabolic microgravity in a sex-dependent manner.

#2 Non-compressible hemorrhage control in space: a role for counterflow hemostatic gauze

Nabil Ali-Mohamad (The University of British Columbia), James Baylis (CoMotion Drug Delivery Systems), Massimo Cau (The University of British Columbia), Alexander E St. John (University of Washington), Xu Wang (University of Washington), Nathan White (University of Washington), Christian Kastrup (The University of British Columbia; Medical College of Wisconsin)

Hemorrhage due to trauma is a potential cause of death for astronauts in future long-term space missions. Working in larger, less controlled areas with larger equipment increases the risk of bodily injury due to penetrating, crushing or blunt trauma. Topical hemostatic agents currently available on earth rely on manual compression for their effective application which may not be possible in a quickly deteriorating patient in microgravity or when injuries are done especially in junctional anatomical regions. Self-propelling CounterFlow technology, consisting of bioabsorbable calcium carbonate and tranexamic acid (TXA), propels potent hemostatics against the flow of blood to stop bleeding. CounterFlow Gauze, was compared to CombatGauze in a swine model of junctional hemorrhage, induced by a 6 mm femoral arteriotomy. 100% of animals (8/8) that received CounterFlow Gauze survived to three hours whereas just 37.5% (3/8) animals receiving Combat Gauze survived ($p<0.01$), both without compression. CounterFlow-Gauze leads to high survival rates in swine models of non-compressible hemorrhage which could be highly applicable to managing trauma in microgravity and other extreme environments.

#3 The effects of microgravity on perceived travel distance

Ambika T. Bansal, Björn Jörges, Nils Bury, Meaghan McManus, Robert S. Allison, Michael Jenkin, Laurence R. Harris

One of the most common, and most complex functions of the human brain is to perceive our own motion. Estimating how far we have travelled is a multisensory process, although the relative contributions from our different sensory systems in estimating travel distance is still unknown. Testing astronauts in microgravity not only allows us to parse out the contributions from the different senses more easily, but it can also inform mission planners and trainers about how our perception of travel distance might change in microgravity. Using VR, we tested astronauts' (n=12, 6 female) perceived travel distance 5 times: once before their flight, twice in space (upon arrival and 3 months after), and twice again when they returned back to

Earth (upon reentry and 2 months after). Preliminary results show no differences between the astronauts' estimations of travel distance after arriving to the ISS, after 3 months in space, or when they returned to Earth. These findings not only provide insights into the sensory contributions involved in making travel distance estimates, but also indicate that there is no adverse effect of long-duration exposure to microgravity on perceived travel distance.

#4 New magnetic resonance imaging scans to detect neuroplastic changes in astronauts

Lila Berger (University of Calgary), Ford Burles (University of Calgary), Rebecca Williams (University of Calgary), Catherine Lebel (University of Calgary), Bruce Pike (University of Calgary), & Giuseppe Iaria (University of Calgary)

There is an increased obligation to better understand the impact space travel has on the brain as more humans are going to space than ever before. Recent Magnetic Resonance Imaging studies report changes in astronauts' brain volumes following spaceflight, with significant and widespread findings. These studies have reported major areas of the brain to have either increased or decreased volumetric changes, with the potential to have cognitive consequences. However, recently, we have demonstrated that the evidence of volumetric changes in the brain of astronauts may be contaminated by the upward shift of astronauts' brains within the skull and redistribution of the cerebrospinal fluid as an effect of microgravity. The shift of the brain and CSF in the skull causes methodological issues in the processes conducted to study brain changes, creating errors in the classification of different matters within the skull and producing artifactual claims of volumetric neuroplastic brain changes following spaceflight. The present proposal aims to reduce these classification errors by investigating the use of a variety of newer MRI scans and protocols that may account better for this displacement.

#5 Investigating wayfinding, sense of place, and environmental familiarity in the International Space Station as experienced in virtual reality

Lila Berger[1], Meaghan Walsh[1], Rishav Banerjee[1], Sornali Banik[1], Ford Burles[1], Lindsay McCunn[2], Giuseppe Iaria[1]

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In this study, we developed a virtual reality simulation of the International Space Station (VISS) to investigate the effects of simulated microgravity, isolation, and confinement on the ability to form and make use of cognitive maps—mental representations of the environment critical for effective wayfinding. Following exposure to the VISS, we also aim to investigate participants' development of environmental familiarity and sense of place (SOP). We hypothesize that prominent physical attributes and landmarks of the environment will contribute significantly to the development of SOP. Additionally, we expect that participants who are better able to form a SOP will report more familiarity with the environment, and will be able to create better cognitive maps than participants who struggle to form a SOP. In a follow-up study, we will alter the VISS environment to test the hypothesis that better-designed environmental features can enhance participants' spatial orientation skills, their sense of environmental familiarity, and SOP.

Findings from these exploratory studies may contribute to the creation of habitable environments for lengthy missions in space and preserve astronauts' sense of environmental wellbeing and spatial orientation skills.

#6 Machine learning hyperspectral microscopy image analysis platform for space and health technology

Na Yu (Toronto Metropolitan University), You Liang (Toronto Metropolitan University), Janakkumar Bhanushali (Toronto Metropolitan University, St. Michael's Hospital), Xun Zhao (St. Michael's Hospital), Keanu Uchida (St. Michael's Hospital), Michael Lapinski (St. Michael's Hospital), Robert Kalisky (St. Michael's Hospital), Tomasz Tkaczyk (Rice University), Neeru Gupta (St Michael's Hospital, University of Toronto), Yeni Yucel (St Michael's Hospital, University of Toronto, Toronto Metropolitan University)

Hyperspectral imaging (HSI) provides rich chemical and compositional information not regularly available from traditional imaging modalities. HSI uses high spectral resolution images from devices like the James Webb Space Telescope to retrieve information beyond the visible light spectrum. The applications of HSI for biomedical research presents us with an opportunity for non-invasive diagnosis of diseases. In this project we develop machine learning algorithms for HSI by using hyperspectral eye images from a microgravity model devised to better understand the effects of Spaceflight-Associated Neuroocular Syndrome (SANS) considered as a red risk for missions to Mars. In this pursuit, we are creating an open-access platform for hyperspectral microscopy to improve patient diagnosis in space as well as on earth. Our method for collecting reference signature spectra involves segmentation and storage of normal and pathological tissue components for research and development in future projects. Lastly, we acknowledge the support of the Canadian Space Agency (19HLSRM02, Ottawa, ON, Canada).

#7 Development of a virtual reality platform to assess cognitive workload during robotic safety-critical tasks in unknown environments

Arnaud Brignol (Concordia University, Canada), Giovanni Beltrame (Polytechnique Montreal, Canada), Emily B.J. Coffey (Concordia University, Canada)

Artificial-intelligence (AI)-controlled robots are increasingly being used in self-organizing fleets to prevent human operators from being directly exposed to potential dangers, for example in exploration missions. However, human cognitive capacities are challenged by increasingly complex and opaque AI systems, with consequences to safety and mission success when they are exceeded. Cognitive workload (CW) (i.e.,mental resources required to perform a task) can be used to predict and improve the performance of an operator in safety-critical environments. There is currently a gap between measuring the CW during standard laboratory tasks, and real-world tasks in which environmental parameters cannot be well-controlled. We will present our research program in which virtual reality (VR) serves as an intermediate platform between the two. Specifically, we are developing immersive and engaging VR exploration missions (e.g., caves, lava tubes), while maintaining control over task parameters so as to enable rigorous neurocognitive assessment. Our ultimate goal is to improve the safety of human operators on Earth as in Space.

#8 Progression of resistance exercise training and tibial bone loss during long duration spaceflight

C.G. Bryans[1,2,3], S.K. Boyd[1,2,4], L. Gabel[1,2] on behalf of the TBone Team

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Astronauts experience bone loss during long duration spaceflight. This project examines the longitudinal effect of resistance exercise (RE) training with the Advanced Resistive Exercise Device (ARED) on microgravity induced tibial bone loss during spaceflight. ARED logs of 17 astronauts were analyzed with generalized additive mixed models to evaluate RE volume and change in repetitions from preflight for heel raises, deadlifts, and squats. HR-pQCT scans of the distal tibiae were taken pre and postflight. Astronauts were stratified at -1.7% total vBMD loss at the tibia. Postflight vBMD change was -5.4%±1.9 in bone loss vs. -0.8%±0.6 in no bone loss. All exercise volume increased during flight and average volume was greater in the bone loss group (0.9,5.1,3.9%) though not significantly different (p>.05).There was no difference in change in repetitions from preflight in all exercises (p>.05).Greater RE volume during spaceflight did not mitigate bone loss in astronauts, though greater consistency was observed in no bone loss. Change in repetitions from preflight did not differ between groups, though greater bone loss occurred in those unable to maintain pre-flight repetitions inflight.

#9 Automated wireless blood flow restriction training for long-duration spaceflights - part III

Jérémie Charron (Department of Physical Activity Sciences, Faculty of Sciences, Université du Québec à Montréal), Michael Stolberg (Department of Physical Activity Sciences, Faculty of Sciences, Université du Québec à Montréal & VALD), Philippe St-Martin (Research Centre on Aging, Sherbrooke, CIUSSS de l'Estrie - CHUS, Université de Sherbrooke & Faculty of Physical Activity Sciences, Université de Sherbrooke), François Lalonde (Department of Physical Activity Sciences, Faculty of Sciences, Université du Québec à Montréal), David H. St-Pierre (Department of Physical Activity Sciences, Faculty of Sciences, Université du Québec à Montréal), Gawiyou Danialou (Department of Physical Activity Sciences, Faculty of Sciences, Université du Québec à Montréal & Royal Military College Saint-Jean), Mary Roberts (Department of Health, Kinesiology & Applied Physiology, Faculty of Arts and Science, Concordia University), Andreas Bergdahl (Department of Health, Kinesiology & Applied Physiology, Faculty of Arts and Science, Concordia University), Gilles Gouspillou (Department of Physical Activity Sciences, Faculty of Sciences, Université du Québec à Montréal, Montréal & Centre de Recherche de l'Institut Universitaire de Gériatrie de Montréal), Isabelle J. Dionne (Research Centre on Aging, Sherbrooke, CIUSSS de l'Estrie - CHUS, Université de Sherbrooke & Faculty of Physical Activity Sciences, Université de Sherbrooke) & Alain Steve Comtois (Department of Physical Activity Sciences, Faculty of Sciences, Université du Québec à Montréal)

Long-duration spaceflights (LDS) will require astronauts to train autonomously in compact and very isolated environments. Blood flow restriction (BFR) training is safe and effective for eliciting gains in muscle mass and strength across multiple populations. The first parts of this study series aim to assess the effectiveness of low intensity resistance training with BFR for upcoming LDS. The

final part's objective is to determine and optimize the feasibility, effectiveness, and efficiency of delivering a remote low-load resistance training intervention using wireless BFR technology (AirBands, VALD) implemented through a telehealth platform (TeleHab, VALD) to increase muscle mass, muscle strength, bone mineral density, blood flow, postural stability, and functional capacity in a healthy adult population. A total of 30 healthy participants, males, and females, aged 18 to 45, will be divided equally into 2 groups: in-person BFR (IP-BFR) and remotely monitored BFR (RM-BFR). This study will enable the gathering of data regarding the feasibility of BFR remote interventions and its potential as a tool for upcoming spaceflights and remote areas.

#10 Preliminary results simulating direct and indirect neutron-induced DNA damage with repair mechanisms

Nicolas Desjardins (Dept. of Physics, McGill University), James Manald (Medical Physics Unit, McGill University), Logan Montgomery (Cancer Centre of Southeastern Ontario, Kingston Health Sciences Centre), John Kildea (Medical Physics Unit, McGill University)

The risk associated with the stochastic effects of neutron radiation is known to be strongly energy dependent. Over the past decade, several studies have used Monte Carlo simulations to estimate the relative biological effectiveness (RBE) of neutrons for various types of DNA damage in order to understand its energy dependence at the fundamental level. However, none of these studies implemented DNA repair simulations in their pipeline. In this project, we investigated the effects of adding repair mechanisms to Monte Carlo-based RBE estimates of DNA damage by neutrons. Our group had previously carried out condensed history (CH) simulations to profile the energy spectrum and relative dose contribution of the secondary particles produced by neutron interactions in tissue. In this project, we used the results of our CH simulations to simulate the irradiation of TOPAS-nBio's DNA model by a flat spectrum of neutrons ranging from 1 eV to 10 MeV, as well as reference X-rays at 250 keV. Induced DNA damage was recorded using the standard DNA damage data (SDD) format. DNA repair was simulated using the DNA Mechanistic Repair Simulator (DaMaRiS) framework.

#11 An examination of cerebrovascular responses in men and women after exposure to artificial gravity

Donya Naz Divsalar (Simon Fraser University), Da Xu (Simon Fraser University), Farshid Sadeghian (Simon Fraser University), Nandu Goswami (University of Graz), Joyce Evans (University of Kentucky), Andrew P. Blaber (Simon Fraser University)

Long-term spaceflight leads to bone, muscle, and cerebrovascular deconditioning. This study investigated the effects of artificial gravity (AG) training on orthostatic cerebrovascular reflexes following simulated spaceflight. Methods: Nine men and eight women were cardiovascularly deconditioned with furosemide. Participants were exposed to 90-minutes of either AG training, or -6-degree HDBR and 21 days later they were exposed to the other procedure. After each 90-minute procedure, participants underwent an orthostatic tolerance test (70-degree head-up-tilt followed by ramped lower body negative pressure until presyncope). Results: Females had a higher mean blood flow velocity in supine and during HUT (64 ± 6, 52 ± 6 cm·s-1) after exposure to AG compared to males (42 ± 5, 40 ± 5 cm·s-1) ($p = 0.01$). No differences were found between males and females after HDBR. Conclusions: Results indicated that females showed a different and more positive

cerebral blood flow response than males after AG training. This observation is consistent with studies done previously on astronauts returning to Earth and emphasizes a possible role of AG in long-term mission to the Moon and Mars.

#12 Near-infrared spectroscopy as an imaging tool for space health

Jeff Dunn (Dept. of Radiology, Cumming School of Medicine, University of Calgary) Joel Burma (Faculty of Kinesiology, University of Calgary) Gordon Sarty (Depts of Psychology and Biomedical Engineering, University of Saskatchewan)

Near-infrared spectroscopy (NIRS) could be a useful space based imaging system. NIRS is relatively low power, can be small, is portable, and provides unique physiological data. NIRS can be used to monitor brain cortical activity, muscle energy metabolism, and tissue oxygen levels. Most NIRS systems detect changes in oxygenation, but to quantify hypoxia between people one needs systems such as Frequency domain NIRS (fdNIRS). We used fdNIRS to quantify hypoxia in neurological disorders and stroke. Mapping brain activity is feasible with functional NIRS (fNIRS) which we are testing as a marker of brain injury and reduced function. We quantified muscle metabolic rate using continuous wave NIRS. NIRS data could be useful for studying a range of space related medical priorities including oxygenation, regulation of vascular function with conditions such as inflammation, examining blood pressure and tissue oxygenation relationships, and mental health conditions. For use in deep space, NIRS could be a part of a complete Spacecraft Medical Imaging System (SMIS) that is fully integrated with a larger spacecraft crew health and performance system.

#13 Impact of 14-d head-down tilt bed rest on body composition and dietary intake in healthy older adults

Alyshia Guan (School of Human Nutrition- McGill University, Research Institute of the McGill University Health Centre), Guy Hajj-Boutros (Research Institute of the McGill University Health Centre), Vita Sonjak (Research Institute of the McGill University Health Centre), Jose A. Morais (Research Institute of the McGill University Health Centre, Department of Medicine- McGill University), Stéphanie Chevalier (School of Human Nutrition- McGill University, Research Institute of the McGill University Health Centre, Department of Medicine- McGill University)

Increasing durations of spaceflight and inclusion of older adults warrant evaluation of exercise strategies to counter muscle atrophy with minimal impact on energy balance. This sub-study of a larger RCT is first to assess the impact of 14-d of 6° head-down tilt bed rest and 1 h/d of mixed exercise intervention on differential changes in body composition, resting energy expenditure, and nutrient adequacy in healthy older adults. Twenty-three were randomized to exercise (EX) or control (CTL); 22 completed (59±3 y, 25±3 kg/m2, 50% women). Most nutrient intakes were adequate during bedrest with the high-quality controlled and balanced diet provided, however, significant weight loss occurred in EX (kg[95%CI]; -1.16[-1.86, -0.46]) and CTL (-1.11[-1.59, -0.64]) without group differences. Exercise attenuated the significant loss in lean mass observed in CTL (total: -0.85 kg[-1.36, -0.34], leg: -0.36 [-0.57, -0.15], both p=0.004) and led to greater fat loss (p=0.002). Findings suggest that nutritional supplements may assist exercise countermeasures in older adults to further abate declines in weight, lean mass, and functional capacity during long-duration spaceflight.

#14 Impact of 14 days of bedrest on body composition, muscle strength and cardiovascular capacity

Guy Hajj-Boutros (McGill University Health Center), José A. Morais (McGill University Health Center)

Head-down bed rest (HDBR) has long been used as an analog to microgravity, but it also enables studying the changes occurring with aging. Exercise is the best countermeasure for the deleterious effects of inactivity. The aim of this study was to investigate the efficacy of an exercise countermeasure in healthy participants following 14 days of HDBR. Methods: Twenty-three participants, aged 55-65 y participated to the study. Peak aerobic capacity, body composition, muscle strength, vertical jump and changes in various blood parameters were measured as well as the effects of exercise countermeasure on these measurements. Results: The exercise group maintained VO2 max levels similar to baseline whereas it decreased in the control group following the intervention. Total and leg lean mass decreased only in the control group ($p<0.05$) while being preserved in the exercise group. However, % body fat decreased ($p=0.040$) only in the exercise group. Both groups significantly decreased their muscle strength following the intervention. In this first Canadian HDBR, an exercise countermeasure helped maintaining cardiovascular fitness and lean body mass without any impact on muscle strength.

#15 Interventional radiology's key contribution to the exploration of space

Katie M Harris (Faculty of Medicine, Memorial University of Newfoundland), Sandra Stankovic (Human Performance Laboratory, Harvard Medical School/Massachusetts General Hospital), Robert Abraham (Faculty of Medicine, Dalhousie University)

As the focus of space agencies and commercial bodies moves to long duration space flight and operational outposts on the Moon and Mars, the need for feasible interventions that can be performed in medical emergencies has been highlighted. The role of interventional radiology (IR) in spaceflight settings has been theoretically explored in the past but has stalled despite the need to provide minimally invasive solutions to treat such disease processes as appendicitis, cholecystitis, diverticulitis, abscesses, obstructing kidney stones, and intravascular thrombus for long duration missions. Our poster will review the theoretical background for IR in space, the feasibility of enabling technologies such as imaging and procedural aspects in the spaceflight environment, and future directions of research to support the implementation of IR in space and other extreme environments.

#16 Analogue Space Research Mission: the UK's first simulated human exploration of another planet

Myles Harris (UCL Space Health Risks Research Group, Space Health Research Ltd)

People in remote and rural environments can experience socioeconomic challenges, which have negative influences on their health. These challenges are caused by limited access to healthcare services, minimal resources, and delayed evacuation times. These challenges exist due to the remote/rural environment, which can be permanently remote due to their geography, or an urban environment can become remote due to vulnerability to natural hazards such as flooding. Rapid innovation and development of health services and products is required to help mitigate the risks to health for people in remote/rural environments. Researching within the context of space is a catalyst for innovation and development.

UCL Space Health Risks Research Group led the first UK analogue space mission that simulated the human exploration of another planet. A remote and uninhabited island in Scotland was used as the analogy of space, which was kept secret from the research participants (analogue astronauts). This meant that when they were brought to the island they saw it for the first time, simulating an astronaut seeing another planet for the first time. During the analogue mission, a programme of research was conducted to investigate how health in space can mitigate risks to health on Earth.

#17 Changes in DNA methylation associated with inactivity or exercise during two weeks of bed rest

Eric T. Hedge (Schlegel-UW Research Institute for Aging, Canada & Department of Kinesiology and Health Sciences, University of Waterloo, Canada), Carmelo J. Mastrandrea (Schlegel-UW Research Institute for Aging, Canada), Robin E. Duncan (Department of Kinesiology and Health Sciences, University of Waterloo, Canada), Richard L. Hughson (Schlegel-UW Research Institute for Aging, Canada)

Regular aerobic exercise is thought to slow the pace of biological aging, while sedentary lifestyles are thought to accelerate it. Prolonged spaceflight is a severe form of inactivity, but astronauts do perform exercise in space to try to maintain health and fitness. The purpose of our study was to evaluate the effects of two weeks of -6° head-down bed rest (HDBR) and high-intensity exercise countermeasures on the estimated biological age of 22 healthy adults (11 women; 55-65 yr). Half of the participants completed ~1 hour of daily exercise, while control participants were inactive. Saliva samples were collected pre-HDBR and at the end of HDBR, and DNA methylation patterns were assessed by next-generation sequencing and analyzed using the Index epigenetic aging clock as an indicator of biological age. The change in Index over two weeks of HDBR was different ($p=0.003$) between control (0.95±1.90 yr) and exercise (-0.74±0.68 yr) groups. These findings suggest rapid and unique changes in DNA methylation patterns resembling a slightly older biological age with acute and severe inactivity, as well as a potentially protective effect of exercise in this paradigm.
Supported by CIHR and CSA.

#18 The perception of object size in microgravity

Björn Jörges (Center for Vision Research, York University), Nils Bury (Institute of Visual Computing, Hochschule Bonn-Rhein-Sieg), Meaghan McManus (Department of Experimental Psychology, Justus Liebig University Giessen), Ambika Bansal (Center for Vision Research, York University), Robert S. Allison (Center for Vision Research, York University), Michael Jenkin (Center for Vision Research, York University), Laurence R. Harris (Center for Vision Research, York University)

Exposure to microgravity can influence the visual perception of object size, however the mechanism remains an object of debate. Gravity might serve as a reference frame in which visual information is interpreted. The absence of gravity should make size judgements then more variable due to the inability to anchor these judgements. We tested this hypothesis by assessing accuracy and variability of astronauts' size judgements before, during, and after a six-month or longer microgravity exposure in orbit. 12 astronauts were tested before take-off, within 7 days of arrival on the ISS, around 90 days after arrival, within 7 days of return to Earth and at least 60 days after return. We found that variability was, indeed, higher upon arrival on the ISS ($p = 0.03$), but not later during space flight. Further, astronauts but not control participants – surprisingly – perceived the object to be significantly smaller ($p = 0.04$) at their last test

session than at their first session, suggesting lasting changes in their perception. Overall, our data provides additional support that gravity may indeed serve as a reference frame in which visual input is interpreted for size judgements.

#19 Novel application of the Adverse Outcome Pathway framework to organize information on space health

Tatiana Kozbenko (University of Ottawa & Health Canada), Benjamin Smith (Health Canada), Dalya Alomar (Health Canada), Emma Carrothers (Health Canada), Mitchell Keyworth (Health Canada), Syna Karimi-Jashni (Health Canada), Ruth Wilkins (Health Canada), Carole Yauk (University of Ottawa), Vinita Chauhan (Health Canada)

In 2012, the Organisation for Economic Co-operation and Development launched the Adverse Outcome Pathway (AOP) framework. The AOP approach involves collaborative work to identify measurable key events at all levels of biological organization to an adverse outcome of regulatory significance. Herein, we demonstrate the utility of the approach through the development of an AOP network to health outcomes from space travel. Long-duration space flight incurs various health risks to astronauts. Such risks are primarily from exposure to stressors that may cause leading to short- and long-term impacts on the individual. An AOP network for space flight health outcomes was developed for vascular remodeling, impaired learning/memory, bone loss, and cataracts. Following review of >30,000 papers, empirically supported AOPs were constructed describing the most simplistic paths to disease and the weight of evidence across the paths was evaluated. Additionally, information on modulating factors that influenced the pathways were identified. The proposed AOP network can help identify knowledge gaps, prioritize research, inform quantitative risk models and possible countermeasures.

#20 Using mobile EEG to monitor brain performance on Mars

Olave E. Krigolson (University of Victoria), Gordon Binsted (York University), Kent Hecker (University of Calgary)

Travelling to Mars will expose astronauts to physical and mental demands, some of which could lead to injury or death. While some of the factors that cause these demands will be easy to monitor, others will not. For example, cognitive fatigue is a brain state in which people are mentally tired and as a result have an increased incidence of performance errors. In an environment in space, these errors could be fatal. To validate mobile electroencephalography (mEEG) as a means for astronauts to track cognitive fatigue we put a research team of six into the HISEAS Mars habitat in Hawaii. During a one-week simulated mission, we measured cognitive fatigue using mEEG technology three times a day. At the end of the week, our results demonstrated an increase in multiple EEG measures associated with cognitive fatigue. Specifically, we saw a decrease in the amplitude of the P300 event-related brain potential and an increase in frontal EEG theta power, both of which have been shown to be indicative of cognitive fatigue. Given that our mEEG assessment took less than seven minutes to perform, we demonstrate here a viable means for monitoring cognitive fatigue and other mental states in space.

#21 How real is VR? Predicting training proficiency using eye and body movements in real and virtual environments

Ewen Lavoie (Cumming School of Medicine, University of Calgary, Faculty of Kinesiology, Sport, and Recreation / Neuroscience and Mental Health Institute, University of Alberta), Dr. Craig Chapman (Faculty of Kinesiology, Sport, and Recreation / Neuroscience and Mental Health Institute, University of Alberta)

We translated an object interaction task from the real-world (Lavoie et al., 2018) into VR to test how visuomotor behaviors change from real to virtual environments. First, we showed that participants in VR change their hand and arm movements to accommodate the virtual body being visualized (Lavoie & Chapman, 2021). These movement changes were correlated with an increase in self-reported feelings of ownership over the limbs. Here, we compare the similarities and differences in eye-hand coordination between the virtual version of this task and its real-world counterpart. In this task, participants move a box of pasta between 3 shelves in a specific movement sequence, repeated at least 20 times. We found that participants moved almost twice as slowly in VR compared to the real world. As well, compared to the real-world behavior, participants spent more time visually fixating their virtual limb immediately prior to, during and just after moving the pasta box. This is likely caused by the minimal haptic information provided to the participants in the VR condition, a finding that is consistent with prosthetic participants performing this task (Hebert et al., 2019), who also lack haptic feedback. Finally, we show that, apart from these differences, participants completing the task in VR exhibit similar timing and relative duration of fixations to objects and targets as their real-world counterparts. Taken together, this study shows that eye-hand coordination in VR and the real world are quite similar, but haptics remains an important hurdle to increase VR authenticity. As well, VR coupled with eye and motion tracking data collection could be a useful tool in analyzing the proficiency of motor task training for space and other high-risk environments.

#22 Semi-automated robotic pleural cavity access in space

Rachael L'Orsa (Dept. of Electrical and Software Engineering, University of Calgary), Madeleine de Lotbiniere-Bassett (Dept. of Clinical Neurosciences, University of Calgary), Kourosh Zareinia (Dept. of Mechanical and Industrial Engineering, Toronto Metropolitan University), Sanju Lama (Project neuroArm, University of Calgary), David Westwick (Dept. of Electrical and Software Engineering, University of Calgary), Garnette Sutherland (Project neuroArm, University of Calgary), and Katherine J. Kuchenbecker (Haptic Intelligence Department, Max Planck Institute for Intelligent Systems, Stuttgart)

Astronauts are at risk for pneumothorax, a medical condition where air accumulating between the chest wall and the lungs impedes breathing and can result in fatality. Treatments include needle decompression (ND) and chest tube insertion (tube thoracostomy, TT). Unfortunately, the literature reports very high failure rates for ND and high complication rates for TT – especially when performed urgently, infrequently, or by inexperienced operators. These statistics are problematic in the context of skill retention for physician astronauts on long-duration exploration-class missions, or for non-medical astronauts if the physician astronaut is the one in need of treatment. We propose reducing the medical risk for exploration-class missions by improving ND/TT outcomes using a robot-based paradigm that

automates tool depth control. Our goal is to produce a robotic system that improves the safety of pneumothorax treatments regardless of operator skill and without the use of ground resources. This poster provides an overview of our team's work toward this goal, including robot instrumentation schemes, tool-tissue interaction characterization, and automated puncture detection.

#23 Short-term response of human meniscus models to simulated microgravity

Zhiyao Ma, David X Li, Melanie Kunze, Aillette Mulet-Sierra, Lindsey Westover and Adetola B Adesida

Purpose: The mechanical unloading that occurs in spaceflight microgravity has been shown to induce OA-like gene changes and breakdown of cartilage in the knee joint of mice. To date, the effects of mechanical unloading on articular chondrocytes have been studied by simulated microgravity (SMG) in laboratory settings. The aim of this study is to investigate the sex-dependent gene expression profile of human meniscus models exposed to short-term SMG. Methods and Materials: Engineered models were constructed with meniscus cells procured from 5 males and 5 females with no history of KOA. The constructs were cultured under static gravity and SMG conditions for 7 days. Scaffolds were harvested on day 0, 1, 3, and 7, and the expression levels of selected markers were measured by RT-qPCR. Results: Short-term exposure of collagen type I based meniscus models derived from primary human MFCs to SMG resulted in OA-like gene expression profiles for both female and male. The degree of OA development and molecular mechanism differences would be further confirmed by RNA-Sequencing.

#24 Screening for Radioprotective Genes in Human Cells Towards Developing Gene Therapeutics for Space

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Microgravity and radiation are key environmental factors affecting human health in space. Exposure to ionizing radiation increases the risk of oxidative stress and DNA damage, leading to cellular apoptosis and carcinogenesis. This obstacle motivated research into radioresistant tardigrades such as *Ramazzottius varieornatus*, which express a nucleosome-binding damage suppressor protein (Dsup) with the ability to partially protect them and transfected human cells from radiation. We transiently expressed Dsup in hTERT-immortalized retinal pigment epithelial cells which were exposed to radiomimetic mutagens and demonstrated a decrease in γ-H2AX phosphorylation (biomarker of DNA damage). The exact mechanism of Dsup protection from DNA damage is still under study. Thus, our project aims to screen for endogenous genes that can be differentially regulated to mimic the radioprotective phenotype conferred by Dsup, without immunological complications associated with heterologous expression of a foreign protein in human cells. Selectively modulating endogenous gene expression may be an effective method to protect astronauts during future long-term missions to the Moon, Mars, and beyond.

#25 Calf muscle volume declined and fat fraction increased in older adults during 2-week bed rest

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Muscle loss and accumulation of fat have been associated with muscle weakness, fracture risk, and mortality in older adults. It is unknown if exercise intervention can prevent inactivity-related fat infiltration in older adults. We investigated changes in muscle volume and fat fraction (FF) of calf muscles over 2-week bed rest, with or without an exercise countermeasure. We obtained MRI scans with a Dixon-based sequence before and after 2-week bed rest from 20 participants (mean age 59, SD 3; BMI 25, 3) randomized into an exercise (N=9) and an inactive control (N=11) groups. We calculated muscles volume and FF from the soleus and gastrocnemius muscles. We assessed changes in volume and FF over bed rest (time) and between the groups (time×group interaction) using repeated-measures MANOVA. There was an effect of time (Wilk's lambda, P<0.001) but no interactions between time and group (P=0.211). The soleus and gastrocnemius volume declined (11 and 12%, respectively), while FF increased (15 and 21%, respectively). Exercise protocol during bed rest appeared insufficient for preventing muscle loss and fat infiltration in older adults.

#26 Biomechanical and anatomical ocular changes in short-duration space flight

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Purpose: To evaluate the effects of microgravity on ocular biomechanics during Valsalva Maneuver. Methods: Medical data including optical coherence images were obtained from a private astronaut who sojourned 15 days aboard the ISS. Ocular rigidity was measured using a non-invasive method enhanced with deep learning-based choroid segmentation. Results: There was a decrease in ocular pulse amplitude (OPA), measured with a Pascal tonometer, of 54.8% for the OD and 33.3% for the OS after flight compared to baseline. Valsalva-induced choroid thickness increased an average of 7.1mm (3.3%), 7.8mm (3.2%), and 9.8mm (5%) in the OD before, during, and after space flight, respectively. There was a Valsalva-induced choroid thickness increase average of 3.5mm (1.8%), 5.2mm (2.4%), and 1.7mm (0.9%) in the OS before, during, and after space flight, respectively. OR was measured in both eyes before (128 days) and after the flight. There was a decrease in ocular rigidity of 32.93% and 32.97% for the OD and OS, respectively. Conclusions: Data suggests a decrease in OR and OPA after space flight. This could lead to a further understanding of space flight-associated neuro-ocular syndrome.

#27 A method for real-time astronaut health monitoring utilizing space data relays

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Astronaut health monitoring is a key component of risk mitigation strategies during manned space missions. Plans for near real-time astronaut health monitoring in Cislunar and on the Moon from Earth are hampered by limited communications infrastructures. A next-generation proprietary hybrid optical and radio frequency data relay satellite will be launched by CommStar for orbit within 41,632 miles from the Moon. This has great potential to support real-time astronaut monitoring from Earth. The Canadian Bio-Monitor was launched to the ISS as part of a SpaceX Dragon cargo spaceflight and commissioned by Canadian astronaut, David Saint-Jacques. It is currently being utilized to support astronaut health research on the ISS such as the Space Health study. Currently, downlink of Bio-Monitor data from the ISS to Earth is via the tracking and data relay satellite radio frequency infrastructure which has a bandwidth of only 600Mbps. This research will demonstrate near real-time Space Health Analytics as a Service using CommStar. Bio-Monitor data will be transmitted from Earth as a data stream to the CommStar satellite, repackaged and returned to Earth as a data stream.

#28 Trabecular bone connectivity changes following astronaut post-flight recovery on earth

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Microgravity-related bone loss presents a challenge to astronauts during spaceflight. Astronauts undergo rapid bone apposition upon return to Earth, which provides an opportunity to examine the mechanisms of bone remodeling. The objective of this study was to detect changes in bone topological connectivity of astronauts from the International Space Station. Seventeen astronauts had their distal tibia and radius scanned using high-resolution imaging before spaceflight, at landing (R+0), and at 12 months post-flight (R+12).Bone images were three-dimensionally registered across time. A skeletonization decomposed the R+12 images to their underlying structure, allowing superimposition to the R+0 image to highlight areas of bone apposition post-flight. Astronauts' apposition sites were 1.2 times larger in the radius and tibia, versus controls ($p<0.001$). Qualitatively examining these sites in astronauts with above-average apposition showed instances of bone bridging the space between two adjacent structures, indicating trabecular repair. Bone resorption and apposition varied considerably between astronauts, with evidence of trabecular repair and changes in connectivity.

#29 Investigation of the radiation resistant mechanisms of Deinococcus Radiodurans using a GFP biosensor

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Student Moon Initiative for Lunar Exploration (SMILE) is a multi-national group of approximately 55 students from 20 countries and 40 universities, who are attempting to land a SmallSat-sized spacecraft on the lunar surface by 2024. SMILE will showcase a biological payload, which is based on

two prior missions, including NASA's GeneSat-1 mission in 2006, and the Tanpopo mission in 2021. This experiment aims to modify several target genes with Green Fluorescent Protein (GFP) that are theorized to be involved in the key mechanisms of radiation resistance in the bacterium Deinococcus Radiodurans. This will allow for the quantitative measurement of the expression of these genes in the deep space environment by recording the fluorescence both en route and on the lunar surface. The organism will be securely contained within the SmallSat-sized spacecraft and independently transit to the lunar surface from an Earth-centred orbit.This research will provide a greater understanding of DNA repair mechanisms and which genetic pathways are involved in genome repair for Deinococcus Radiodurans, and will contribute to future technology for biological storage mechanisms for DNA and RNA.

#30 Motion sickness: effect of vestibular disturbances on postural control

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The most common hypothesis for motion sickness (MS) is the sensory conflict theory. Visual, vestibular and somatosensory interaction is crucial for postural control, making this task ideal for assessing sensory conflict in individuals with motion sickness. Recent studies suggest that individuals with MS susceptibility have less postural stability during sensory disturbances, supporting the hypothesis of a multisensory interaction deficit in this population. Studies have yet to investigate the effects of vestibular disturbances on static postural control in this population. Our goal was to examine the effects of vestibular perturbation on static postural control in people susceptible to MS. Participants with a greater susceptibility to MS as measured by the MSSQ-Short and as many controls performed a postural control task on a force platform with and without bipolar noisy galvanic vestibular stimulation (GVS). The group with MS demonstrated reduced postural stability during GVS, which is in accordance with the multisensory interaction deficit hypothesis in those with motion sickness.

#31 Citizen science approach for searching and curating literature on the effects of spaceflight on cardiovascular outcomes in rodents and humans

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Spaceflight causes significant changes to the structure and function of the cardiovascular system (CV). The goal of this project is to quantitatively summarize data on the effects of actual or simulated microgravity and radiation exposure on the CV system. Based on CV terms selected by the NASA Ames Life Science Data Archive (ALSDA) Analysis Working Group, medical librarians executed a search strategy in Medline, CINAHL, Embase and NASA repositories. In parallel, we recruited ~100 students and professionals from various space affiliated organizations focusing on underrepresented minorities in STEM. Using the systematic review tool Covidence, they will screen ~18000 studies, extract and curate data for meta-analysis of the CV spaceflight literature, and submit appropriate datasets to the new ALSDA repository. This effort will result in collaborative publications based on literature meta-analyses and public datasets available for reuse, modeling, and machine learning. Our approach reduces title/abstract screening time from the 1-2 years needed for this volume of studies to 3-4 months, while also providing a unique experience in space research and knowledge synthesis tools.

#32 Collecting and curating literature-derived space life sciences data for informatics reuse.

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Artificial intelligence (AI) is an important approach for unbiased analysis of space exploration data. However, experiments in space are costly and rare, making legacy data acquired over years of space research important for enriching datasets. Therefore, there is a need for finding, curating, and incorporating legacy data into AI-ready databases. Previously, we curated legacy data on bone health in space travelers using knowledge synthesis approaches. This study focused on developing the protocol for incorporating the legacy data into the NASA Ames Life Sciences Data Archive. This incorporation required extensive revisions of assay configurations to account for historical changes in nomenclature, methodologies and analysis. New data templates had to be created due to different dimensionality of current (single subject) and legacy (aggregate) data. The next step involves developing computational tools for analyzing legacy data together with current data. The standardized protocols we developed can also facilitate incorporation of other high value legacy data with contemporary AI-driven protocols, such as medical data of rare disorders and environmental data from natural disasters.

#33 Towards measuring cognitive load during planetary exploration

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Robotics operations are becoming increasingly complex and opaque to the operator. One example is in planetary exploration missions, in which operators might supervise semi-autonomous robotic swarms. Our work aims to improve the safety and effectiveness of human-robot operations by measuring physiological correlates of cognitive state (i.e., electroencephalography, pupillometry, skin conductance, and heart rate variability). Real-time measures can be used to evaluate systems, to provide alerts to users, and for adaptive automation (in which workload is adjusted). In a first study that compared different interfaces and deployment strategies used during an exploration task with drones, we used physiological sensors to indirectly measure cognitive load along with a subjective measure (NASA-TLX). In a follow-up experiment, we are investigating which combinations of physiological measures are most reliable to classify workload levels across different laboratory tasks constructed with clear workload levels. These steps will lay a solid foundation for measuring continuously varying workload changes of operators in field conditions and will facilitate real-time adaptive automation.

#34 Internal jugular vein distension during parabolic flight with and without a Valsalva maneuver

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A fluid shift toward the head during spaceflight causes internal jugular vein (IJV) distension and could elevate risk for venous thrombosis and spaceflight associated neuro-ocular syndrome. Non-contact, near-infrared coded hemodynamic imaging (CHI) is a new technology that may enable continuous venous monitoring in microgravity. We assessed the feasibility of CHI to estimate changes in IJV blood volume in acute microgravity. Ten healthy adults completed eight parabolic flight maneuvers with ~20s of microgravity (0G). During four parabolas, participants performed a moderate intensity Valsalva maneuver (VAL) for 10s beginning 5s after the onset of 0G. The right IJV was imaged continuously by CHI throughout all parabolas. In 1G, IJV area was 0.14±0.11cm2 and CHI-estimated volume was 1.08±0.09a.u.. Ultrasound imaging found IJV area increased at the onset of 0G (0.99±0.59cm2) and increased further during VAL (1.29±0.57cm2). Similar directional changes were found with CHI (0G 1.18±0.10a.u.; VAL 1.32±0.10a.u.). CHI detected the increase in IJV blood volume at the onset of microgravity. The Valsalva showed that IJV is not fully distended in parabolic flight.

#35 Mapping pulsatile optic nerve head deformation using OCT

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Astronauts who have undergone long-duration space flights missions in microgravity environments can suffer from SANS. The pathophysiology leading to SANS is still uncertain and research is actively done to understand the development of these symptoms and ways to counter them. Ocular biomechanical properties are the focus of many studies in different ocular diseases. Optic nerve head (ONH) biomechanical properties could be a key factor to the development of SANS.We present a non-invasive technique to quantitatively assess the pulsatile deformation of the ONH tissue by combining high-frequency OCT and image processing algorithms. Our technique demonstrates good reproducibility, and the capacity to accurately map the pulsatile deformation of the optic nerve. The capacity of the technique to measure physiological changes in tissue strain would enable the application to SANS research. A better understanding of ocular properties could help us in identifying better therapeutic options and prognostic tools in

different eye diseases. This technique is easily implementable since the required equipment is already available in clinics and in the ISS.

#36 Canadian aging and inactivity study: effects of 14 days of bed rest on the cardio-postural control

Farshid Sadeghian, Donya Naz Divsalar, Catherine Taylor, Tiffany Stead, Andrew P. Blaber

Orthostatic hypotension in older persons is commonly caused by inactivity and associated deconditioning. As part of the Canadian Aging and Inactivity Study (CAIS), we evaluated the effect of 14 days of 6-degree head-down tilt bed rest (HDBR) with or without combined upper and lower body strength, aerobic, and high-intensity interval training exercise on cardiac and muscle-pump baroreflex in 55- to 65-year-old participants. Methods: Supine-to-stand tests were performed to measure baroreflex activity. Baroreflex fraction time active and gain values were characterized through wavelet transform coherence. Convergent cross-mapping provided the causal directionality between blood pressure (BP) and heart rate (cardiac baroreflex), and between BP and lower leg muscle electromyography (EMG) (muscle-pump baroreflex). Results and conclusions: Our results showed that all cardiovascular measures were negatively affected following HDBR and that the exercise countermeasures implemented in this study may have partially alleviated muscle-pump, but not cardiac baroreflex declines, in older adults from 14 days of inactivity.

#37 Automated Wireless Blood Flow Restriction (BFR) Training for long-duration spaceflights (LDS)-Part 1

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LDS mark a turning point since current exercise devices can no longer be used due to their large size. Conventional guidelines often call for high-intensity resistance training (HIRT), which represents an important mechanical load and a risk of injury. BFR combined with low-intensity resistance training (LIRT) is safe and somewhat as effective as HIRT for eliciting gains in muscle mass and strength. The objective is to determine and optimize the effectiveness and efficiency of wireless BFR technology (AirBands) combined with LITR to increase muscle mass, muscle strength, bone mineral density, muscle blood flow, postural stability and functional capacity in participants at risk of muscle and strength loss. A total of 30 inactive participants, males and females, aged 55 to 65 will be divided equally into 3 groups: HIRT, LIRT+BFR and control group. After baseline testing, all exercise groups will train 3x/week on non-consecutive days. The same tests will be administered at mid-point and after 8 weeks of training. This study will enable the gathering of very pertinent data regarding BFR training and its potential as a countermeasure for LDS as well as hospitalized elderly patients.

#38 Repeatability of presyncope test protocol in short-arm human centrifuge investigations for males

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Short-arm human centrifuges (SAHC) are being explored for spaceflight deconditioning countermeasures. In this study we investigated the repeatability of SAHC tests to presyncope conducted six months apart with male participants whose daily activities did not change between tests. Methods: The presyncope data were collected from two separate studies using the same protocol (07/2021 and 02/ 2022) at MEDES (Toulouse, France) in which a subset of four males participated in both. A ramped (0.1 g increments) artificial gravity (AG) protocol from 0.8 g at heart level until presyncope was used. Repeatability was examined from the time-to-presyncope and heart rate (HR) response between the two studies using linear regression. Results: Comparison of July and February time-to-presyncope gave a regression of Feb(2022) = -114±179s+1.11±0.11July(2021), r2=0.98. The average HR comparison (n=4) over centrifuge levels was Feb(2022) = 0.8±11.3 bpm+1.09±0.04July(2021), r2=0.97±0.03. Conclusion: Time-to-presyncope and HR regression were highly correlated with slopes not different from one and intercepts not different from zero. The SAHC presyncope test with males was repeatable over 6 months.

#39 Epigenetic/microbiome physiological research during terrestrial analog missions

Catherine Taylor (SFU), Donya Divsalar (SFU), Tiffany Stead (SFU), Dr. Andrew Blaber (SFU)

The effects of Long-Distance Space Flight (LDSF) on human physiology have been extensively studied since the beginning of the space race. Space in situ studies have and continue to assess the deleterious effects on human physiology once astronauts enter LEO's irradiated microgravity environment. However, studies researching astronauts' epigenome and microbiome changes, if any, during LDSF are still in their infancy. Equally juvenile is the differentiation of which factors are impactful (i.e., physical/psychological forces of take-off and landing, irradiated microgravity, or confinement). The current research aims to investigate any epigenetic and gut-brain axis changes during Terrestrial Analogs ("Analogs"). The research outcomes can assess if confinement has significant effects which can then serve as baselines for stressors of actual spaceflight.

#40 Evaluating cytoskeletal changes in natural killer cells after simulated microgravity exposure

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Spaceflight induces immune dysregulation, including affecting the cytotoxic function of natural killer (NK) cells. NK cells are innate immune cells that secrete cytotoxic granules to kill cancerous and virus-infected cells. Previous studies of NK cells exposed to spaceflight and simulated microgravity (SMG) report a decease in cytotoxicity, however an underlying mechanism for this detriment has not been proposed. Our study aims to explore the observed decrease in cytotoxicity, through the lens of investigating cytoskeletal changes to NK cells after SMG exposure. Preliminary three-colour fluorescent images reveal a potential increase in the clustering of NK cell actin and microtubules after SMG exposure, compared to NK cells cultured under normal gravity. Other studies have shown similar patterns with lymphocytes and macrophages subjected to spaceflight. Our study may provide insight into possible mechanisms of reduced NK cytotoxicity, to help mitigate these effects during spaceflight. Additionally, studying cytoskeletal changes in SMG may contribute to the understanding of diseases caused by cytoskeletal dysregulation on Earth.

#41 Melanin-containing films for protection from space radiation

Michelle Vargas Fernandez (University of Saskatchewan, Mackenzie E Malo (University of Saskatchewan), Ekaterina Dadachova (University of Saskatchewan

Space travel is the future of discovery, however astronauts face risk due to exposure to ionizing radiation. Development of shielding material is necessary to ensure the protection of astronauts. Melanin, a natural pigment found in numerous organisms, has unique physicochemical properties, including radioprotection. We hypothesized that melanin-containing materials could provide radioprotection from highly energetic particles. Poly(vinyl alcohol) (PVA) films containing melanin nanoparticles (MNPs) were subjected to shielding performance tests with 177Lu and 111In. When evaluating 177Lu the MNPs-PVA films showed a reduction in dose rate compared to PVA film with no MNPs. In the case of 111In, films were tested to understand the influence of nanoparticle size and total amount. It was observed that varying MNP size did not significantly change shielding, but that increasing the total amount of MNPs significantly altered the shielding capacity. If successful, this material could scale up for use in other fields such as medicine, electronics, and many other applications.

#42 A mouse model of spaceflight-associated neuro-ocular syndrome

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Astronaut health is at the forefront of biomedical research with plans for more long-duration spaceflight missions well underway. A major health barrier and potential cause of impaired health affecting almost half of astronauts within a month of spaceflight is called Spaceflight-Associated Neuro-ocular Syndrome (SANS). Swelling in the optic nerve, retina and choroid are hallmarks of the disease, although the etiology is unknown. A glial-cell-dependent lymphatic circulation that allows entry of CSF fluid into the optic nerve has previously been described, and we hypothesize that fluid shifts involving this pathway may play a role in SANS. Since there is no animal model of SANS, we have been developing the first mouse model for SANS. We developed a Hindlimb Unloading (HU) protocol, suspending mice from the tail for 21 days, before releasing them for 14 days. We used optical coherence tomography (OCT) and developed a segmentation algorithm to assess retinal and choroidal thickness changes at weekly intervals. A tracer was injected at the endpoint into the CSF and photoacoustic imaging was used to quantify fluid dynamics. Here we describe our protocol and preliminary results.