The Orbiter 2023

Annual Newsletter of the Aerospace Medicine Student and Resident Organization

Credit: NASA/Terry Zaperach

Intro

Welcome to the 2023 edition of the Orbiter! We are excited to share with you the many inspiring experiences of the members of our community. They come from all around the world but - as usual - their articles are out of this world.

As a special in this edition, we expanded the translation into other two languages besides Spanish. We want to bring aerospace medicine to more than just English speakers, so in a big team effort, all articles were translated into Spanish, Italian and Mandarin! No small feat. You will find the QR codes leading to the translations on the next page. And if you are an English-speaking aerospace medicine geek, then this is your chance to learn three new languages! ;-)

If you do not fancy reading, take a look at the winners of our space analogue photo contest! We were impressed by the creativity and quality of the submissions. We are convinced photos can go a long way in inspiring others and we hope these will make you smile and wonder.

Finally, we decided to add a list of publications to the newsletter to strengthen the scientific exchange. This way interested students and residents can reach out to the researchers on the list. We encourage you to do that if you find a research area that you are interested in!

Do not hesitate to reach out to us, if you have feedback (yes we want to hear it!), comments or questions or are already plotting a plan for an article submission next year: editor@amsro.org.

Enjoy The Orbiter 2023!

Sophie Rosahl
Chief Editor

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Italian

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Mandarin

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Letter from the AMSRO President

by **Ben Johnson**, MSc | Johns Hopkins University

Hello AMSRO!

Welcome to this year's Orbiter Newsletter and to the President's Letter. Thank you for being a part of our organization for the past year. It has been an extremely active year and I am excited to share our achievements, but I would like to start with some words of appreciation for you, our members.

To say AMSRO is nothing without its members is a big understatement. For me, joining AMSRO in 2017 felt like I'd reached the light at the end of the tunnel. Being interested in our niche field of aerospace medicine can be an isolating experience. Despite being an accredited medical specialty, is it far from widely known, and the most common reply I get to telling people that I am pursuing a career in aerospace medicine is still, "Aerospace Medicine? What's that?"

Joining AMSRO, however, changed all that. I vividly remember when I went to my first

AsMA conference in Dallas (2018), walked up to the AMSRO table, and said, "Hi, I'm a new member." Immediately I was amazed by how welcoming everyone was and someone quickly invited me to come with them to watch the AsMA opening session together. Suddenly, I had found people that not only knew that Aerospace medicine existed but cared about it deeply, and were excited to discuss it with me.

AMSRO has more than doubled in membership since my first conference, five years ago, and I think our welcoming spirit has only grown since then. We are a lighthouse guiding students and trainees to opportunities in aerospace medicine, and a warm spot by the fire to discuss the nerdy space topics that our other friends and family may have grown tired of hearing us talk about. I am so proud of the community that we have kept strong.

The executive committee's grand project of this year has been to improve the foundations on which AMSRO stands to ensure that it lasts for many more years and can provide valuable services to all our members. Firstly, we have worked to improve our financial health by receiving recognition as a 501(c)3 nonprofit organization and establishing a nonprofit business bank account. These accomplishments allow us to receive tax-deductible donations and keep our funds in a more secure location while increasing our ability to pay expenses flexibly. We have also improved our digital organization and recordkeeping, making sure the ExCom and committees are coordinating in the same digital workspaces and Slack channels to improve efficiency. We are building directories of members, guest speakers, and award winners to both keep our history, improve our efficiency, and make sure our connections for bringing in speakers are not just individual but organizational. Lastly, we have started a project to reorganize the chapter system to more closely follow our parent organization, AsMA, which will allow our current chapters to operate with both more autonomy and more support. We have expanded the size and scope of the chapter coordinating committee to provide more support to local groups for designing events and inviting speakers. While these updates don't even capture everything that has happened this year, it's a glimpse into the dedicated work that everyone on the executive committee has been doing to ensure a bright future for AMSRO.

On a personal note, it's been an incredible honor to serve as president of AMSRO this year, as I couldn't have imagined 5 years ago that I would be leading the organization now. I believe that it is a unique and passionate community of students and trainees and I have such thanks for each and every one of you that has welcomed and encouraged me and each other along the way.

Ad Astra,

Ben Johnson

2023 AMSRO President

Experiences and Reflections: The NASA Aerospace Medicine Clerkship

by **Shilpi Ganguly,** MS4 | University of Miami Miller School of Medicine

and **Lynn Stanwyck**, MD | Virginia Tech Carilion School of Medicine

As fourth year medical students, we were finally eligible to apply for a rotation sponsored by the National Aeronautics and Space Administration (NASA) at the Johnson Space Center in Houston, TX. This rotation, open to fourth year medical students and practicing physicians, is available twice a year during the months of April and October. Through rigorous didactics, site tours, and individual research projects, the NASA aerospace medicine clerkship offers the unique opportunity to dive deeper and gain meaningful experience in the niche world of space medicine. Although quite competitive with applicants applying on average 2-3 times before being selected, we were both lucky enough to gain a spot in the October 2022 cohort.

The October 2022 NASA Aerospace Medicine Clerkship Cohort at Ellington Fields

Prior to starting the NASA clerkship, we both had previous experience working in the world of aerospace medicine including working at SpaceX Medical (Shilpi) and at the Federal Aviation Administration (Lynn). The other clerks, who ranged from fourth year medical students to chief residents and attendings, also had interesting backgrounds such as working as military flight surgeons or participating in space medicine related research projects. A

(Left) Shilpi at SpaceX in Cape Canaveral, FL and (Right) Lynn at the annual Aerospace Medicine Association conference presenting research she worked on at the FAA

range of training backgrounds were also represented among the clerkship class, including family medicine, emergency medicine, internal medicine, occupational medicine, radiology, and ophthalmology.

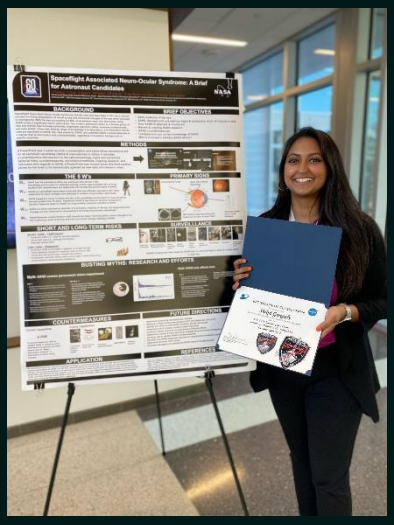
During the clerkship we were given engaging and unique lectures by a diverse group of space medicine physicians, researchers, and astronauts. Some highlights included an overview of aerospace medicine with astronaut Michael Barratt, ISS acoustics, space nutrition and biochemistry, space suit design, medical risk modeling, EVA Physiology, medical kits, bone and muscle health, neurovestibular adaptations, and close calls and accidents. We learned so much about the sheer breadth of space medicine in such a short amount of time!

As a requirement, we were each assigned a research project to work on over the month with the help of a mentor. Our projects included exploring associations between variables related to spaceflight associated neuro-ocular syndrome

(Left) Dr. Michael Barratt presenting space medicine cases, and (Right) Lecture by Kristine Davis discussing space suit design

(Shilpi), creating a brief on spaceflight associated neuro-ocular syndrome for astronaut candidates (Shilpi), and examining the influence of the ACTN3 gene on muscle health and physical fitness to potentially inform future countermeasures with the precision health team (Lynn). These projects were a great way to dive deeper into just a few of the innumerable variables that impact human health and performance in space. At the end of the month we prepared a poster presentation and both of us were able to submit our work for presentation at AsMA in 2023!

A must note highlight of our time on site were the numerous insider tours we were taken on. Some of the notable tours included mission control, where we watched Crew 5 launch to the space station; the neutral buoyancy lab, where we watched two astronaut candidates perform training operations and egress from the 40 foot deep pool; the astronaut training facility, where we got to try out the exercise equipment they use on the space station such as the treadmill and cycle ergometer with vibration isolation and stabilization (CEVIS), as well as the Advanced Resistive Exercise Device (ARED); and the acoustic lab, where we experienced simulations of ambient noise on the ISS.



(Left) Shilpi and (Right) Lynn at the end of clerkship poster presentation session

(A) Shilpi at the NBL, (B) Lynn at the Astronaut Training Facility, (C) Shilpi in front of the HERA Analog Module, (D) Lynn in front of the ISS Mockup

Despite our busy schedules, there was still plenty of time to explore Houston and get to know the other clerks. Given it was October, we participated in many spooky activities such as watching scary movies, going to a haunted house, and hosting an end of clerkship Halloween party! We also explored the Houston bar scene, visited local breweries, ate ice cream on the boardwalk, and went to a Greek Fest. Before heading home, both of us volunteered to be a part of the medical team at Wings over Houston - the local airshow - alongside several other clerks, physicians, and astronauts, for one last hurrah!

Safe to say the month went by in the blink of an eye and turning in our badges at the end was extremely difficult, however we both created memories and friendships that will surely last a lifetime. Overall we were both extremely satisfied with our experiences and highly recommend applying if you have the opportunity. Just remember, even if you aren't selected the first time around don't feel discouraged, just keep trying!

A collection of photos of activities across Houston

For more information and to apply please visit the website below!

https://www.nasa.gov/feature/aerospace-medicine-clerkship

*Of note this opportunity is only available for US Citizens at this time.

The Future: Space Surgery during Deep Space Exploration

by **Eleonor Frost** | University of Aberdeen, UK

Dora Babocs, MD | General Surgery, University of Szeged, HU

and Sophie Rosahl | Neurosurgery, University Hospital Zurich, CH

The new goals and aspects of human spaceflight remodeled the significance of Aerospace Medical disciplines, giving an essential role to the exploration of space surgery. Due to the duration of Lunar and Mars missions, or even beyond, deep-space travel carries several risk factors for the human body. Considering the extended exposure to this dangerous environment major and minor surgical events - even in healthy, pre-examined subjects - must be expected. With the following fictional stories - with hyperlinks to real research - we would like to show you what can already be done in space surgery and where we still have to come up with new solutions.

Onboard Medical Officer's Log – November 17th, 2035 (Eleonor)

After a successful launch and uneventful week in transit to Lunar Gateway and then lunar base, the mission has taken a turn for the worse. Yesterday Jenna was out on EVA collecting rock samples for return when a large boulder dislodged due to the drilling and rolled right over her left femur. Somehow the suit kept its integrity long enough for Dan to drive out and get her back to the Hab (Habitation Module) in time. When she arrived in the medical suite she was in a lot of pain, so after my primary survey I administered some morphine, hoping that a few days in lunar gravity had allowed her body to return from the abnormal fluid distribution in microgravity which can affect anaesthetics [1]. Luckily, with the slight gravity field and thus air convection currents I was also able to give her some Entonox without worrying about it building up as a bubble around her. The next challenge was to strap her down on the table and use my foot restraints [2] to make sure I could move around smoothly and not have to hop to walk (which would not be ideal in surgery). We needed 3

people and a makeshift pulley to put her in a traction splint because of the opposing forces. Thankfully the bleeding was low pressure venous blood and so just built up on her skin surface rather than shooting arterial streams [3]. She's stable now after fixing the fracture in the longest surgery I've taken for such a procedure! Everything here seems to take longer and movements must be so calculated. A retrieval mission is on the way and I'm hoping she stays stable enough to avoid ballistic re-entry because of the G's that would be put through the plate and screws.

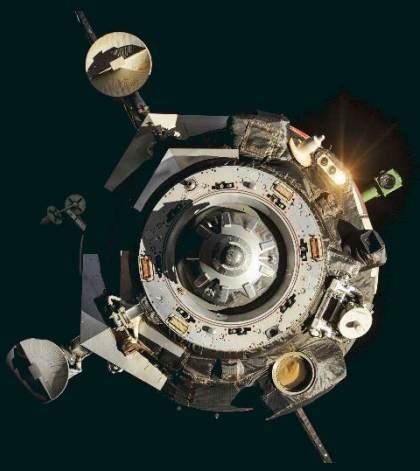


Photo Credit: NASA

Onboard Medical Officer's Log - December 12th, 2035 (Dora)

The Solar Dragon Z036 was 31.9 million km away from our planet, about halfway to reaching Mars, with 33 passengers on board. Since we have already left the protective "shield" of Earth's Magnetic field, ionizing radiation is a serious issue. A total of two cancer cases have been suspected and diagnosed with the help of thorough physical and ultrasound examinations, and blood tests. Mammary ductal cells, lungs, and the thyroid gland are really susceptible areas, especially in women [4]. Today at 10:02 am (EST time-zone, Planet Earth), one passenger Rachel showed signs of an acute abdominal condition. She had symptoms of dizziness, fever, nausea, vomiting, and tachycardia without any abnormalities on her ECG or noticeable with a stethoscope. Physical examination: RUQ tenderness, Murphy's sign: positive. Blood test: leukocytosis elevated level of ALP. An onboard ultrasound examination confirms gallstones and cholecystitis. Conscientious medical examination ruled out acute pancreatitis and appendicitis.

After contacting the Mission Control Center (MCC), and estimating the risks and benefits of medical treatment options, with a group of trained specialists we carefully planned the steps of the onboard Robot-Assisted Minimally Invasive Surgical (RAMIS)[5] intervention. Due to the 8-24 minute signal delay in communication with the MCC; the operation was performed autonomously. Thanks to the long and professional pre-flight surgical training on Earth, the surgery was successful. All the vital signs of our patient are stable. Postoperative care has been started. As a consequence of the numerous stressors of

long-duration spaceflight, changes in the arterial, venous and lymphatic [6] system, increased risk of thrombosis, and delayed wound healing [7] with increased susceptibility to infections are under continuous monitoring and adequate medical support.

Onboard Medical Officer's Log – July 8th, 2036 (Sophie)

We have been circling Mars for two days and today, we get ready for touch-down on its surface. The descent goes smoothly until, suddenly, the lander starts to spin violently. Dan is no longer in his seat, his head hits the side wall, the rest is a blur. I pass out. When our capsule hits the ground, I wake up again. At first glance, no one was harmed but Dan's head hurts. After we get everyone safely to the crew modules that had been landed here on Mars on an earlier unmanned mission, we take off our pressure suits and recover from this not-so-pleasant landing. Everyone is happy now, I am just worried about Dan who starts getting sleepier. I perform neurological exams on him periodically during one of which he starts to slur and cannot lift his left arm anymore.

Then Dan loses consciousness. One-sided deficits with delayed but sudden onset after trauma - I suspect an epidural hematoma which will have to be evacuated. It is only the adrenaline that prevents me from losing my mind right now. I am on autopilot performing procedures I have done my whole life on Earth. Matt anesthetizes, sedates [8] and intubates [9] Dan, I clean, drape and arrange the 3D-printed [10] instruments. I cut, drill, evacuate the blood. Paradoxically everything feels light and easy compared to Earth – Mars' gravity is fooling with me, mentally this is the hardest thing I have ever had to do [11]. We keep Dan supported with i.v. fluids produced from our habitat's recycled water [12]. When he wakes up, everyone is happy to see him alive and smiling.

Conclusion: Surgery in space is hard but not unthinkable. We thought up these stories to give you an idea of what is already realistic to implement in space on the road to more invasive therapeutic procedures and what is still just that - a story.

References (also hyperlinked in-text)

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Space Analogue Photo Contest

AMSRO members take part in so many exciting experiences, internships, conferences and courses that it is almost sad we cannot share all of it. To change that a bit and because The Orbiter needed more pictures from AMSRO members, we ran a photo contest this year.

The prompt: Submit a photo of a situation when you felt closest to a space environment. Add one sentence about why this made you feel like you were in a space analogue.

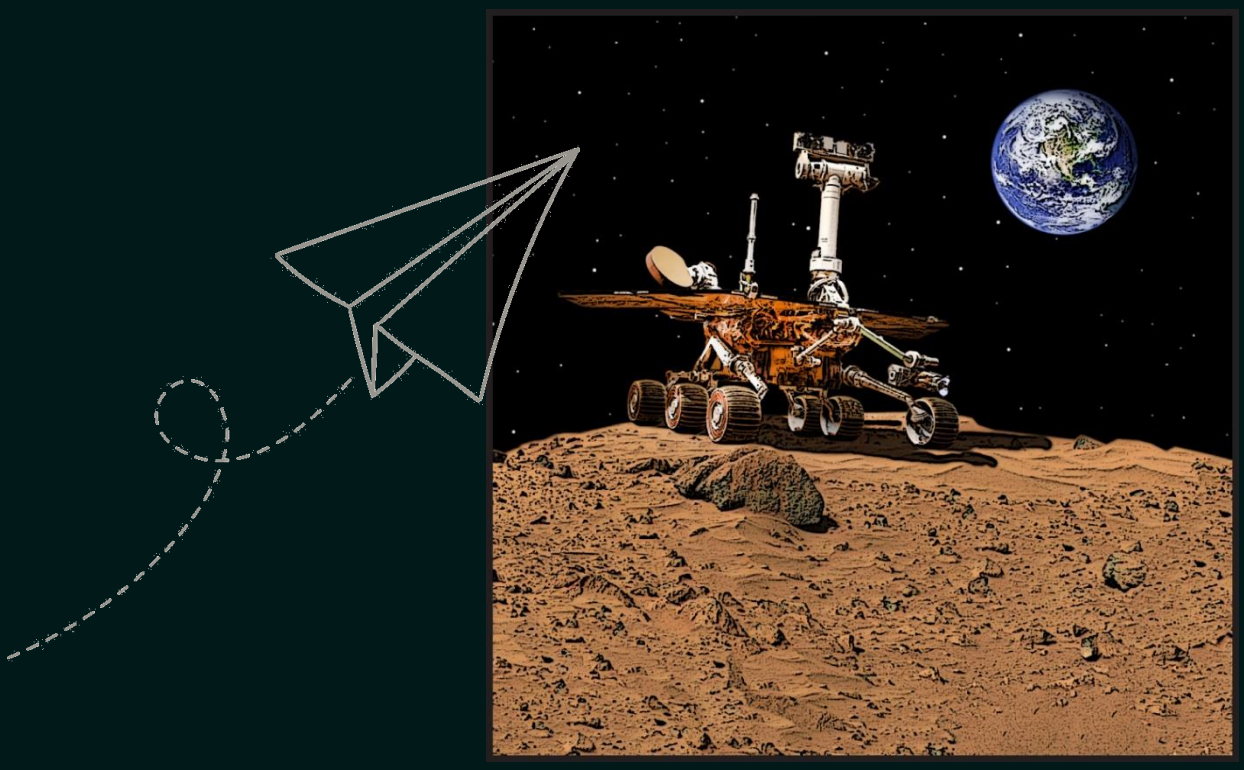
Here are the winners:

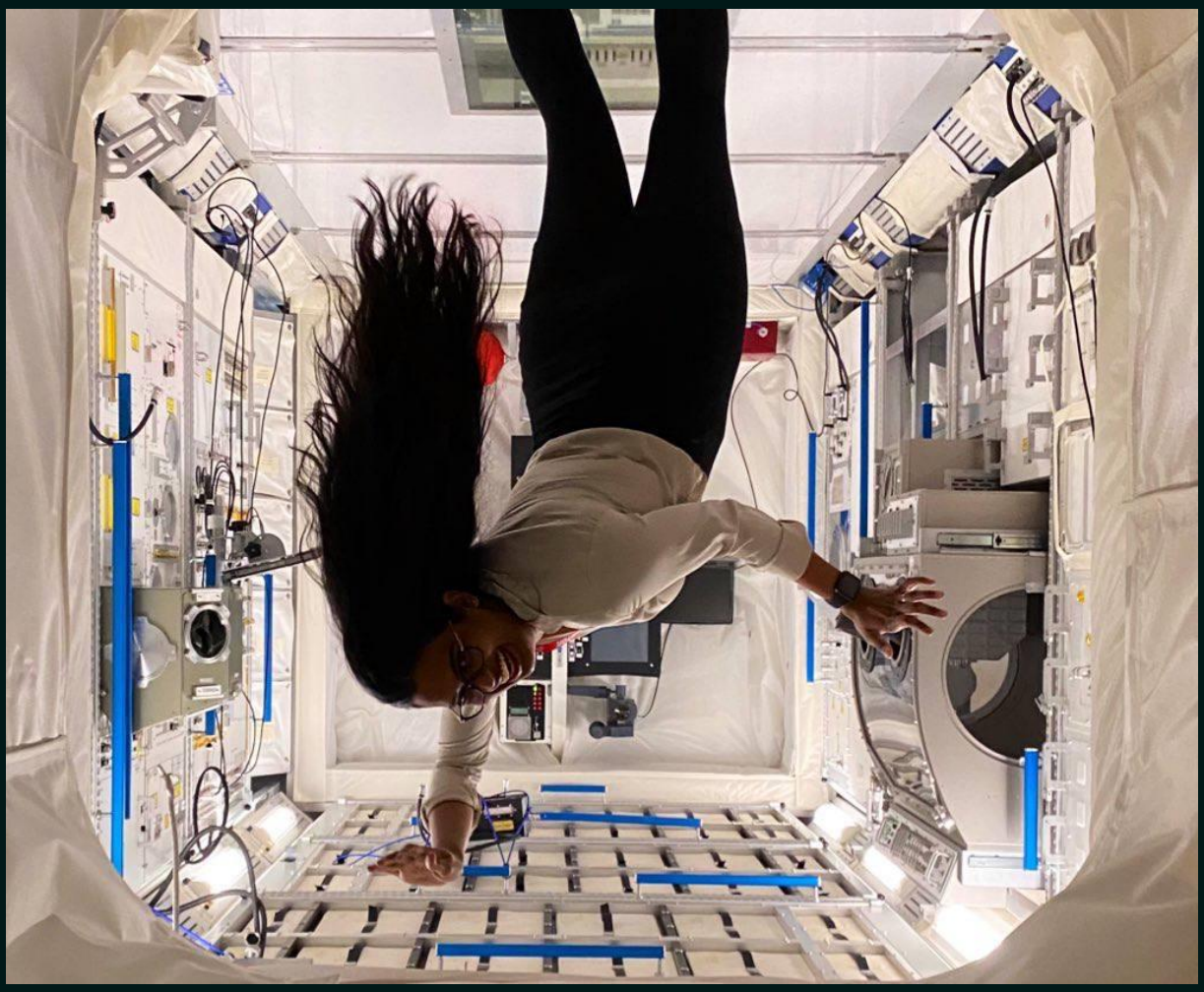
Diving Mexico's cenotes on my first-ever SCUBA trip allowed me to simultaneously experience the weightlessness of neutral buoyancy while exploring otherworldly geological formations.

By Andrew Lam | University of Virginia School of Medicine, USA

I imagined Oppy taking this picture in an inhabitable and fertile version of Mars.

By Claudia Covarrubias | McGill University, Montreal, Canada





Columbus Module Simulator at the European Astronaut Centre in Cologne during SPTC training in January 2023: This incredible experience made me feel like I was in a space analogue because the simulator replicated the disorienting and weightless feeling that astronauts encounter on the ISS.

By Lydia Johnson Kolaparambil Varghse | University of Perugia, Italy

Thank you for the creative and thoughtful submissions. Keep on documenting and sharing your aerospace medicine experiences!

ICAM 2022 - An AMSRO Attendee Perspective

by **Dr. Nina Purvis** | Medical doctor and aerospace medicine researcher from the UK

The 1st International Conference of Aerospace Medicine was an anticipated event for the whole aerospace medicine community, originally planned for 2020 but postponed and postponed again due to Covid-19, it eventually took place in Paris, France in September 2022! The event was organised by the International Academy of Aviation and Space Medicine (IAASM), the European Society of Aerospace Medicine (ESAM), the Aerospace Medical Association (AsMA), and the Francophone ociety of Aerospace Medicine (SOFRAMAS).

The main stage welcome

AMSRO social group lunch

Over 270 abstracts were submitted with around a 2 in 3 acceptance rate. To maximize content and allow a personalised experience, three sessions ran in parallel each day. These included a mix of orbital & exploration class space medicine, commercial spaceflight medicine, commercial aviation medicine, military aviation medicine, aerospace physiology, safety and human factors in aerospace activities, aeromedical evacuation, and travel medicine, with speakers from industry, government, military and academia. From waste management aboard the ISS to diabetes management in airline pilots - this truly brought together a multinational and multi subspecialty community. AMSRO members met up from the UK, Ireland, France, Portugal, India, America, Egypt, Canada, Germany, Nigeria, and more!

The event kicked off with the opening ceremony then The Allard Lecture was given by Luc Tytgat, Director of the Strategy and Safety Management Directorate at EASA (that's no typo, EASA and ESA are separate organisations!). Aside to the main scientific program there was a refresher course for AMEs (Aeromedical examiners), and all conference attendees were given a certification of 10 hours worth of CPD (continuing professional development) from the scientific programme. On Friday

evening, ESA Astronaut Thomas Pesquet gave a stellar presentation themed around his experiences as an astronaut with a subtle medical twist. Of course, he spoke directly to his flight surgeon in the audience which was both insightful and entertaining, then took questions from the audience on dreams in space and back problems.

Some presentations that I would like to shout out from AMSRO members include Dr Katie Harris and her team's excellent talk on point of care ultrasound (PoCUS) during spaceflight; Dr Lisa McNamee's work on aeromedical dispatch of helicopters and agreement in appropriateness; Dr Lydia Kolaparambil's presentation on CNS neoplasms in microgravity; Sophie Rosahl's talk on therapeutic hypothermia on deep space missions; and Dr Gonçalo Torrinha's analysis on structural brain changes detected by MRI during head-down tilt bed rest studies. As well as talks, more of our community gave poster presentations including Eleonor Frost's framework for evaluating quality of care provision during exploration class missions; lessons learned from education around human spaceflight physiology by Dr Jason-Flor Sisante; Anushka Gupta's poster on in-flight medical support on airplanes; and a mention of my own poster on utilisation of omics to assess health risk and create countermeasures in a personalised way for astronauts. It was wholesome to see AMSRO members supporting each other in the session audience and at posters – a great turnout of the future of aerospace medicine!

ESA Astronaut Thomas Pesquet

Last but certainly not least is a review of the food! The conference offered a plethora of coffee break refreshments and snacks (the French pastries were a hit), an open bar social with live music and appetizers, and lunch each day in the form of French baguette sandwich, fruit, and sweet pastries (the plus of the very long queues were they proved useful for networking). In the evenings there were social events that you could attend for an extra fee; I attended the gala dinner and the three course meal was well worth the price of the ticket with champagne to boot. The gala dinner was hosted under the wings of various spacecraft exhibited in the City of Science and Industry Main Exhibition Hall including Solar Impulse (the long-range solar powered aircraft that circumnavigated the Earth), and attendees were allowed to view the scientific exhibits after dark including the aquarium.

The conference was a whirlwind of inspiring aerospace medicine and a fun social calendar in a beautiful city, but as an early career attendee it was at quite a cost of 600 euros for registration plus travel and accommodation. Sadly, there were no (to my knowledge) student or junior clinician/researcher scholarships offered by the event unlike some of the events hosted in the past by the organising societies. I would definitely advocate for more early career support.

There is no online evidence of a 2nd ICAM…but watch this (aero)space!

All photos taken by author. Permission from mentioned authors/photographed people granted.

AMSRO group photo in front of the helicopter, with some on point dress-aircraft coordination!

Boldy Going Where No Med Has Gone Before: The Final Pharmaceutical Frontier

by **Emma Ives** | PharmD Candidate 2025, UNC Eshelman School of Pharmacy | B.S Biology, The Ohio State University

The standard long-term treatment for most venous thromboemboli (VTE) is Direct Oral Anticoagulants (DOACs). They are effective, have no needles involved, and do not require weekly outpatient monitoring. It's no wonder physicians prefer them over complicated drugs like warfarin, enoxaparin, or heparin. It is hard to imagine the practice without them. But what happens if the patient cannot even see a physician to determine need for anticoagulants, for example, they are an astronaut aboard the ISS? Picture this: an obstructive left internal jugular venous thromboembolism is found during an ultrasound examination part of a vascular experiment. The patient has no signs and symptoms, no family history, and there are only 107 drugs to choose from. None of the DOACs are among them (they take up too much space) nor are any of the reversal agents available to stop bleeding. This is not science fiction. This is an actual case from 2020.[6,7] NASA convened a multispecialty team to come up with an action plan using the resources available. Due to the lack of data surrounding VTE in low gravity, the drugs were prescribed under assumptions of Earth conditions, ignoring the change in gravity as a factor. While the outcome of the case was positive with no complications, it demonstrated previously unforeseen problems that arise during space travel.

With the increasing number of launches from American soil to the ISS as well as commercial spaceflight looming on the horizon, it is clear that these astronauts will need medicine, making a greater understanding of drug stability, pharmacokinetics, and pharmacodynamics in space much more vital. NASA employs five pharmacists. The pharmacy at Johnson Space Center was created in 2000.[1] While the technology to get humans to space and protect them once they get there has progressed in leaps and bounds, life sciences research, especially in pharmaceuticals, is significantly lacking. If humans are going to space for extended periods of time, it is vital to know how drugs affect the body in space.

Houston We Have A Problem: Pharmacokinetics and Pharmacodynamics in Space

Pharmacologically active compounds have been in space since the early days of space flight. The Gemini-7 spacecraft carried 10 compounds while the med kits on Apollo 11 carried 13.[2] Time in space alters the physiology of the body, but there is a limited understanding on drug pharmacokinetics and pharmacodynamics in space, especially when drugs are subjected to lengthy periods of time in low gravity.

Medications are still administered under the assumption of Earth conditions. There have only been a handful of studies on the pharmacokinetics of medications while in microgravity. Of that group, only three clinical studies were conducted during spaceflight. Most of the data available is from the NASA Twins Study and parabolic flights.[2] Because of the difficulty in collecting samples firsthand, several studies have been conducted using bedrest models and water immersion to study pharmacokinetics in a controlled Earth environment. While these models are great for simulating physiological changes experienced in microgravity, sometimes there can be differing results from the inflight studies. The most recent one was in 2009, and as of 2019 no new studies have been planned.[3] Several reviews and the pharmaceutical community have suggested the development of a more accurate ground-based model to predict the pharmacokinetic behavior of medications without the impracticality of spaceflight studies. In addition to pharmacokinetic studies, there is very little known about pharmacodynamics (study of effects of drugs and their action mechanism) in space. It is hypothesized that loss of plasma volume may alter drug receptor interaction, affecting response to medications, but more research is needed to support this.[3] The cardiovascular system is largely affected by microgravity, which can lead to different pharmacological effects of antihypertensives and diuretics. There have been some studies in simulated microgravity. For example, Schuck et al., 2005, saw similar plasma concentrations of ciprofloxacin in both earth and simulated microgravity conditions but less tissue perfusion in simulated microgravity.[4] However, the results of the study cannot be generalized to all antibiotics or other medications.

Thanks to the Mercury Missions from the 1960s, scientists know fluids in the body shift in space due to the way the astronauts sit during launch and the changes in gravity. Some drugs use the bloodstream to move around the body, and the altered blood flow of astronauts can affect the rate

of drug absorption, distribution, and elimination.[3] Another problem astronauts face is bone loss and muscle atrophy when they return to Earth. This is especially problematic on longer missions, where 30% more muscle loss has been observed than on earth.[2] Muscle atrophy can hamper drug performance due to decreased volume of distribution (Vd).[2] Decreased Vd can potentially alter maximum drug concentration, thereby impacting the desired pharmacological effect. Muscle wasting also adds to the unpredictability of serum creatinine, which can alter drug elimination. Pharmacists are trained to adjust medications based on a variety of patient factors, including creatinine clearance. However, they cannot apply their clinical expertise if there is no available data to back up their analysis.

Shelf Life Assumes Optimal Conditions: Space is anything but

A round trip from Earth to Mars and back again will be about 3 years. The shelf life for most medications marketed in the US can be anywhere from 12 to 60 months from date of manufacture when stored at optimal conditions, depending on the dosage form. Once a drug is taken out of its original packaging (to consolidate for transport to the ISS for example), the degradation clock starts. Conditions pre-launch are not optimal. While awaiting launch on the tarmac, medications are subjected to Florida temperatures for weeks while the supplies are packed into the rocket. Temperature on the International Space Station isn't an issue for drug storage. Once they make it outside the atmosphere, medications are no longer protected by the ozone layer and are subjected to galactic cosmic rays (GCRs) just as astronauts are. It is theorized radiation might accelerate degradation of medications.[8] A 2011 study found 4 out of 14 medicines stored for 28 months on the ISS did not meet the United States Pharmacopeia (USP) requirements when compared to the same medications at ground control.[5] The number of medications that failed stability requirements was associated with increased time spent in space.[2] More research is needed in this area to determine what can be done to protect these medications for long haul missions, such as cryofreezing medical kits, shielding medication storage, or selecting medications with hardier excipients to survive the interplanetary radiation environment.[8] The feasibility of accomplishing this research within the next decade is questionable due to financial constraints, available Earth models, and the fast approaching decommissioning of the ISS.[8] All of these factors decrease the likelihood this knowledge will be available to those planning the three-year Mars mission.

Pharmacists will have to rely on clinical judgment and theory when deciding what medications could make it to Mars.

The pharmaceutical field is reaching new heights as we get closer to sending humans to the moon and eventually to Mars. But with new heights there are new obstacles and even areas of pharmacy that have not been created yet. More pharmacokinetic studies are necessary to determine the risk-benefit ratio of prescribing medications in microgravity and inform future prescribing behavior. The first documented venous thrombosis during spaceflight imparted the necessity for pharmacy in space and an appreciation of the clinical expertise of pharmacists.[6,7] As humans continue to spread out amongst the stars, they will need medicine, and pharmacists will need to boldly go where no one has gone before.

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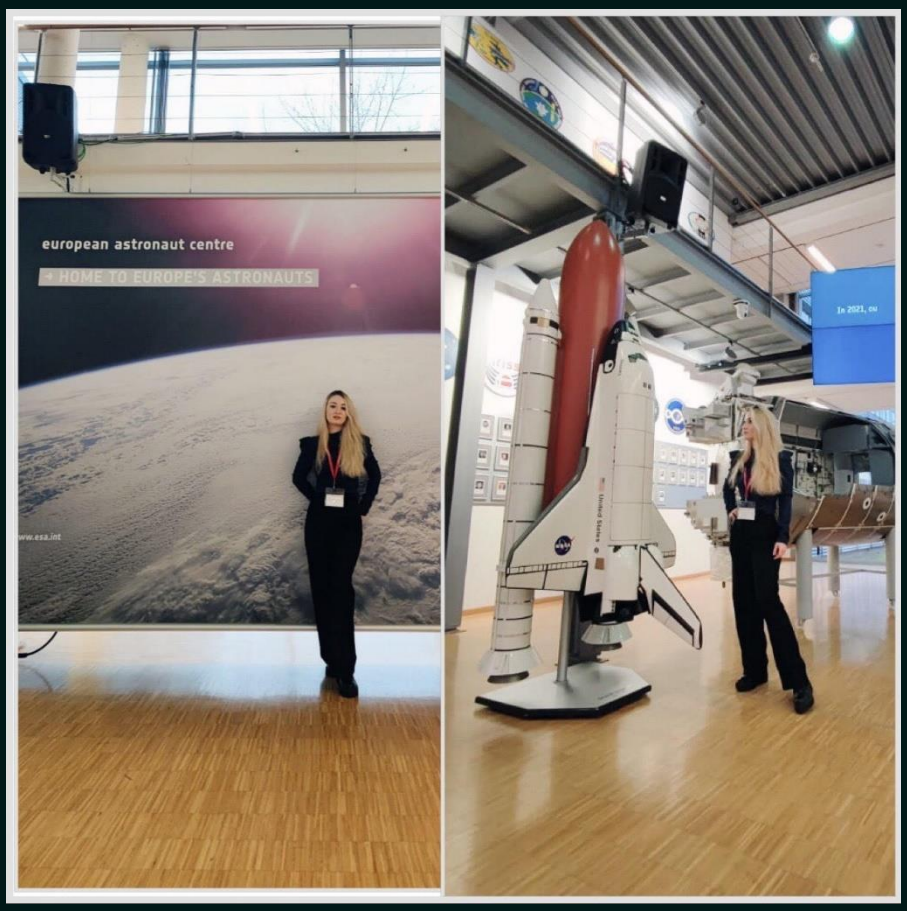
Inspiring the Next Generation: Our Journey at the ESA Space Physician Training Course

by **Dora Babocs**, MD | General Surgery Resident at the University of Szeged, Hungary | University of Szeged, Department of Aviation and Space Medicine

Space Physicians, Class of 2023: The Space Physician Training Course 2023 (SPTC23) is a 3-day intense medical training organized by the European Space Agency (ESA). Since the education is firmly related to space medicine, previous studies, and a medical degree are required for the application. This year 25 physicians were selected from several countries all over the world. The training took place in Cologne, Germany at the European Astronaut Centre (EAC).



The European Astronaut Centre (EAC)

Operations Control Room

Three days to reach the Moon:

Day 1: After receiving our ESA badge, we could enter the EAC, where most of our program took place. After a short, brief overview of ESA, we had several lectures on the space environment, and how it affects the human body and crew health. Another important topic was space operations. I believe the most interesting part of the day was when we had a Q&A session with Samantha Cristoforetti - everybody was keen to hear about her thoughts and experiences.

Day 2: On the second day besides the lectures - where I especially enjoyed the space radiation presentation - we also had some exciting group activities. We visited the Operational Control Room - where we could have an insight into EUROCOM's responsibilities. At the next station, we learned about the medical criteria for astronaut selection and certification. ESA also gave us the opportunity to work in teams and try to find ideas and solutions for some interesting, and important difficulties of human spaceflight. Our team had to discuss the potential solutions for orthostatic intolerance during Lunar missions. After the long training, we all had dinner at a nearby restaurant, where we had some more time to get to know each other better.

Day 3: On the third day, we mainly had group activities: at first, we visited the ESA physical training facility. The most impressive part of this training hall was the centrifuge training laboratory. The next “station” of our visit was the Neutral Buoyancy Facility where we could learn about Extra Vehicular Activity (EVA) training. After the tour, we had our workshop presentations, therefore we could learn a lot from each other too.

Sum up SPTC23*:* It was an amazing experience with various interactive, and theoretical educational elements about space medicine, operations, and astronaut training. Furthermore, I made a lot of new friends. Time flew by so fast, and before we knew it, the training had finished. Sadly, we had to say goodbye, but - as promised - we will see each other again soon!

The centrifuge training laboratory

PUBLICATIONS LIST Name	Publication Title	Link to publication	Lab/PI Name	Lab Location	Contact information
Michelle Hohm	Hearing exposure of the Christoph 23 crew at the BwZKrhs	https://www.researchgate.net/publication/364302717_Hearing_exposure_of_the_Christoph_23_crew_at_the_BwZKrhs	Tesla Manufacturing SE	Federal Armed Forces Central Hospital Germany	Hohm.michelle@posteo.de
Nate Barott	Current Understanding of Relevant Trends in Altitude Illness in Nepal (CURTAIN)	Not yet published – link to team: https://www.acep.org/wilderness/newsroom/newsroom-articles/sept2022/adventure-in-nepal-team-curtain-current-understanding-of-relevant-trends-in-altitude-illness-in-nepal/	James Marvel, MD	Khumbu and Manag Regions, Nepal	barottn@upstate.edu
Mohammad Hirzallah	Optic nerve sheath diameter and spaceflight: defining shortcomings and future directions	https://www.nature.com/articles/s41526-022-00228-1	Hirzallah	Baylor College of Medicine, Houston, TX	Mohammad.hirzallah@bcm.edu
Sam Stephenson	Simulated Space Radiation Exposure Effects on Switch Task Performance in Rats	https://www.ingentaconnect.com/content/asma/amhp/2022/00000093/00000009/art00008;jsessionid=18le7sn0iyi4o.x-ic-live-03	EVMS: Dr. Britten	Norfolk, VA	sds3nf@virginia.edu
Sam Stephenson	Radiation and CNS effects: summary of evidence from a recent symposium of the Radiation Research Society	https://www.tandfonline.com/doi/full/10.1080/09553002.2023.2142984	EVMS: Dr. Britten	Norfolk, VA	sds3nf@virginia.edu
Eleonor Frost	Microgravity surgical workstation design	https://www.sciencedirect.com/science/article/abs/pii/S246889672100063X	University College London, Eleonor Frost	London, UK	eleonor.frost@spacegeneration.org.uk
Tom Diaz	Description: An analysis of the proteomic alterations in the heart and plasma of mouse models after exposure to simulated space radiation at the NASA Space Radiation Laboratory (NSRL).		Dr. Dawn Bowles	Duke University - Durham, North Carolina, United States	dawn.bowles@duke.edu

Dr. Vance H. Marchbanks, Jr.:

The Black Flight Surgeon Who Stopped the Military from Grounding Sickle Cell Carriers

by **Andrew Lam**, MD | University of Virginia School of Medicine

This article was initially published on Instagram during Black History Month 2023 as part of the Diversity Committee's Instagram series.

This Black History Month, we honor the legacy of Dr. Vance H. Marchbanks, Jr. His historic contributions to aerospace medicine amid systemic racism exemplify the resilience of the Black community as a whole within the field.

Born in 1905, Vance Marchbanks was afforded few opportunities as a person of color. Prior to his medical studies at Howard University in Washington, DC, he suffered racial discrimination as an undergraduate at the University of Arizona, not only being excluded from on-campus lodging and dining but also frequently discovering insects like cockroaches placed in his food. Despite these challenges, he excelled in his career and served as one of the first two Black flight surgeons for the US Army during World War II, albeit in the segregated all-Black units that would come to be known as the Tuskegee Airmen. While Dr. Marchbanks is often remembered for his later work with NASA, such as monitoring astronaut John Glenn during his pioneering 1962 orbital flight and developing life support systems for the Apollo program, it was his relationship with the Tuskegee Airmen that led to one of his greatest accomplishments for Black pilots, astronauts, and aerospace medicine professionals.

In the late 1950s, scientists were beginning to uncover the genetic origins of sickle cell disease, a condition marked by potentially fatal bouts of pain and anemia that has historically been most common in malaria-affected regions of the world. It was found that symptoms of sickle cell disease arose when patients inherited two copies of a recessive genetic variant and that those who inherited only one copy, a phenomenon termed “sickle cell trait,” did not tend to exhibit symptoms. Nevertheless, scientists hypothesized that people with sickle cell trait still had a

theoretical risk of being affected by stressful or low-oxygen situations, and the United States Air Force conservatively opted to ban people with even a single copy of the sickle cell variant from flying. Unfortunately, as the majority of Americans with sickle cell variants have African ancestry, this policy disproportionately affected Black prospective pilots and led to the infamous 1979 dismissal of an Air Force Academy candidate with sickle cell trait.

Photo Credit: Smithsonian Institution

In response, Black physicians urged Dr. Marchbanks to scientifically investigate the matter; as of yet, no rigorous evidence had been collected to justify this policy decision. Using the connections he had built with the Tuskegee Airmen during World War II, Dr. Marchbanks collaborated with Dr. Oswaldo Castro of the Howard University Center for Sickle Cell Disease to recruit Black fighter pilots for a landmark research study. Together, they genetically tested 154 veterans and discovered 10 individuals with sickle cell trait, all of whom had successfully flown in combat without adverse events, including one who had accrued 600 hours of experience. After Dr. Marchbanks published their findings in Aviation, Space, and Environmental Medicine (now known as Aerospace Medicine and Human Performance) in 1980 and the Journal of the National Medical Association in 1981, the Air Force retracted its former policy on sickle cell trait, quickly followed by similar actions from the other military services.

Dr. Marchbanks's story is an inspiration for many reasons. But perhaps the most remarkable is the lesson that when the community comes together—fliers, flight surgeons, researchers, and policymakers—we can make the aerospace medicine community a more inclusive environment for all of our members.

Committee Updates

International Outreach Committee

Britt Wiseman (North America), Dora Babocs (Europe) and Takuma Ishibashi (Asia)

The international outreach committee's goal is to spread awareness of AMSRO and of aerospace medicine. Over the 2023 term we are planning to host events, including an international panel/speaker series, where aerospace medicine professionals from around the world will share their experiences and insights into the industry. Additionally, the outreach committee is partnering with AsMA Foundation and the Communications committee to create content for social media, an aerospace medicine podcast, and more, to expand AMSRO's outreach even further. AMSRO's International Outreach Committee is determined to create a more inclusive community of aerospace medicine enthusiasts and professionals worldwide!

If you have questions or ideas you can reach us here: bwiseman@ualberta.ca, babocsdora@gmail.com and ishibashi-takuma671@g.ecc.u-tokyo.ac.jp

Diversity Committee

Andrew Lam, Kseniya Masterova, Curran Varma

The Diversity Committee is led by Andrew Lam, Kseniya Masterova, and Curran Varma. This year, we systematized documentation and processes to sustain future momentum. We have strengthened public relations, decreasing stigma by renaming our recurring Diversity Scholarship to the Trailblazer Scholarship, connecting with historically black colleges and universities, and starting an Instagram series highlighting minority aerospace professionals. Per our annual tradition, we will present a poster at the 2023 AsMA Scientific Meeting entitled "A review of evidence-based diversity initiatives in medical education and their applicability to training in aerospace medicine." Please email AMSRO.Diversity@gmail.com to join our efforts!

Chapter Establishment and Coordinating Committee

Anushka Gupta, Eric Chan

In the past few years, the Chapter Establishment and Coordinating Committee has seen tremendous growth with the incorporation of numerous chapters from across the nation and around the world. Currently, the committee is looking to restructure the network of existing chapters as well as continue to improve the chapter experience for all individuals involved.

Womxn in Aerospace Medicine

by Melissa Jordan

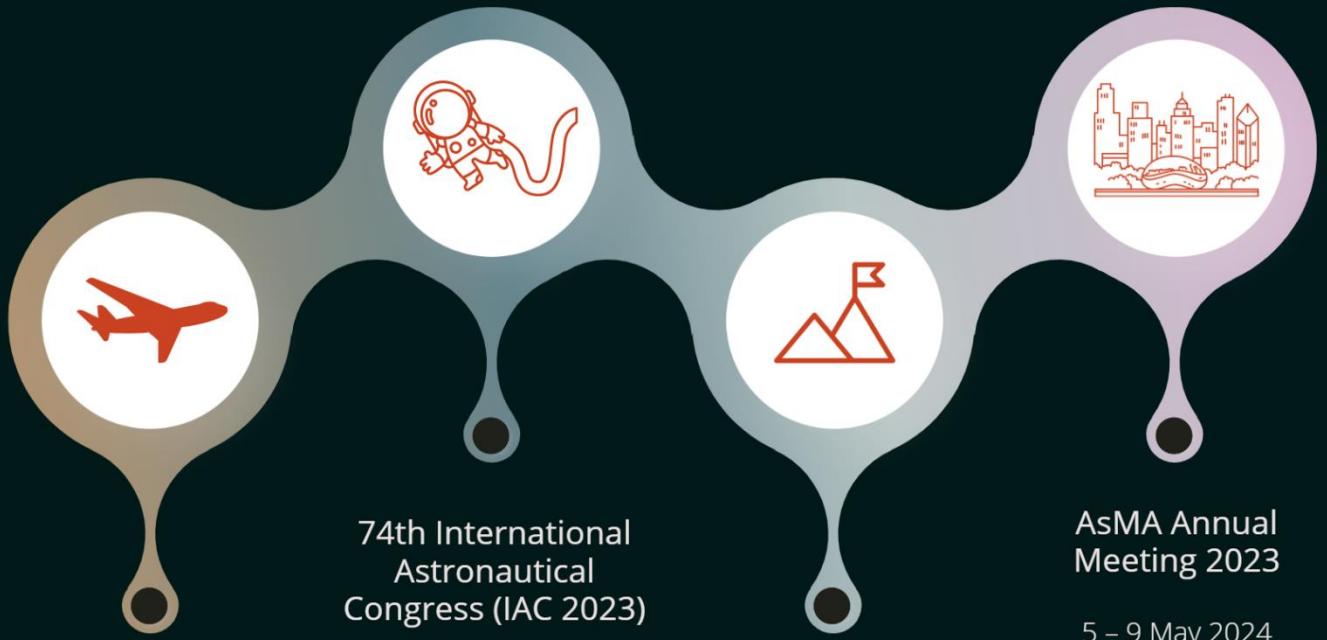
Womxn in Aero(space) Medicine (WAM) is a diversity initiative of AMSRO. We are here to provide support to bring diversity, representation, scholarship, and leadership to aerospace medicine – bottom line, we're here for you!

Since WAM was founded in 2020, we have grown to a global network of female-identifying members, friends, and allies. Going into 2023, we have diverse member opportunities and hope you can join us! Monthly meetings have opportunities to learn from amazing guest speakers. In the past, this has included astronauts, scientists and researchers, flight surgeons, and member spotlights. In addition, we can be reached through social media and our member group chat, which gives the opportunity for a community to celebrate your successes, to share interesting events, and peer mentorship for career growth. Our new goals this year are to create a distribution system to highlight the numerous opportunities to engage in the field, as well as to seek out opportunities for internships and hands on learning.

The path into aerospace medicine doesn't have just one right answer, and as you explore options for your area of interest, the WAM community is looking forward to being able to support you!

Web page:
https://sites.google.com/view/womxninaeromed/home

Upcoming Aerospace Medicine Events



Aviation Health Conference

26 – 27 September 2023
London, UK

74th International Astronautical Congress (IAC 2023)

2 – 6 October 2023
Baku, Azerbaijan

International Congress of Aviation and Space Medicine (ICASM 2023)

26 – 29 October 2023
Abu Dhabi, UAE

AsMA Annual Meeting 2023

5 – 9 May 2024
Chicago, USA

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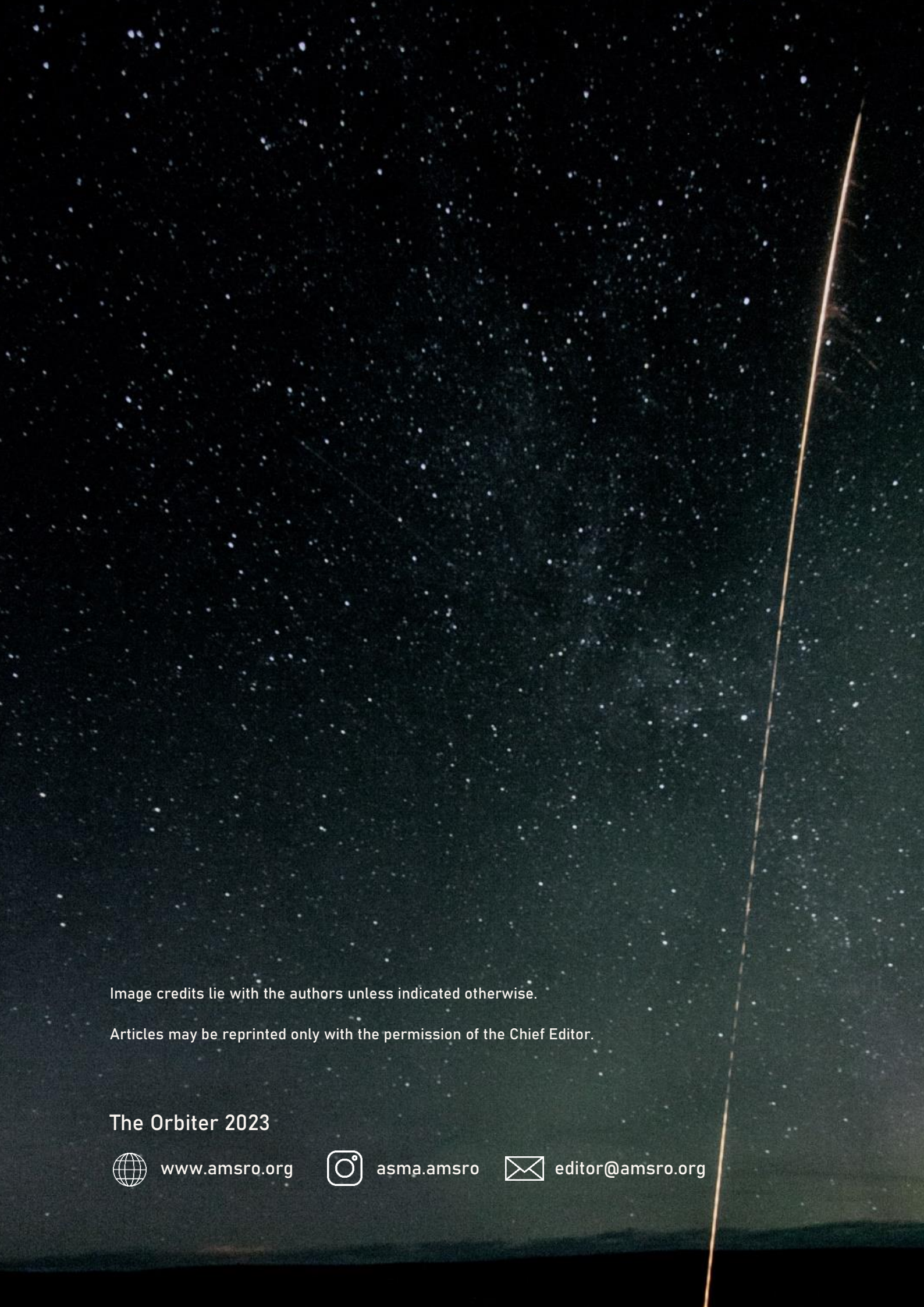

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www.amsro.org asma.amsro editor@amsro.org