2024 CANADIAN SPACE HEALTH RESEARCH SYMPOSIUM POSTER PRESENTATIONS

Posters will be in the Mustang Lounge (main floor of the University Community Centre) – Western University.

ODD-numbered posters will be attended by presenters on Thursday November 7 (16:00 – 17:30), and EVEN-numbered posters will be attended on Friday November 8 (15:30 – 17:00)

#1 Astro-fly: An Animal Model to Investigate the Impact of Microgravity on Human Health

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Exposure to microgravity is a significant stressor for astronauts, and, as such, it is critical to understand its impact on health. Here, we used Drosophila melanogaster (fruit fly), to study the impact of exposure to simulated microgravity, on the ability to deal with an additional stressor, specifically starvation. We exposed fruit flies to simulated microgravity for seven days and found an increase in sensitivity to starvation that significantly reduced survival. Importantly, we also found that increased sensitivity to starvation is affecting males more than females, with males displaying a greater reduction in survival. These findings suggest that exposure to microgravity is a stressful experience that may impact the ability to cope with further stressful events. Future studies will need to explore physiological and genetic changes that may explain increased sensitivity to starvation, and examine the impact of microgravity on the ability to cope with other stressors such as DNA damage.

#2 BRACE Bed Rest Study: Combined exercise and artificial gravity countermeasure does not protect against increased lower-limb venous pooling following 60-day head-down bedrest

Anjali Chauhan[1], Eric T. Hedge[23], Carmelo J. Mastrandrea[23], Andrew D. Robertson[23], Dag Linnarsson[4], Richard L. Hughson[2]

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Head-down bedrest (HDBR) provokes orthostatic intolerance (OI). Artificial gravity (AG) can mitigate post-HDBR intolerance, but its effects when combined with exercise have not been explored. We investigated if AG applied during exercise attenuates changes in venous pooling in the legs during orthostatic stress, a potential contributor to OI. Twenty-four healthy men (age: 30±6 years) completed 60 days of 6° HDBR and were randomly assigned to sedentary control (n=8), exercise (n=8) or exercise + AG (n=8) groups. The exercise group performed daily supine interval cycling, while exercise + AG performed the same cycling protocol on a short-arm centrifuge. Venous pooling was measured by near-infrared spectroscopy over the lateral head of the right gastrocnemius before (PRE) and immediately after (POST) HDBR during an orthostatic stress test [15 min of 80° head-up tilt followed by incremental lower-lower body negative pressure while upright (-10 mmHg every 3 min)]. The change in total hemoglobin (tHb) from supine was greater when matched for test duration for all 3 groups after HDBR (main effect: p=0.003), with no evidence of a protective effect of exercise or exercise + AG (interaction: p=0.445). Increased tHb after HDBR was attributable to greater increases in deoxygenated hemoglobin, while the change in oxygenated hemoglobin remained stable (p=0.290). Both exercise and exercise + AG were ineffective in attenuating increases in venous pooling during orthostatic stress after HDBR.

#3 Cerebral hemodynamics during acute microgravity

A. D. Robertson[1], C. A. Patterson[2], E. T. Hedge[1], R. L. Hughson[3]

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The transition to microgravity (0 Gz) imposes a significant stress on the cardiovascular system. In this study, we examined concomitant changes in arterial, venous and intracranial circulations during parabolic flight. Ten healthy men and women each completed 4 parabolic maneuvers while seated. We measured blood pressure, cerebral blood velocity (MCAv), cerebral blood volume, exhaled carbon dioxide, and internal jugular vein (IJV) distension. We calculated estimates of stroke volume and total peripheral resistance. During the parabolic transition to 0 Gz, we observed immediate and sustained increases in stroke volume, IJV cross-sectional area, and total hemoglobin, consistent with a headward fluid shift. Reflexively, total peripheral resistance and heart rate decreased, leading to reduced arterial pressure. While pressure was reduced centrally, it increased within cerebral vessels due to the suspension of the hydrostatic pressure gradient in 0 Gz. Cerebrovascular conductance dropped immediately in 0 Gz, and markers of cerebrovascular tone were elevated. Despite increased tone, mean and diastolic MCAv increased transiently over the first 5 s of 0 Gz. Increases in both IJV cross-sectional area and total hemoglobin during microgravity were correlated with increased cerebrovascular tone, suggesting hemodynamic congestion. Simultaneous monitoring of arterial and venous circulations

furthers our understanding of cerebrovascular regulation in 0 Gz. Funding: Canadian Space Agency.

#4 Designing a Microbiology Experiment for Spaceflight

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Despite extensive research efforts to develop new antibiotics, the United Nations projects that drug-resistant bacteria will cause 10 million deaths annually by 2050. Those with compromised immune systems, including astronauts, are at the greatest risk of developing bacterial infections, which are becoming increasingly challenging to treat. Escherichia coli (E. coli) lives inside the human gut and has been identified on spacecraft surfaces and in the air. Since astronauts cannot return to Earth for medical care during long-duration space flights, developing new ways to treat these infections is imperative. In microgravity, E. coli can share genes, proteins, and other molecules that protect them more effectively from immune cells and antibiotics. As part of the Student Spaceflight Experiment Program, our proposal investigates whether Concanavalin A decreases the growth of E. coli in microgravity. It underwent selection by a panel of scientists and experts in the aerospace industry at the National Center for Earth and Space Science Education (NCESSE). Ultimately, the experiment received over $ 27000 in funding and was selected to fly to the International Space Station this fall, where it will be conducted by astronauts. The project will be the first to investigate the potential for Concanavalin A as a cost-effective solution to combat antibiotic-resistant bacteria in astronauts.

#5 Disrupted Brain Fluid Drainage in Microgravity: Insights from NASA's Mouse Model

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Background and Purpose: Vision loss in astronauts due to Spaceflight-Associated Neuro-ocular Syndrome (SANS) is likely caused by microgravity-induced headward fluid shift. MRI studies show brain changes, such as dilation of cerebral ventricles filled with CSF. It is

unclear whether microgravity alters lymphatic drainage of cerebrospinal fluid (CSF) from the brain and whether this might lead to the eye changes observed after long-duration flight. Here we use NASA's mouse model to determine potential disruptions of the CSF drainage via the lymphatic system. Methods: To study CSF drainage, we used NASA's hindlimb unloading (HU) mouse model. Eight adult mice (5F/3M) underwent HU conditions for 3 weeks and were then released for 2 weeks; 10 mice (5F/5M) served as controls. A tracer was then injected into the CSF, and neck lymph node signal intensity was measured over time using in vivo photoacoustic tomography. The Area Under the Curve (AUC) of mean pixel intensity (MPI) was calculated and compared between HU and control groups (Mann-Whitney U-test). Results: The AUC of MPI in neck lymph nodes was significantly decreased in HU mice compared to controls (0.0025 ± 0.0002 vs. 0.0044 ± 0.0001; $P < 0.005$), indicating impaired lymphatic drainage of CSF. Conclusions: Impaired lymphatic drainage from the brain may contribute to CSF accumulation and eye changes in microgravity conditions while in space and may contribute to the development of SANS.

#6 Effects of aerobic exercise countermeasures and artificial gravity on the regulation of energy intake and energy balance during long-term bedrest in healthy men

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Sustained negative energy balance, i.e., total daily energy expenditure (TDEE) exceeding energy intake (EI), commonly observed during spaceflight, can worsen microgravity-induced health effects. Understanding energy balance (EB) regulation is an operational and medical priority for space exploration. We hypothesize that aerobic exercise (AE) disrupts the coupling between TDEE and EI, leading to energy imbalance, and explore the effects of AE with and without artificial gravity (AG) on EB components. In the latest 60-day

continuous -6° head-down bedrest (HDBR; 2023-May 2024) study, 24 healthy men (aged 29.5±5.7 years; BMI 23.9±1.9 kg/m2) were randomized into three arms: (1) control, (2) AE, and (3) AE+AG by human centrifugation. The exercise groups performed 30 minutes of high-intensity interval training (40%-80% VO2max) daily, six times a week, on a lying ergometer bike. Habitual diet (3-day food records) and physical activity (3D-accelerometry) were evaluated before HDBR. Results for EI, food preference (Leeds Food Preference Questionnaire), body weight and composition (DXA), and the components of TDEE (doubly labeled water and indirect calorimetry) over HDBR will be presented. Metabolic and appetite-related hormones in response to a standard and ad libitum meal were collected before HDBR and at the end. We expect our results to enhance understanding of EB regulation under microgravity and refine exercise countermeasures to optimize health while avoiding energy deficit.

#7 Flow-mediated dilation as a marker of endothelial function in 55- to 65-year-old adults undergoing two weeks of head-down bedrest with and without exercise

C.A. Patterson[12], E.T. Hedge[23], C.J. Mastrandrea[23], R.L. Hughson[2]

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Background: Flow-mediated dilation (FMD) is an endothelium-dependent marker of vascular health and is an independent predictor of cardiovascular disease. FMD was unchanged following spaceflight , but paradoxical results were reported after prolonged head-down bedrest (HDBR), with enhanced dilation being found in young healthy adults. However, aging naturally leads to endothelial dysfunction in older adults. We hypothesize that two weeks of HDBR will cause endothelial dysfunction in late-middle-aged adults, leading to decreased percent FMD, but that a high-intensity exercise countermeasure will protect endothelial function during HDBR. Methods: 22 participants (11F) underwent 2 weeks of 6° HDBR. 11 participants were randomized into the exercise intervention group and 11 were assigned into the control group. The exercise group performed ~1 h of exercise each day, consisting of high-intensity interval and constant-load cycling, as well as upper- and lower-body resistance exercises. Brachial artery FMD was measured prior to HDBR and 12 days into HDBR. Linear mixed models will evaluate the effects of HDBR and exercise on endothelial function. Conclusion: FMD results will be related to finding elevated oxidative stress in female participants. Together, our results can inform potential exercise countermeasures for future spaceflight, and further our understanding of the vascular consequences of prolonged periods of hospitalization or transitions in care in the older adults.

#8 Gene expression and skeletal morphology changes of larval zebrafish after short-term exposure to simulated microgravity

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As the era of long-duration space missions is fast approaching, it is now more important than ever that we broaden our understanding of how bone cells react to the microgravity environment of space. The objective of our study was to further examine how bone cells react to a short exposure to simulated microgravity. Based on our previous studies which showed a decrease in ossification and increase in some bone-related genes in 3.5 day old zebrafish following a 24-hour exposure to simulated microgravity (SMG), we sought to determine whether a similar response would be observed in slightly older larval fish, namely fish at 8 days post fertilization. Using a random positioning machine to simulate microgravity we subjected both wild-type and transgenic anesthetized larval zebrafish at 8 days post fertilization (dpf) to simulated microgravity for 24 hours. Morphological changes will be assessed via whole mount bone and cartilages staining while gene expression changes will be determined via qPCR. Specifically, we will quantify the expression of skeletogenic genes. Using the transgenic zebrafish line, we will analyze fluorescent images to count the number of bone-depositing cells and changes in skeletal morphology. This research will provide insight into how simulated microgravity impacts bone tissue and holds important implications for future studies investigating the effects of microgravity on human bone cells.

#9 Health Technologies for Space Environments: How to Spot the Difference Between Microgravity-Adapted and Gravity-Agnostic Health Innovations

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1. University of British Columbia. 2. The Schlegel-UW Research Institute for Aging. 3. Innovance AI, Global Head of Invenk Solutions, Gateway Earth

As human exploration of microgravity environments expands, the demand for health technologies that function in microgravity and increased radiation grows. Despite advancements, significant gaps remain in life science devices tested on the International Space Station and other spacecraft. This underscores the need for microgravity-adapted (MA) technology adapted from an existing health technology used on Earth but distinct from its Earth-based counterpart (e.g. a tool or device that required a new engineering solution to work in microgravity), and gravity-agnostic (GA) engineering approaches, those not requiring any modifications to work in microgravity. This research reviews space health technologies, highlighting challenges and opportunities while providing insights and strategies for patenting new inventions in space health. The study characterized the space health technology landscape by compiling a list of patents related to microgravity conditions with healthcare applications. The landscape is divided into specific technology domains crucial for healthcare in space. Classifying these patents into MA and GA technologies allows for a nuanced understanding of the adaptations required for successful

implementation in space. This research recognizes the need for a dedicated patent classification system tailored to space health technologies and argues for its necessity in the paper's conclusions.

#10 Heart Rate Outcomes in Humans Exposed to Microgravity: Systematic Review and Meta-analysis

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The spaceflight environment causes significant changes to the structure and function of the cardiovascular system, including fluid redistribution, alterations in blood pressure, and changes in cardiac output. The overarching goal of this project is to quantitatively summarize legacy data on the effects of actual or simulated microgravity resulting from spaceflight on the cardiovascular system. We completed a search of 4 libraries to retrieve 18,837 articles. Following title and abstract screening, 3739 included articles were divided into subgroups, with our primary group of focus being humans and actual microgravity, containing 981 articles. 217 articles made it through full text screening, and were further divided into subgroups based on cardiovascular outcomes: cardiac measurements, vasculature, pressure and heart rate. Analysis of heart rate outcomes from 53 articles shows that spaceflight a significant increase in heart rates when comparing pre and post flight measurements. These values are also heavily dependent on measurement position, where the astronaut is either standing, seated or supine. Additionally, analysis of short (<30 days) vs long term spaceflight shows no significant difference in returning heart rates. Our results will help inform space health strategies by strengthening the knowledge of human physiological adaptations in microgravity, mitigating health risks of space travel.

#11 Mechanogenomic Suppression of Microgravity-Induced Chondrocyte Hypertrophy in Bioengineered Human Cartilage

Madeline Barker, Zhiyao Ma, Gordie Seikaly, Jillian Seikaly, Aillette Mulet-Sierra, Melanie Kunze, Lindsey Westover, Adetola Adesida

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Articular cartilage (AC) of the knee exists under a low oxygen and mechanically active environment. Mechanical unloading conditions of spaceflight microgravity pose a risk for astronauts to develop knee osteoarthritis (OA), which causes degradation of AC over time. Mesenchymal stem cells (MSC's) are a promising cell source for modelling cartilage development. We have previously found that the combination of low oxygen and mechanical loading (mechano-hypoxia conditioning) during cartilage development of human bone marrow (hBM) derived-MSC under gravity conditions can reduce OA characteristics. This experiment aimed to determine the effect of mechano-hypoxia conditioning on cartilage developed from hBM MSCs under SMG. HBM MSCs were collected, expanded, and induced to form engineered cartilage models. The engineered cartilage models were subject to static conditions, SMG 3 weeks, SMG 6 weeks, and SMG + dynamic compression respectively. SMG constructs were cultured in a rotatory wall vessel bioreactor for the specified time. The results of this experiment are pending. It is expected that SMG will induce an OA phenotype in the engineered cartilage. This is expected through a decrease in healthy cartilage markers, and an increase in OA markers. Mechano-hypoxia conditioning will be expected to reduce some of these effects. The outcome of this experiment will advance our understanding of the mechanobiological process of cartilage breakdown in microgravity and avenues for prevention.

#12 Nature Leads to Space: A Meta-Analysis of MicroRNA Patterns in Hibernators Reveals Intersections Between MicroRNA Dysregulation During Microgravity and Irradiation

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Human hibernation (or synthetic torpor) will become an increasing necessity to combat the psychological, logistical, and biological issues of long-duration spaceflight. Two parallel approaches for synthetic torpor mirror those existing in nature, and include either induction of hypothermia – complex and requiring high levels of human/material interventions – or a high-temperature torpid state. MicroRNA (short, noncoding, RNA molecules capable of altering gene expression without changing the DNA sequence itself) are both critical in facilitating hibernation as well as implicated in molecular dysregulation observed during spaceflight. I conducted a meta-analysis of studies identifying differentially-regulated microRNA during warm hibernation, cold hibernation, microgravity, and irradiation to elucidate if conserved miRNA responses exist at intersections of these stresses. I found common responses between all four groups, totalling 65 microRNAs with shared expression and 41 microRNAs with opposite expression. Particular emphasis on p53 signaling, DNA damage repair, radioresponsive miR-21, and oxidative stress-induced miR-16-5p was also noted across groups. Taken together, I propose this subset of microRNAs and their functional roles as ideal targets for further research/therapeutic interventions in humans. By uncovering molecular mechanisms behind hibernation on Earth, we can create

countermeasures for astronauts enduring the increasingly longer and harsh conditions of space.

#13 Sensitivity to vection may influence astronauts' perception of visually created gravity in space

Meaghan McManus[1], Björn Jörges[2], Nils Bury[3], Ambika Bansal[2], Robert S. Allison[2], Michael Jenkin[2], Laurence R. Harris[2]

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The vestibular signal provided by the otoliths is inherently ambiguous as they respond to all linear accelerations. One source of linear acceleration can be misperceived as another as in centrifugation where centrifugal acceleration is misperceived as body tilt. Here we ask whether visually simulated linear motion down a virtual reality corridor might also lead to a misperception of body tilt. If so, then after viewing accelerating optic flow, a (simulated) floor should appear tilted. If constant velocity optic flow is viewed instead no tilt should be observed. We visually translated twelve astronauts down such a virtual corridor at 0.8ms2 or 4ms before, during, and after exposure to microgravity on the ISS. On Earth, we recorded whether they experienced the sensation of vection (illusory self-motion) when viewing such motion. If astronauts felt that they were actually moving instead of just viewing optic flow, they might be less likely to misinterpret the translation as tilt. Exposure to microgravity led to a small increase in the perceived tilt of the floor when viewing constant velocity but not acceleration. Additionally, we found an overall effect of vection experience on the amount astronauts tilted the floor after viewing constant velocity: when no vection was felt the floor there was also an increase in the perceived tilt of the floor compared to when vection was felt ($p = 0.014$, mean difference: 0.76°). No effects of vection were found when viewing acceleration.

#14 Sex- and protocol-dependent changes in orthostatic tolerance of 55- to 65-year-old adults following two weeks of head-down tilt bed rest

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Orthostatic tolerance is reduced immediately following spaceflight and its analog, head-down bed rest (HDBR). Women are typically identified as being at higher risk for experiencing orthostatic intolerance or syncope. The purpose of our experiment was to assess changes in orthostatic tolerance of late-middle-aged men and women following HDBR with two commonly used tilt and stand protocols. Twenty-two 55- to 65-year-old adults (11 women) completed two weeks of HDBR, with half the participants performing a

daily high-intensity exercise countermeasure program while in bed. Orthostatic tolerance was assessed using 15-min, 80° head-up tilt tests and 8-min stand tests before and after HDBR. Post-HDBR tilt tests were conducted as the first instance of upright posture, while post-HDBR stand tests were conducted ~5 h later. Tilt tolerance times were reduced following HDBR ($p<0.001$), with no protective effect of exercise and no differences between sexes (both $p>0.05$). Exercise did not protect stand test tolerance time either ($p=0.574$); however, there was a sex by bed rest interaction ($p=0.004$), with women having reduced stand tolerance time, but not men after HDBR. These divergent sex-based findings between tilt and stand tolerance times raises questions about potential differences in how quickly men and women in this age group readapt to upright posture, or respond to passive versus active orthostatic stresses. Supported by CIHR, CSA and NSERC.

#15 Short-Term Gene Expression Responses in Danio rerio Larvae following Simulated Microgravity Exposure

Juan David Carvajal-Agudelo, Tamara A. Franz-Odendaal

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Simulated microgravity (SMG) is a condition that can be set up in a laboratory setting using devices such as a clinostat or a random positioning machine (RPM). In a ground-based simulated microgravity (SMG) environment, exposed organisms experience a near-weightless state, which can disrupt physiological processes and potentially lead to adverse health effects. The objective of our study was to determine the effects of SMG exposure on bone development. In our study, we exposed larval zebrafish (Danio rerio) at 3.5 days post-fertilization to this SMG environment through a 3D rotational model for 6-24 hours. We then examined gene expression changes after 6, 12, 18, and 24 hours of exposure, as well as one week after the 24-hour exposure. Our data shows significant increases in the expression of some skeletogenic genes (e.g. genes associated with bone resorption) after 18 and 24 hours of exposure, while others are unaffected (e.g. genes associated with bone deposition). This data indicates that bone homeostasis is disrupted after SMG exposure such that bone resorption by osteoclasts is triggered. This bone response is likely the cause of the observed bone density loss observed by astronauts after space flight. This research thus offers valuable insights into how external factors like SMG can negatively impact bone development and homeostasis in zebrafish and highlights the usefulness of ground-based whole organism studies to space health research.

#16 Spaceflight-Associated Neuro-ocular Syndrome: Insights from Eye Changes Following Microgravity Simulation

Arya Zarrinbakhsh[12], Neeru Gupta[345], Xun Zhou[45], You Liang[6], Yeni Yücel[451278]

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Purpose and Background: To understand the effects of spaceflight on astronauts, this study tests whether NASA's hindlimb unloading rodent model, mimicking the headward fluid shift in microgravity, can be used to study eye changes. Spaceflight-Associated Neuro-ocular Syndrome (SANS) includes optic nerve edema, retinal and choroidal thickening and globe flattening, along with a transient increase in intraocular pressure (IOP). IOP is an important physiological parameter, and its elevation is a major and modifiable risk factor for glaucoma; however, IOP has not yet been systematically studied within the context of SANS. Methods: We subjected 10 albino mice to a hindlimb unloading (HU) protocol for 5 weeks, which included 3 weeks of HU followed by 2 weeks of release. 10 control mice did not undergo HU. IOP of both eyes were measured weekly with a rebound tonometer. Splined linear mixed model analysis was used for statistical analysis. Major Results: Statistical analysis revealed a significant increase in IOP of both eyes in the HU group on day 14. Splined linear mixed model analysis further revealed a significant increase in the IOP rate of change within the first two weeks, followed by a significant IOP decrease back to baseline for both eyes. The control group did not show any change in IOP. Conclusions: These findings suggest that the HU model could be a useful experimental model for understanding microgravity-induced eye changes and developing countermeasures to prevent SANS.

#17 Spaceflight-Induced Changes in the Neural Mechanisms of Spatial Orientation

Ford Burles, Giuseppe Iaria

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Long-duration spaceflight poses significant challenges to astronauts' spatial orientation and navigation skills, potentially leading to operational errors in critical tasks. This study investigates the neural adaptations in spatial cognition following extended exposure to microgravity. Functional magnetic resonance imaging (fMRI) data were collected while 16 astronauts performed a spatial orientation task, both six months before and two weeks after their missions onboard the International Space Station (ISS). We identified a general reduction in brain activity across key spatial-processing regions, including the precuneus, angular gyrus, and retrosplenial complex. The most pronounced decrease was observed in

the precuneus, a region crucial for visuospatial imagery and mental representation of space. Notably, these changes in neural activation were not correlated with either alterations in behavioral performance or grey matter concentration. These findings suggest astronauts adopt compensatory cognitive strategies, relying less on traditional spatial neural networks, likely in response to the altered sensory environment of space. This research underscores the importance of developing countermeasures to mitigate spaceflight-related impairments in spatial cognition, which is particularly relevant for future long-duration missions to the Moon and Mars.

#18 Stimulating Microgravity Induces Retinal Changes in Mice

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Background and Purpose: Vision loss in astronauts due to Spaceflight Associated Neuro-ocular Syndrome (SANS), is considered a critical risk for long-duration space missions. The specific mechanisms underlying retinal changes are unknown, and experimental models are lacking. Here we simulate microgravity in mice to investigate possible retina changes using a non-invasive imaging approach. Methods: We adapted NASA's hindlimb unloading (HU) model to study eye changes in MG. 10 adult albino mice underwent HU for 3 weeks and were then released for 2 weeks; 10 adult albino mice served as controls. OCT of both eyes was performed weekly at baseline and during HU using the same device available on the International Space Station. A pre-trained machine- learning pipeline segmented the retina and retinal nerve fiber layer (RNFL), followed by manual correction. RNFL thickness was calculated using a k-nearest neighbours algorithm. Results: Preliminary data from 20 albino mice showed a significant decrease in RNFL thickness in the right eye of the HU group at 2-week HU, remaining stable for the remainder of the experiment. Total retinal thickness remained unchanged in both HU and control groups. Conclusions: A mouse model of microgravity induced retinal changes measurable in vivo using the same device available on the ISS. This finding may be useful to efforts to understand and overcome vision loss in astronauts due to SANS.

#19 Systemic Genome Correlation Loss as a Central Characteristic of Spaceflight

Anurag Sakharkar[1], Kiven Erique Lukong[1], Lauren M. Sanders[2], Sylvain V. Costes[2], Changiz Taghibiglou[1], Jian Yang[1]

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Space exploration has captured the imagination of humanity for generations. From the first steps on the moon to the recent Mars rover and Artemis lunar exploration missions, space travel has always been an ambitious goal for humanity. However, as we venture further into space and prepare for long-term missions to other planets, the physiological and health risks associated with prolonged space travel are becoming more prominent. Most current research on astronaut health focuses on identifying individual genes or pathways for specific symptoms astronauts face. The human system is complex and delicate, and the effects of microgravity, radiation, and isolation on astronaut health during long-duration spaceflight are still not fully understood. This study used a novel ranking and analysis methodology to combine space omics data from multiple datasets in the NASA OSDR repository. The data was used to generate a multi-omic, integrative bioinformatics analysis pipeline, which identified and characterized a genome-wide spaceflight gene expression correlation loss as a central biosignature for astronaut health on the International Space Station (ISS). Our findings indicate that genome-wide correlation loss corresponds to a breakdown in gene synchronization and cooperation, showcasing the systemic symptoms spaceflight induces and their genomic roots.

#20 The virtual International Space Station: A new platform to investigate the effects of simulated microgravity, isolation and confinement on spatial cognition

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The ability to navigate our surroundings (i.e., wayfinding) and establish a positive emotional connection with our environment (i.e., sense of place) are essential for effective daily functioning and well-being. However, astronauts on long-duration spaceflights are exposed to various factors, such as microgravity and increased social isolation and confinement, which could negatively affect their spatial orientation skills and sense of place. To explore these effects, we created a virtual reality version of the International Space Station (ISS) where individuals perform various spatial tasks while navigating a simulated

microgravity environment. This virtual ISS platform offers a time- and cost-effective opportunity to extensively investigate the impact of spaceflight on astronauts' spatial cognitive processes, and their experience of sense of place toward the ISS as a physical setting.

#21 Uncovering Hippocampal Volume Loss in Astronauts Following a Mission to the International Space Station

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Astronauts often experience spatial disorientation while exposed to microgravity in the International Space Station (ISS). Here, we tested the hypothesis that these challenges may be linked to structural changes in the hippocampus, a brain region critical for spatial orientation. To test this hypothesis, we collected Susceptibility Weighted Imaging (SWI) scans in 21 astronauts before and after a six-month ISS mission, and calculated percent volume changes between pre- and post-mission scans. We found greater volume loss in the whole left hippocampus, and decreased volume in the head and body of the left and right hippocampus, respectively. We also found greater loss in the right hippocampus of males as compared to females, and in the left hippocampal body of astronauts with previous spaceflight experience. These findings provide the very first evidence in astronauts of hippocampal changes that may explain the spatial orientation challenges experienced during a spaceflight.

#22 A Canadian Perspective on Aerospace Medicine Training: Insights from the UTMB Principles of Aviation and Space Medicine Course

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The UTMB Principles of Aviation and Space Medicine (PASM) course is a Institution led, month-long program that introduces medical professionals to the fundamentals of aerospace medicine, featuring didactics on flight regulation, space physiology, and life support technology, along with practical experiences at NASA Mission Control and commercial space facilities. In July 2024, I attended this course as a second-year emergency medicine resident from Canada. My participation allowed me to gain critical insights into the unique demands of space health and its relevance to healthcare professionals working in remote and extreme environments. This poster presents key learnings from the course, emphasizing the applicability of aerospace medicine principles to Canadian healthcare settings, particularly in the context of wilderness and remote medicine. I also highlight

opportunities for future space medicine contributions for missions to the moon. Additionally, the poster will discuss the challenges and opportunities for Canadians seeking to engage in international aerospace medicine programs, highlighting the need for greater funding and institutional support. By fostering increased participation, Canada can continue to play a pivotal role in advancing aerospace medicine and ensuring its future contributions to this evolving field.

#23 Commercial Spaceflight (CSF): Musculoskeletal Health Scoping Review

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IIntroduction: To aid primary care providers in conducting medical risk assessments for commercial spaceflight (CSF) candidates with musculoskeletal (MSK) comorbidities, a scoping review (ScR) was conducted to assess available literature regarding MSK, orthopedic, and renal status, and to identify gaps in knowledge and evidence. Methods: Peer-reviewed, English-language literature published between 2000 and 2023 was retrieved from 5 databases (PubMed, EMBASE, CINAHL, PSYCINFO, and Web of Science). Covidence software facilitated title/abstract screening and full-text reviews. Results: 287 system-specific and global search terms yielded 7,754 articles. After removing 2,776 duplicates, 4,978 articles underwent title and abstract screening. A full-text review was conducted for qualifying articles. Despite the known MSK physiology changes due to microgravity, most research pertains to professional astronauts, and few studies address CSF or analog settings. Discussion: This rigorous ScR provides primary care providers with useful evidence for screening CSF candidates with MSK comorbidities, focusing on MSK considerations for spaceflight, particularly under varying gravitational fields. To maximize utility, combining these findings with existing aerospace medicine standards and CSF guidelines is recommended. These results aid the aerospace medicine community in developing CSF screening standards, safety regulations, and guiding future research for medically diverse CSF participants.

#24 Contemporary Space Health Research Themes: A Bibliometric Analysis of the Literature

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Background: As humanity enables deep-space exploration, a robust evidence base will be required to support the delivery of terrestrial-quality health care for astronauts. In this study, we used bibliometric methods to describe the nature of recent space health literature. Methods: PubMed and Scopus were searched using "space medicine" and "space health" keywords for 2023/24. Publication titles and abstracts were screened for inclusion; an iterative process was used to identify thematic topic areas. Keyword analysis was completed. Country of origin was denoted by first author affiliation. Results: 93 papers were included. Thematic topic areas included: impacts of space flight on human health (n=27); biomedical research (n=12); healthcare delivery (n=11); countermeasures for physiological effects of being in space (n=8); space healthcare workforce (n=8); artificial intelligence and digital health (n=7); medical imaging (n=6); individual and environmental monitoring (n=4); specialized medical equipment (n=4); applications of space health to earth (n=3); and health screening (n=2). Two frequent keyword pairs included: space medicine and microgravity; and microgravity and space flight. Top countries of origin were the US (46, 49.5%), Canada (8, 8.6%), and England (7, 7.5%). Conclusion: The current space medicine literature is broad and heterogeneous, spanning the domains of biomedical, clinical, and health services research.

#25 Dynamic Cerebrovascular Resistance and Compliance Before and After Head-down Tilt Bedrest

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The transition from supine to standing reduces blood pressure (BP) and middle cerebral artery blood velocity (MCAv), causing cerebral hypoperfusion and postural instability, a risk for astronauts. Data from a study on orthostatic tolerance during 14 days of -6° head-down bedrest (HDBR), an analog for spaceflight in 19 older adults (8 females, 11 males, aged 55-65) were analyzed. Measurements of MCAv and continuous finger BP were taken during transitions from supine to standing at baseline (BDC), day one of recovery (R1), and four weeks post-HDBR (R4wk), with exercise and control conditions.
Results showed males had higher cerebrovascular resistance than females ($p < 0.01$), while compliance was stable across all conditions ($p > 0.05$). Females had higher MCAv and lower resistance compared to males ($p = 0.04$; $p = 0.07$), suggesting sex-specific vascular

differences. These findings highlight how vascular resistance impacts cerebral blood flow during orthostatic stress and suggest sex differences in vascular structure. Males generally have larger vessel diameters, which may increase vascular resistance and contribute to sex-specific differences in cerebrovascular responses. Stable compliance across conditions indicates that while resistance varies by sex, vessel elasticity remains consistent. These findings provide insight into physiological vascular differences between sexes in older adults, which may contribute to fall risk in astronauts, highlighting the need for targeted interventions.

#26 Effects 14 Days Head-Down Tilt Bedrest on Resting Cerebrovascular Resistance and Compliance

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Decreases in blood pressure and cerebral blood flow upon transitions to upright postures must be counteracted through cerebral autoregulation to help prevent orthostatic intolerance (OI). Post-spaceflight, astronauts have reported OI, however, the exact mechanisms contributing to symptoms are unknown and varied in men and women. We used a Windkessel model of the cerebral artery vascular bed to investigate cerebrovascular blood pressure, blood velocity (MCAv), resistance and compliance in 22 adults (11 women, 55-65 years) before and after 2 weeks of 6-degree head-down bed rest. Half of the participants did 1 hour of daily exercise during bedrest to test its effectiveness as a countermeasure to deconditioning. A supine-to-stand test was conducted in 3 separate sessions: baseline data collection, the recovery period immediately following bedrest, and a follow-up visit 4 weeks post-bedrest. We did not find substantial differences in hemodynamic variables between the exercise and control groups. Here, we present findings from the steady state period immediately before standing. Women demonstrated higher MCAv and lower mean resistance than men in all sessions. Cerebral mean arterial pressure decreased in women post-bedrest. Cerebrovascular compliance did not change substantially across sessions or between sexes. Our results suggest distinct cerebrovascular adaptations to head-down bedrest in men and women; these changes were not influenced by the study's exercise countermeasure.

#27 Impact of Spaceflight on Brain Metabolism: A Comprehensive Review of Cognitive and Energy Alterations in Astronauts

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This comprehensive review examines the effects of spaceflight on brain metabolism, focusing on cognitive and energy alterations observed in astronauts. Exposure to microgravity, radiation, and stress during space missions disrupts normal brain metabolic processes, particularly ATP production and mitochondrial function. These disruptions are linked to cognitive impairments and increased neurological risks, which are significant concerns for long-duration space travel, including future missions to Mars. The review synthesises existing human and animal studies, highlighting the role of oxidative stress, mitochondrial dysfunction, and metabolic flexibility in brain energy utilisation during spaceflight. It also explores potential countermeasures, such as exercise, pharmacological interventions, and dietary adjustments, to mitigate these effects and ensure astronaut health.

#28 A radiobiological characterization of the anhydrobiotic yeast (s. Cerevisiae) model organism

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Anhydrobiotic yeast models, such as desiccated Saccharomyces cerevisiae, are of increasing use in radiation biology, particularly in space radiation and dosimetry studies. This model organisms decreased intracellular water content is theorized to perturb the biological effects of ionizing radiation exposure significantly, provided the decreased contribution of the indirect action pathway of radiation-induced cellular damage. This research focuses on the radiobiological characterization of anhydrobiotic yeast to assess the relative biological effectiveness (RBE) and oxygen enhancement ratio (OER) in this model. We quantified RBE for 74 MeV protons and neutrons (0.1–500 MeV), using 320 kV X-rays as a baseline, and evaluated OER in yeast stored under aerobic and anaerobic conditions. Results revealed an RBE of 1.03 ± 0.03 for protons and 13.0 ± 1.0 for neutrons, with negligible oxygen effects in desiccated yeast (OER = 1.06 ± 0.05). These findings suggest that, in the absence of intracellular water, the direct action of radiation dominates, RBE remains relatively unperturbed, and oxygen effects are significantly diminished. These results will inform researchers on how to accurately interpret the results of experiments conducted with this unique model organism.

#31 Inter-agency comparison of cytogenetic damage in astronaut lymphocytes for effective space radiation biodosimetry assessments

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Radiation in low earth orbit (LEO) consists of a mixture of sparsely and densely ionizing radiation and can induce cytogenetic damage in astronauts. Biodosimetry using fluorescence in situ hybridization (FISH) has been a method routinely used to assess radiation exposure of astronauts from the National Aeronautics and Space Administration (NASA) and the Canadian and European Space Agencies (CSA, ESA). Personalized calibration curves (CCs) are generated by irradiating pre-flight whole blood samples to different X-ray or γ-ray doses up to 2 Gy and measuring cytogenetic damage in lymphocyte cells by FISH. To investigate the complexities of LEO biodosimetry results and improve exposure assessments, an intercomparison was performed on 36 NASA and 10 CSA/ESA astronauts who completed International Space Station missions of at least 3 months. Statistical analysis of damage pre- and post-flight revealed significant inter-individual and inter-agency differences for several endpoints. Supervised machine learning (SML) algorithms were developed by pooling multiple damage endpoints and analysis features. Damage in post-flight samples was used to estimate radiation exposure with fits from both CCs and SML algorithms. Variability in the results, possibly attributed to differences between scoring and culturing practices between laboratories, led to fluctuations in personalized CC-based dose estimations. Estimates from SML were more robust and in better agreement with physical dosimetry.

#32 Multi-modal MRI identifies regional brain perturbations following space-like radiation exposure in melanin shielded mice

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Growing interest in space exploration outside Earth's magnetosphere means prolonged exposure of astronauts to Galactic Cosmic Rays and Solar Particle events. Our understanding of the impact of Deep Space radiation on the Central Nervous System (CNS) is critical to ensuring astronaut safety and aids in development of shielding materials. Our lab has demonstrated the utility of the pigment melanin, a high molecular weight polymer, as a radioprotective agent. We hypothesize that melanin-containing plastics could protect the CNS of mice from space-like radiation. In this study male and female CD-1 mice were irradiated with 10-25 cGy of high energy 16O ions at NASA Space Radiation Laboratory at

the Brookhaven National Laboratory with and without shielding by plastic containing melanin from fungus Gliocephalotrichum simplex. At 8 weeks post-exposure brains were evaluated by ex vivo magnetic resonance imaging (MRI), with T2-weighted imaging and diffusion tensor imaging used to detect alterations in 40 bilateral regions of the brain. As first step we compared to control mice (no exposure) to 16O-exposed mice which showed global decreased axial diffusivity, decreased fractional anisotropy, decreased radial diffusivity, and increased T2 signal. Using multimodal MRI we are able to identify altered regional brain changes that can report pathology resulting from exposure to high energy ions. Furthermore, we can use this approach to assess the utility of our melanin-containing materials to shield and prevent these deleterious effects.

#33 Use of Intestinal Organoid Models to Study Biological Effects from Ionizing Radiation

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The intestine is a highly regenerative tissue and a radiosensitive organ, where exposure of the intestine to high doses of radiation causes characteristic gastrointestinal (GI) distress. The effects of low doses of radiation (LDR; absorbed doses <100 mGy) on the GI tract, however, are less defined, yet an important component of understanding radiation risk in occupational and environmental exposure contexts, including spaceflight. This study examined the effects of low and high radiation on intestinal cells using 3D, murine intestinal organoid models. Following acute exposure to gamma rays at absorbed doses of 10 mGy, 100 mGy, and 2000 mGy, including sham-treated (0 mGy) control, the epigenetic profiles of exposed organoids were examined using DNA methylation sequencing techniques. Significant methylation differences were observed in treated organoids compared to control, with many differentially methylated regions annotated to genes implicated in colorectal cancer. Future work includes development of human induced pluripotent stem cell (hPSC)-derived, intestinal organoids, which will support new initiatives at the Canadian Nuclear Laboratories to examine the effects of space radiation qualities on human tissues. Overall, this work will increase our understanding of the radiation response of the intestine following exposure to various radiation sources and offer novel methodology to examine individual radiosensitivity.

#34 Monte Carlo Modelling of Biodosimetry Calibration Curves For Use in Space Applications

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Exposure to ionizing radiation is a significant hazard to astronauts and must be carefully quantified. In addition to physical dosimetry, biodosimetry techniques (BD) can provide dose estimates while accounting for other biological factors. BD characterizes an individual's radiation response through dose-response calibration curves (CC), which can be used to assess measured damage, such as chromosome misrepair, to provide a dose estimate. Given the difficulty to produce space radiation sources, CCs are established with X-rays or gamma-rays. The goal of this study is to use computational methods to adjust these CCs using a model of the space radiation environment. Using Monte Carlo simulations in TOPAS-nBio, DNA damage induction from X-rays was simulated in fibroblast cells. The repair and misrepair was then calculated using the Mechanistic DNA Repair and Survival (MEDRAS) model and the yield of misrepaired chromosomes was determined. The simulated CC was compared to published data and was found to underestimate misrepaired yield requiring input parameters to be adjusted for better agreement. As there are notable differences between responses of different cell types, the output of these simulations was compared to experimental results produced with lymphocytes, more commonly used for BD. The next step is to produce computational simulations of lymphocyte cells with X-rays, which can then be replaced with a space radiation equivalent source to produce more representative CCs.

#35 Cerebral microbleeds in astronauts: a potential indicator of spaceflight-induced cerebrovascular damage

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Spaceflight poses a significant health risk to astronauts, with known cardiovascular, musculoskeletal, and other risks due to microgravity and radiation exposure. In this work, we utilized susceptibility-weighted magnetic resonance imaging to identify small cerebral microbleeds (CMBs) in astronauts before and after a typical six-month space flight onboard the International Space Station. In other contexts, CMBs are indicative of small vessel disease and have also been associated with cognitive decline. Our analysis did not identify a significant increase in CMB burden between preflight and postflight time points, indicating that space flight does not present an immediate cerebrovascular risk as measured by CMB burden. However, we did identify that astronauts with prior spaceflight experience, as measured at our pre-flight timepoint, showed significantly higher CMB burden than their peers without previous spaceflight experience. This burden was also higher burden than would be expected in the general population. These findings suggest prior spaceflight experience may produce cerebral microbleeds that manifest slowly, as opposed to immediately after spaceflight. While the potential mechanisms driving these effects are multifaceted, these findings highlight the importance of ongoing monitoring of astronauts'

cerebrovascular health, especially considering the planned increase in mission duration and distance.

#36 Artificial Intelligence Based Retinal Layer Segmentation in a Microgravity Mouse Model

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Background and Purpose: Monitoring the eye health of astronauts while in space is currently limited. We design an artificial intelligence (AI) -automated pipeline to segment the retina and choroid with thickness analysis for captured images, aiming to provide rapid clinical analysis, capable of operating offline with limited computational resources while on earth and in space. Methods: We used a longitudinal in vivo Optical Coherence Tomography (OCT) dataset from mice subjected to NASA's hindlimb unloading protocol for 5 weeks using the same commercial device available on the International Space Station. Albino mice were used to minimize laser light absorption by melanin. The retina, retinal nerve fiber layer (RNFL), and choroid were manually segmented to train a UNET-based deep neural network. Predicted labels were manually corrected. A K-Nearest Neighbors (KNN) algorithm was used to calculate volumetric thickness, and linear interpolation generated isotropic measurements. Thicknesses of 8 circular sector regions centered on the optic nerve were analyzed. Results: The segmentation model achieved an average DICE score of 0.95, significantly reducing manual segmentation time. Thickness measurements were consistent longitudinally for each individual. Conclusions: Our study demonstrates the potential of combining an AI pipeline with longitudinal eye imaging datasets to adapt machine learning tools for early diagnosis of eye diseases in remote settings, both in space and on earth.

#37 Automatic Hierarchical Graph-Based Image Segmentation for Hyperspectral Fluorescence Images

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While hyperspectral imaging is commonly used in geospatial research and in astronomy, it applications for healthcare are emerging. Among multiple imaging modalities, fluorescence microscopic hyperspectral imaging (FMHSI) of unstained biological tissue is a foundational tool in diagnostic pathology and biomedical research, which enables the acquisition of datasets with high spectral and spatial resolutions. Semantic segmentation of FMHSI images is essential for obtaining labelled HSI data. We aim to develop an automatic unsupervised hyperspectral image segmentation approach that produces high-quality segments for high-level vision tasks such as remote disease diagnosis and pathology-assisted surgery. Our multi-step algorithm starts with image denoising and dimension reduction using superpixels. Next, a kernel is applied to enhance the image contrast. An automatic graph-based image segmentation method is then applied to create image segments based on the spectral and spatial information. Finally, a hierarchical region merging process is performed using a correlation-based spectral similarity metric to output the final set of tissue sections. We will open-source the algorithms and develop an application, which empowers the users to gain deeper insights into the intricacies of FMHSI data. Moreover, the approach and app hold significant promise for enhancing the comprehension and diagnosis of eye diseases, including Spaceflight-Associated Neuro-ocular Syndrome.

#38 Can a small gradient system meet stringent space MRI power constraints?

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MRI is a widely used imaging modality. In the context of space health, no ionizing radiation, ease of use compared to ultrasound, and ability to visualize the central nervous system are attractive features. Recent work suggested a RF based image encoding technique TRASE had promise for space based MRI scanners, as it produces images with a quarter of the power and has been tested on portable low field magnets. We wanted to explore if a small gradient system can provide benefits to TRASE based MRI methods by adding a small Left-Right gradient to our portable MRI system we call the Owl. A gradient based MRI system has some benefits over a traditional two-RF coil system, in particular our gradient system,

provides an elegant solution to phase distortion inherent to spatially selective RF coils result in improved image quality. Power usage is comparable to RF based TRASE.

#39 Creating an Aeromedical Genetic Roadmap

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During spaceflight, astronaut health and performance can be compromised due to factors such as space-related physiological changes, unexpected medical conditions, ineffective medications, and exposure-related illnesses. Providing healthcare in challenging and isolated environments necessitates preparation and preventive measures. A compendium of aeromedically-relevant genetic markers has value for pre-flight identification of individual risk factors, thereby enabling optimization of astronaut health during long-duration flights. Our project identifies genetic markers relevant for personalizing health maintenance and preventing illness, especially during long-duration missions. By reviewing genetic databases and commercially available tests, over 100 markers were catalogued into 3 aeromedically relevant categories: 1) markers indicating predisposition to conditions prone to arise in adults over anticipated mission durations, facilitating early in-flight surveillance; 2) markers of susceptibility to environmental stressors; and 3) pharmacogenetic markers guiding medication selection, safety, and efficacy. Increased understanding of pharmacogenetics, genetic predisposition to disease and spaceflight-associated health risks allowed for the creation of a database of aeromedically-relevant genetic markers. Genetically-informed pre-flight evaluation enables an individualized approach to health risk mitigation and enhanced management strategies and optimization of astronaut health.

#40 Creation of a Society for Space Radiology

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Introduction: As crew autonomy increases with exploration-class spaceflight, onboard medical care capabilities have become a key consideration for buying down mission risk. Radiology is one of the backbones of medical decision-making on Earth and is similarly critical for diagnosis of acute conditions during spaceflight, in addition to its research uses. Motivation: The only diagnostic imaging currently performed in space is ultrasound; however, there are active efforts to extend the toolkit of available portable medical imaging modalities to include radiography and eventually magnetic resonance imaging. However, these efforts often do not engage in crosstalk between groups and disciplines and lack a strategic plan to enable wider collaboration. Intervention: We will present the strategic plan

of the newly founded Society for Space Radiology (SSR). The mission of the SSR is to advance the field of space radiology by promoting research, developing best practices, and fostering collaboration. The society aims to bridge the gaps between aerospace medicine, radiology, emergency medicine, preventative medicine, and related fields, promoting interdisciplinary cooperation to address the challenges posed by the space environment. We hope to garner feedback from Canadian experts and trainees during this symposium regarding their interests in medical imaging in spaceflight and how it relates to other multidisciplinary pursuits in the Canadian Space Health research landscape.

#41 Development and validation of an evaluation framework for implementing Artificial Intelligence for healthcare in a rural community

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Brightshores Health System is one of Ontario's largest rural multi-site hospitals, serving the Grey Bruce region. Advanced age, limited resources and geographic barriers are some barriers that limit access to care for residents. Digital health tools (DHT) have the potential to bridge these gaps by allowing people in remote locations (earth or space) access the right treatment at the right time. Innovative technologies must be carefully evaluated and implemented in a way that is responsive to the local context. The purpose of this work is to describe the validation process used to inform and implement a local measurement and evaluation (M&E) framework of an artificial intelligence solution for healthcare in the Grey Bruce region. An M&E framework was developed by first defining the local ecosystem, defining priority metrics, performing stakeholder interviews and validating the framework. Outcomes included 43 indicators guided by the Quintuple Aim that were meaningful to the local context. Lessons from our experience are relevant for similar uses of DHT in space and other remote settings, allowing for an understanding of the intricacies of relevant factors and meaningful indicators of success.

#42 MicroPREP: Automating Biological Sample Preparation for Space Missions, Advancing Health Monitoring in Space

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Space health poses a critical challenge for long-duration missions: How can we efficiently monitor astronaut health in microgravity? The International Space Station (ISS) faces many limitations, including restricted crew time, equipment, and safety protocols, making complex biological assays and their time-consuming manual sample preparation difficult. Previously, blood samples had to be returned to Earth for analysis. MicroPREP technology, a CSA-NRC-MDA joint mission, set to launch in 2025, transforms this process by enabling on-site sample preparation using a pneumatic-centrifugal microfluidic platform. MicroPREP automates key steps in biomolecular assays, from metering and mixing to thermal lysis, and washing, all within sealed Microfluidic Units. This innovation reduces crew time, improves precision, and confines liquid handling in space. The platform requires small sample sizes (capillary or 3-5 mL tubes) and automates protein biomarker isolation and nucleic acid purification, supporting future health initiatives such as DNA sequencing or real-time biomonitoring. As a CSA-NRC intern and space health trainee, I contributed to MicroPREP during a defining stage, helping identify three key biomarkers for space health. And helped conduct over 20 experiments demonstrating MicroPREP's efficiency, matching or exceeding manual methods. MicroPREP represents a leap forward in space health diagnostics, with potential applications in remote, resource-limited environments on Earth.

#43 Harnessing Computational Topological Data Analysis for Diagnostic Imaging in Remote Settings: Applying Persistent Homology to Hyperspectral Imaging of Eye Tissue

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Purpose and Background: To advance the field of medical imaging with improved diagnostic capacity, this study tests whether persistent homology, a method of computational topological data analysis (TDA), can enhance eye tissue segmentation through hyperspectral imaging. We applied persistent homology to hyperspectral data cubes of mouse eye tissue sections. Methods: To reduce computational complexity and to improve detection performance, we used the distance on chessboard approach to disassemble hyperspectral images into spatial and spectral dimensions. We input the result through the persistent curve algorithm for detection intensity in the wavelengths. Before this approach,

we used the bottleneck distance to secure distinct bands in a particular cube. The hyperspectral data cubes (210 X 210X78; x, y and λ) were obtained with an image mapping spectrometer (with 78 wavelengths from 528 nm to 836 nm) mounted on a fluorescence microscope. Major results: We found a distinction between some wavelengths and compared their persistence through the persistence curves to see the types of structure they have in the data. We also visualize the intensity of those distinct wavelengths and apply machine learning to the persistent vectors. Conclusions: Our study improved performance in machine learning by reducing noise while preserving the global structure of images. The use of TDA methods effectively reduced computational complexity while enhancing detection performance, suggesting potential applications for remote imaging on Earth and in Space.

#44 Humanoid Robots in Outer Space: A Simulated Caring Process

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Background: The integration of artificial intelligence (AI) and robotics in aerospace nursing presents unique ethical and safety challenges, particularly in extreme environments such as outer space. Issues of reliability, quality, and empathy in care delivery are magnified under these conditions. Effective communication is essential with advanced signal processing for emotional recognition. However, traditional nursing philosophies often exclude robotic assistance, raising questions about the capacity of robots to provide genuine care in aerospace settings. Methods: A computational simulation using agent-based modeling simulates interactions between patients, humanoid robots, and healthcare systems in aerospace environments. By incorporating stochastic elements and quantum-inspired concepts, the study examines complex behaviors over 100 iterations, conceptualizing empathetic robotic systems through a closed-loop feedback system represented by the wave function (Ψ). Results: Findings reveal the intricate dynamics of healthcare interactions in aerospace nursing, characterized by variability in care actions and quantum-like behavior, particularly under the stressors of extreme environments. Discussion: The study emphasizes the need to re-conceptualize aerospace nursing with robotics, viewing robots as enhancers of care. Challenges such as environmental extremes, communication barriers, and the need for adaptive learning are addressed in proposed blueprints for realistic simulations of the caring process. Conclusion: Responsible integration of robotic technology in aerospace nursing requires balancing humanistic values with technological advancements, addressing ethical concerns, and enhancing communication capabilities to ensure effective caregiving in extreme environments.

#45 Integration of Teledentistry in Space Missions: Implications and Innovations

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Teledentistry shows promise in managing dental care during space missions, addressing the unique challenges posed by prolonged exposure to microgravity. These challenges include changes in bone density and blood flow that can affect oral health. This innovative field utilizes technologies such as fluorescence intraoral cameras, portable diagnostic tools, and AI-driven systems to enable real-time remote diagnosis and disease management, ensuring continuous monitoring and care vital for the success of long-duration missions. In Quebec, teledentistry has proven effective among underserved populations, providing a strong foundation for its adaptation to space. This approach not only enhances dental care in isolated and extreme environments but also supports self-management of oral health and facilitates the collection of crucial health data. Current pilot projects in Quebec simulate space-like conditions to refine these technologies, ensuring their reliability and effectiveness for space applications. Thus, teledentistry in space missions demonstrates how terrestrial healthcare innovations can be adapted to meet the unique demands of space travel, improving astronaut health and paving the way for future explorations.

#46 Intuitive Imaging Spectroscopy Analysis: A Machine Learning Tool

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Fluorescence hyperspectral imaging (FHSI) is an essential tool in diagnostic pathology and biomedical research. However, visualizing and analyzing high-dimensional FHSI images remains a challenge. We develop an innovative and open-source desktop application for the visualization and analysis of FHSI images of eye tissue sections. The aim is to devise segmentation and boundary detection algorithms for examining the distribution of biomolecules exhibiting endogenous fluorescence within specific layers of eye tissue using the desktop application. This application offers a suit of functionalities: data preprocessing tools such as normalization, denoising, and superpixel generation; visualization tools such as 2D and 3D spectral-based interactive exploration, region of interest (ROI) selection,

average spectral curve calculation and demonstration, and initial identification of endmember signatures; segmentation tools such as Spectral Information Divergence Spectral Angle Mapper with optional unmixing and Fuzzy C-means clustering; and tissue boundary detection tool. The integrated algorithms offer an effective approach for analyzing FHSI images across different environments. This integration facilitates the unsupervised segmentation of eye layers, such as the retina, choroid, and sclera, significantly diminishing the time required for experts to label these layers for subsequent quantitative analysis and holds significant promise for enhancing the diagnosis of various eye diseases.

#47 Long Duration-Deep Space & Remote Community Health Delivery: What it means for Space Exploration and Canada's eHealth Landscape

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Humans are soon poised to return to the Moon and extend further to Mars but face grave challenges with the mission's success due to the healthcare challenges of such a remote, isolated, and extreme environment. Remote and indigenous communities on Earth face nearly congruent obstacles too – a lack of medical resources, delayed communication, and long transports for evacuation. A previous attempt at solving these challenges via a terrestrial analog of space has provided success and valuable lessons for current and future sustainable iterations of innovation. The current work examines human adaptations to space flight as well as the historical and current telemedicine style initiatives conducted by the National Aeronautics and Space Administration (NASA) and the Canadian Space Agency (CSA). Implementation styles are contrasted, and new insights brought forward for sustainable and meaningful terrestrial collaborations that advance human health on Earth and in long duration-deep space missions. Contrary to an early telemedicine project, new work under partnerships with the CSA has revealed a standard of practice to benefit health in space, on Earth, and in Canada's eHealth Landscape.

#48 Microgravity-Induced Seed Germination of Cannabis: Insights from the ISS

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Efficient farming systems are essential for supplying oxygen, food, and medicine during extended space missions. This research investigates whether it is possible to grow cannabis seeds in a weightless environment on the International Space Station (ISS). Cannabis is a great option because of its strong growth and its ability to produce oxygen, absorb carbon dioxide, and create various materials. The study employs Yuri Type-V equipment to examine ideal seed germination conditions in space, with a specific focus on nutrient uptake

and growth progress. The project consists of two stages: Ground Development tests the best conditions for germination, like light and nutrients, using Yuri ground units, while Flight Execution implements the final protocol on the ISS. This research seeks to advance space agriculture technologies crucial for future human space exploration by studying the effects of microgravity on cannabis growth.Redwire is helping us in this research, drawing on their vast expertise in developing pharmaceuticals and growth chambers in space and critical infrastructure solutions. The findings of this research will help enhance life support systems and the sustainability of deep-space missions through enabling effective plant-based resource generation

#49 Reproducibility of a novel method to determine microvascular function

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Microgravity and/or cardiovascular disease can lead to impaired microvascular function, thus reusable and convenient methods for its measurement are required in space and remote environments. Ramraj et al. found that the microvascular function index (MFI) method is correlated to EndoPAT measures (J Vasc Res 2024 Jul 29: 1-8). The current study aims to test the day-to-day reproducibility of MFI enhancing its effectiveness. Microvascular function was evaluated (n=14, 5 females, 34.4 ± 12.2 years) using both MFI and EndoPAT simultaneously. The protocol consisted of 5 minutes of resting measures, 5 minutes of forearm blood flow occlusion (+50mmHg systolic blood pressure), and 5 minutes of reactive hyperemia. EndoPAT probes were placed on index fingers and piezo-electric pulse transducers (ADInstruments) were placed on middle fingers. EndoPAT used proprietary software to determine reactive hyperemia index, while MFI used LabChart software. For MFI, the integral of each pulse waveform was calculated along with average area under the curve for 3.5min baseline, for each 30s of reactive hyperemia, and 10s around peak response. Day-to-day reproducibility showed the greatest reliability using the intraclass correlation coefficient (0.60) at the 30-60 second average. Similarly to Ramraj et al. we also found a correlation between EndoPAT and MFI methods (r=0.61, p=0.02). MFI is a convenient and reproducible method to assess microvascular function in space and isolated environments.

#50 Targeting cognitive health with peak performance in space: Brain-Computer Interface as a technology measure

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Background and Aim: Space exploration poses challenges to spacenauts' physiological and cognitive health due to variable gravity and spaceflight conditions. While physiological effects are well-documented, cognitive and mental health impacts remain less understood. Spacenauts must sustain peak performance under cognitive stress; however, cognitive load can reduce this performance. This study aimed to explore the potential of brain-computer interfaces (BCIs) as a technology countermeasure to monitor cognitive health and tackle performance decline. Methods: A narrative review was conducted, analyzing research on cognitive health and peak performance in space from 2014 onward. Google Scholar searches used keywords like astronaut, space, cognition, peak performance, EEG, and BCI. Data on study locations, health aspects, and participant demographics were also reviewed. Results: Forty-five studies were categorized into themes: peak performance, cognitive health in space, and BCI applications. Studies on peak performance highlighted its link to cognition and behavior, while the cognitive health theme emphasized the need for mental health interventions during and after space training. The third theme demonstrated BCIs' efficacy in tracking cognitive health through electrophysiological feedback. We also add to this, our AI-application framework to tackle the performance-health challenge. Conclusion: BCIs can aid in maintaining peak performance sans compromising mental well-being in space.

#51 Telepractice assessments in post-stroke aphasia: A systematic review

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The purpose of this systematic review was to examine the current use of telepractice assessment protocols for people with aphasia. Specifically, the review sought to: a) identify the assessments utilized in the aphasia telepractice literature; b) appraise critically the quality of such investigations; and, c) evaluate critically the psychometric properties of the standardized tests used. A review of the literature published in English since 2000 was conducted by searching MEDLINE, EMBASE, PsychInfo, CINAHL, and Scopus databases. Two reviewers assessed records independently finding 11 articles eligible for inclusion. Data extraction was conducted once and validated by a second reviewer. Quality appraisal was carried out for the included studies as well as for the standardized testing measures used in these studies. There was a lack of variation among the telepractice assessment protocols and aphasia tests used across all of the included studies. That is, there was limited investigation of screening tests, discourse analysis, extra-linguistic cognitive measures, and the use of patient-reported measures. Study characteristics lacked high quality and free of bias examinations. Most standardized tests that were utilized exhibited poor validity and reliability properties. Overall, the current systematic review pointed to the need to investigate a wider range of aphasia assessment protocols that can be offered via telepractice.

#52 The HARMONY Connected Care Medical Module for Asynchronous Remote Healthcare in Space and Remote Areas on Earth

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Commercial space missions are opening up access to space exploration and human health research in orbit. Maintaining crew health beyond low-Earth orbit is increasingly more complex due to the limited access to healthcare practitioners and communication constraints. Remote communities, natural disaster response aids, conflict zones, and exploratory expeditions on Earth face similar constraints resulting in disparities in health equity. We have proposed a rapid prototype of a Connected Care Medical Module (C2M2) for the Canada Space Agency named HARMONY. HARMONY is an integrated asynchronous remote healthcare solution that is underpinned by an EMR offering wearable and non-wearable Telemetry data capture and real-time Behavioral Health & Wellness capability. It also includes an advanced Medical Training system to support urgent care and medical training. The patient experience is managed through a Virtual Concierge, which also integrates the management of the "smart container" to facilitate a seamless remotely supported experience. Our initial prototype supports the detection of arrhythmias including atrial fibrillation, monitoring of sleep disorders, screening for anxiety and depression, first aid care and virtual training including CPR, pneumothorax treatment and reduction of a dislocated shoulder. We will present HARMONY, explore lessons learned and outline the opportunities to deploy this same concept for Indigenous, remote, and other underserved communities in Canada.

#53 Assessing Soil Grade and Compaction on Plant Growth Across Lunar, Icelandic, and Terrestrial Soils

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This study investigates the impact of soil texture and compaction on the germination and growth of plants, with a particular focus on lunar and Icelandic soils compared to a terrestrial control soil sourced from a similar environment. Icelandic soil is chosen for its volcanic origin and unique mineral composition, which closely resembles the conditions found on other planetary bodies like the Moon and Mars. Conducted in Iceland, the research examines how soil structure—specifically compaction and grain size—affects plant development, a critical concern for space agriculture where alternative soil types may be necessary. The experiment involves three distinct soil mixtures: Fine and Compact Soil, High-Grain Soil, and Fertilized Soil. Over a 14-day period, plant germination, seedling height, and leaf development are monitored daily alongside environmental parameters such

as pH, humidity, temperature, light exposure, and moisture levels. These comprehensive measurements provide a detailed understanding of how different soil compositions and textures influence plant growth. The findings will offer valuable insights into the suitability of lunar and Icelandic soils for supporting plant life, particularly in terms of soil texture and environmental factors. This research is essential for future Moon or Mars missions, contributing critical data on the impact of non-terrestrial soil characteristics on plant growth and aiding the development of sustainable agricultural strategies for long-term space exploration.

#54 Inducing Hypometabolic States for Long-Duration Space Missions: The Role of Human Hibernation

Ekaterina Kostioukhina

Harvard University

As space agencies worldwide focus on deep space exploration, the challenge of sustaining human health during extended missions becomes increasingly critical. Human hibernation, inspired by natural hibernation in animals, presents a transformative approach to mitigating the physiological risks associated with prolonged space travel. Our research explores the physiological adaptations required for human hibernation, examining metabolic downregulation, neuroprotective mechanisms, and immune system modulation. We investigate the potential to induce and maintain a hypometabolic state, reducing the need for life support resources and minimizing exposure to space radiation. This study not only aims to advance our understanding of human hibernation for space missions but also offers potential applications for medical conditions on Earth, such as trauma management and critical care. By bridging terrestrial health research and space exploration, our work contributes to the development of sustainable strategies for human survival in space.

#56 Comparative Study of Plant Germination in Lunar Regolith, Earth Soils, and Icelandic Volcanic Substrate

Harmil Kalia, Vasundhara Kalia

McMaster University, Canada

The feasibility of using extraterrestrial soil for agriculture is critical for sustaining long-term human presence in space. This experiment, conducted over a 14-day period in Iceland, investigated the growth of radish seeds in three soil types: lunar soil, Icelandic soil, and a control (terrestrial control soil) to evaluate their potential as mediums for plant growth.

The importance of this research lies in its implications for future space missions, where in-situ resource utilization is essential to reduce dependency on Earth supplies. The study examined germination rates, plant height, leaf count, and overall health of radish plants grown in these soils. Under controlled conditions, each pot was filled with a consistent volume of soil, and variables such as water, pH, temperature, light exposure, and soil moisture were meticulously monitored and recorded. Data were collected daily, and statistical analysis was applied to identify significant differences in plant growth between the three soil types. The findings reveal variations in plant development across the soils, offering essential insights for developing sustainable agricultural practices in space. These results contribute to the broader goal of creating self-sustaining habitats, advancing human space exploration and settlement.

#57 Converting Asteroids to Food for Deep Space Exploration

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To deeply explore the solar system, it is necessary to become less reliant on the resupply tether to Earth. Current food supply technologies are dependent on consumables from resupply missions from Earth (e.g., dried, freeze dried, irradiated and frozen food). Farming in space is possible, but is extremely complex, and requires an initially considerable input of resources from Earth and may still require periodic resupply. What if humanity could acquire the raw materials to make food in space? This proposed research investigates new techniques developed to recycle plastic waste into food on Earth and extrapolating these techniques to the application of converting asteroidal material into food. The proposed research explores an approach to providing human-edible food employing naturally occurring organic compounds commonly found in specific types of meteorites: the carbonaceous chondrites. Selected asteroids could provide the raw materials – organic compounds and water – that when processed by bacterial consortia in bioreactors, would form the basis of an extra-terrestrial food-supply chain. Meteorites, particularly the carbonaceous type, are a precious and often limited resource. Fortunately, reasonable terrestrial analogs of meteoritic organic compounds (kerogens) are readily available. This study will use a consortium of bacteria in a bioreactor and determine yield of edible biomass in 3 stages of increasing test fidelity: (1) coals, (2) simulants, and (3) meteorites.

#58 Dry Immersion Reveals Genetic Targets for Hypercoagulability in Spaceflight Venous Thrombosis and Coagulopathy

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Rationale: Spaceflight induces adaptions that result in physical deconditioning upon return to Earth. However, a recent incidental discovery of a thrombosis in the internal jugular vein of an astronaut aboard the International Space Station prompted the need to understand the risk of venous thromboembolism (VTE) in microgravity. The dry immersion ground-based microgravity analogue allows for the assessment of hypercoagulability, a risk factor for VTE. Objective: The aim of this study was to examine mRNA precursors of coagulation-related genes to determine if the hemostatic system shifts toward hypercoagulability in microgravity. In this study, we investigated the hemostatic responses of females, an underrepresented space research population. Methods: mRNA sequencing was performed on blood samples from 16 female participants to measure changes in gene expression activity. Measurements taken on the last day of the 5-day dry immersion experiment were compared to baseline data collected one day prior to immersion. To determine relationships between genes of interest, we conducted correlations and false discovery rate analysis. Results: Females showed significant upregulation of F5, BMAL1, C4BPA, and FGL2 genes in response to dry immersion. A strong, significant correlation was found between F5 and BMAL1. Conclusion: Females showed disruptions in hemostatic balance at the level of mRNA expression when exposed to dry immersion. Upregulation of F5 showed similar responses to previous study of males highlighting a genetic target for space-thrombosis regardless of sex. FGL2 and C4BPA warrant further investigation with space thrombosis. The link between F5 and BMAL1 also requires further exploration.

#59 Exploring Individual vs. Group Stress Modeling Techniques to Support Aerospace Operators in Extreme Settings

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Stress is a critical factor affecting performance and well-being in extreme environments (e.g., astronauts and pilots) during missions. A literature review from the NASA (2023) reported that the management of stress of astronauts is mainly based on group approaches. Current methods may not capture individual variations, requiring an individualized approach to stress assessment. First, a scoping review will be conducted to explore two stress modeling techniques: individualized vs. group-oriented. The second step of the project will involve a comparison and evaluation of the two approaches to stress modeling

techniques in clinical and aerospace settings. The procedure will be done incrementally, starting with controlled environments and progressing to more extreme situations, such as aerospace operations. Sociodemographic data will be collected to assess their impact, and non-invasive wearable technologies will be used for data collection. Self-reporting assessments, stressful tasks, and physiological markers will be collected to develop state prediction models using AI techniques such as decision forests and gradient-boosting algorithms. This study, funded by the Canadian Space Agency, represents a pivotal initiative to address a significant gap in stress measurement by considering interindividual differences. Additionally, the research focuses on personalized stress management, optimizing the operator's performance in extreme environments, and avoiding catastrophic outcomes.

#60 Exploring Mars500 data : How coping strategies influence stress and recovery in space

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Deep space exploration poses unprecedented psychological challenges due to its extended duration, extreme isolation, and confinement. While psychological adaptation is a key component of crew well-being and mission success, only a few studies have investigated its underlying mechanisms, such as coping strategies. Using Mars500 data, this study provides a unique opportunity to enhance our understanding of how humans cope with these extreme stressors. The aim of this study is to investigate the moderating role of coping strategies in the stress and recovery responses during a simulated space mission. Mars500 was conducted at the Institute of Biomedical Problems in Moscow, where six healthy volunteers spent 520 days in pressurized facilities simulating a flight to Mars. Participants were selected by the European, Chinese, and Russian space agencies. Monthly questionnaires were administered to assess multiple psychological measures, such as stress, recovery, and coping strategies. Results of multilevel growth curve analysis indicated that stress and recovery responses varied over time. Additionally, the analysis showed that different coping strategies significantly influenced the trajectory of these responses. By clarifying the psychological well-being trajectories and identifying the most effective coping strategies in a deep space environment, this research contributes to the improvement of the selection, preparation, and psychological interventions during future space missions.

#61 Faking fitness: The challenges of social desirability and self-report accuracy in the behavioral health assessment of astronauts

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Self-report measures are widely used in astronaut selection and in-flight monitoring to assess constructs such as mood, personality, and overall behavioural health. Common tools include the Profile of Mood States (POMS) and the NEO Personality Inventory, both of which provide valuable insights into emotional regulation and personality traits critical for long-duration spaceflight. However, these measures are inherently susceptible to socially desirable responding, where respondents may distort their answers to present themselves in a more favorable light. This is particularly problematic in high-stakes settings such as astronaut selection and monitoring, where the desire to appear psychologically fit can lead to exaggerated or falsified responses. Research in Industrial/Organizational (I/O) psychology has consistently demonstrated that motivated individuals can easily manipulate their scores on self-report assessments. Studies on applicant faking behavior reveal that with minimal effort, respondents can modify their answers to align with perceived selection criteria and organizational image, posing a challenge for accurate assessment. This project explores the extent of this issue within astronautical contexts and discusses strategies from I/O Psychology, Human Factors, and Human Performance, that can be applied to mitigate the influence of faking on these critical assessments.

#62 Flywheel Device Exercise Programming for Future Deep Space Missions

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Introduction: Given the transition from the International Space Station to deep space exploration in the Orion spacecraft, the exercise countermeasures must adapt. For the first few Artemis missions, only a flywheel device will be available for exercise, with limited exercise modalities, and time. We aimed to compare different physical training programming following Artemis II's constrains on exercise. Methods: Sixteen participants completed the generic eight sessions of 30 min. Four movements (squat, deadlift, bent over row and deadlift high-pull) and three inertia levels [low (0.01), medium (0.06) and high (0.11) kgm2] were prescribed. We collected heart rate (HR) and load lifted (kg) and compared average HR, HR reserve (HRR), absolute and percentage time spent in aerobic stimulus zone (≥70% HRR) and load lifted across sessions with ANOVA ($p<0.05$). Results: The average HR and HRR (session difference, $p<0.05$) ranged 108-125 beats/min and 41-53%, respectively. Participants spent 3.5-13.5mins or 14-45% of time in aerobic stimulus HR zone, and lifted 3067-5851 kg of load in each session (session difference, $p<0.05$). Conclusion: Training with low repetition per set, low resistance and fast pace appeared to provide more aerobic stimuli than training with high repetitions per set with low/medium resistance or strength-like training with low repetitions and high resistance. Future studies should explore flywheel exercise in microgravity with potentially more exercises variations.

#63 Human Factors in Designing Wearable Systems for Space Health

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Wearable systems hold great potential to support astronaut health and well-being during long-duration space missions. This poster examines how human factors (HF) principles can enhance the design of wearable technologies, ensuring comfort, intuitive use, and adaptability to the challenges of space environments, such as microgravity and restricted mobility. Wearables can offer real-time guidance for physical activity, posture correction, and health monitoring, integrating seamlessly into astronauts' routines. By considering elements such as usability, durability, and effective communication of health-related data, this work discusses how these wearables can improve astronaut health and performance. Additionally, the poster will explore how sensory feedback mechanisms, including haptics, can enhance user interaction without intruding on daily activities, contributing to both physical and cognitive well-being throughout the mission.

#64 Space Pharmacovigilance: Safeguarding Astronaut Health in the Era of Human Spaceflight

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Pharmacovigilance (PV) is a science concerned with the continuous monitoring of adverse drug reactions (ADRs) to existing medications. It plays an indispensable role in ensuring the health and well-being of humans, here on Earth. Recent strides in next-generation spacecraft technology have reignited global enthusiasm for the exploration of humans beyond our pale blue dot. However, this surge should be in sync with the pressing need for innovation for the continuous monitoring of ADRs in those who travel far and beyond, namely the astronaut(s). For example, microgravity has been evidenced to cause changes in gastrointestinal function, in turn affecting drug absorption or decreased clearance of numerous drugs, thus potentially reducing their efficacy or increasing their toxicity. Hence, situations like these, call for a specialized branch of PV or Space Pharmacovigilance (SPhV), which would be dedicated to the monitoring and management of the above-mentioned ADRs in astronauts when faced with the extraordinary environment of space. This, in turn, would not only ensure the safety and efficacy of pharmaceutical products but also could aid in bioastronautical research which aims to understand the physical responses of humans to the environment of space and develop countermeasures to minimize health risks for astronauts through the development of effective and viable engineering designs, such as in

astronaut suits, and/or in-situ medical units on board the proposed Bharatiya Antariksha Station (Indian Space Station). Hence, consequently, providing a framework for effective integration of SPhV within the existing framework of bioastronautical research and ensuring a holistic approach to astronaut health, which could address both pharmacological and physiological challenges posed by space travel. In this regard, the present concept paper aims to emphasize the significance of space pharmacovigilance and explore the most effective means of achieving it through the development of a unique SPhV database for the analysis and monitoring of ADRs pertaining to astronauts.

#65 Team Dynamics and Coping Strategies in Extreme Environments: A Qualitative Approach to Analyzing Historically High-Stress Events

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Teams in extreme environments frequently encounter unique challenges and must use powerful coping strategies to problem solve. While there are efforts being made to understand team dynamics from an individual and experimental point of view, there are very few interpretations of high-visibility teams from the past. In our research, we analyzed significant high-stress historical events to better understand team adaptation that occurs in these conditions. Our project examines multiple cases simultaneously across different industries, i.e. aerospace, rescue, corporate, in an attempt to generate a broader appreciation for coping strategies in extreme environments. Through criteria search across several research databases and manual search in journals related to extreme environments, we narrowed our study down to eight cases, most notably Apollo 13, the Chilean Mining Incident, and the Enron Scandal. Preliminary results have supported current literature coping frameworks, specifically in seeking social support, persistence, and superstition. We have identified several underemphasized coping categories, such as mindfulness and normalcy, with the goal of building a more robust coping framework for future teams in need. While more research is for needed to make generalizable claims, our study highlights practical insights into teams working in extreme environments that can inform training across industries.

#66 Correlates of Post-Expedition Growth in the Aftermath of Antarctic Expeditions: An Exploratory Mixed-Methods Study

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Evidence suggests that stress experienced on expedition to extreme and unusual environments (EUEs) in polar locales may lead to psychological growth, however little is known about the personal factors that predispose individuals to experience growth in these environments. The purpose of this study was to assess the incidence and correlates of post-expedition growth (PXG) in returned Antarctic expeditioners. Using a mixed-methods approach, we examined the relationship between PXG and factors known to associate with growth in trauma-exposed populations (i.e., proactive coping style, mindfulness facets, resilience, universalism) and in past EUE research (i.e., duration of isolated, confined, and extreme (ICE) exposure, relationship status, personality traits). Further, drawing from post-traumatic growth concepts, the prevalence of five specific growth indicators was assessed: 'new opportunities', 'relating to others', 'personal strength', spiritual change', and 'appreciation of life'. Quantitative results indicated positive associations between PXG and proactive coping, as well as between PXG and universalism. PXG was negatively associated with the mindfulness facet of acting with awareness and, like prior findings, PXG was distinct from resilience. Qualitative findings provided a more nuanced understanding of PXG, including the emergence of a sixth growth indicator: an enhanced relationship with nature. Our findings contribute to a deeper understanding of PXG and may help inform measures for mitigating health and wellbeing risks following exposure to isolation and confinement in extreme environments, such as spaceflight.

#67 Evaluation of the gastrointestinal tract following simulated space radiation exposure in melanin shielded mice

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Expanding interest in space travel outside Low-Earth Orbit demands improved radiation protection for astronauts with particular interest in protecting the radiation sensitive gastrointestinal (GI) tract. Melanin pigment is a high molecular weight polymer, ubiquitous in nature, highly conserved from fungi to mammals, and reported to have radioprotective properties. We hypothesize that orally administered melanized fungus or externally applied melanin-containing plastics could protect the GI tract from space-like radiation. Mice were exposed to 10-25 cGy of high energy ^{16}O ions at NASA Space Radiation Laboratory (NSLR) at the Brookhaven National Laboratory. They were fed melanized fungus *Auricularia auricula-judae* prior to irradiation or were shielded with plastic containing melanin from fungus *Gliocephalotrichum simplex* during irradiation. The impact of exposure was evaluated by counting the number of goblet cells present in villi at 5-weeks post exposure. Goblet cell hyperplasia observed in female mice following 10-25cGy exposure suggests a compensatory increase in response to radiation to enhance the protective mucus layer in the GI tract. External plastic shields prevented this effect, but independent of melanin. Ingestion of melanized fungus prior to exposure reduced goblet cell hyperplasia in a melanin-dependent manner. This effect was significant at both doses, but more pronounced at 25 cGy. Fungal melanin presents a promising agent for protection from space radiation.