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Dear AMSRO Members,

It has been such an honor to serve as your president for the last two years! I have been part of the AMSRO executive committee since 2015, and it has been quite the journey. A lot has changed since I joined AMSRO in 2014 and I have watched our organization grow as more and more students and trainees that share a passion for this unique field have come together to support each other.

At my first meeting in San Diego in 2014, I remember the AMSRO annual meeting consisted of maybe a dozen people in a small room together voting on bylaw changes, officers providing reports, and voting for our next officers on pieces of scratch paper. At our last in-person meeting, in 2019, dozens and dozens of you piled in, until there was standing room only. We had featured speakers, special announcements from guests, and we introduced our new officers, that now were able to participate in elections regardless of their ability to physically be there that day. I am so proud of the work that all of you have done to grow this organization.

Even just two years ago, at our last in-person meeting, we had 111 members. Today, I’m proud to say that we have nearly doubled that as we stand at 205 members. We achieved this during a pandemic with no in-person activities, all with your hard work spreading the word and making this field more accessible. A big contributor to our growth was the establishment of local chapters that are bringing AMSRO to your communities and institutions at home. Kudos to all our chapter leaders for taking the initiative and gathering your fellow peers to bring Aerospace Medicine to so many corners of not only the United States, but around the world!

I’d like to leave you with this- AMSRO has always thrived on community and mutual support. When I joined, I remember feeling so welcomed into the Aerospace Medicine world. That sense of belonging came from the AMSRO members who greeted me with open arms and took me under their wing, especially our late past president, Anita Mantri. I encourage all of you to embody this sense of community. Reach out to each other, welcome new members, and if you meet someone new to this world, take them under your wing, show them around and help them find their place. This is what makes AMSRO special, and this is how AMSRO thrives. Being a part of this organization has meant the world to me, and it has changed my life in so many ways. Thank you all for being a part of this truly marvelous group.

As I once said when leaving my first AsMA conference in San Diego that lit a fire in me that I didn’t know was there- So long, and thanks for all the fish!
OMM IN SPACE:
ARGUMENTS FOR AND AGAINST OSTEOPATHIC MANIPULATIVE
MEDICINE (OMM) IN SPACE APPLICATIONS

by Matthew Knapp

Abstract
Osteopathic manipulative medicine (OMM) is the therapeutic approach to medicine involving hands-on treatment to alleviate the structural or functional dysfunctions which may be present in the human body at any given time, especially after physically taxing activities. OMM has proven successful in the treatment of these dysfunctions on patients for over a century. This paper will explore how OMM may be implemented into the care of astronauts both on the ground and during long duration spaceflight.

Discussion
In the early days of spaceflight, Russian cosmonauts had reported hyperreflexia upon returning to the 1-G environment of Earth. This finding was reproduced by the crew members of the Skylab 3 mission in 1973. It was hypothesized that this hyperreflexia was due to muscle imbalance resulting from atrophy of the muscles in zero gravity environments for prolonged periods of time [1]. Fast forward 50 years and it is widely recognized that muscle atrophy is a feature of long duration space flight and has posed an area of extensive research. Even with regular exercise, astronauts still lose muscle tone. Physiologists have discovered the reason being that muscle atrophy is the body’s natural response to decreased load in microgravity, making it difficult for astronauts to artificially counteract this natural phenomenon. Even so, muscle atrophy often leads to a somatic dysfunction. A somatic dysfunction is any alteration in the components of the somatic system, including skeletal, arthrodial, and myofascial structures and their related vascular, lymphatic, and neural components. Osteopathic manipulative medicine (OMM) diagnoses and treats somatic dysfunction.

Back on Earth, many of the OMM techniques are aimed to relieve the effects of a muscle imbalance. When a muscle imbalance occurs due to atrophy, sudden movement, trauma et cetera, spinal facilitation and increased muscle spindle sensitivity follow. The result is a restricted range of motion. In addition, a muscle imbalance directly involves the pulling of affected muscles on their bony attachments. Forces generated on the vertebra in the thoracic or lumbar spine by tight, spastic long restrictors, such as the erector spinae and quadratus lumborum muscles cause a dysfunction following Fryette Type 1 mechanics, where the spine is in neutral and a series of vertebra have sidebent one direction and rotated the opposite.
Additionally, osteopathic exams and treatment during long duration space flight have the potential to maintain musculoskeletal integrity by proactively countering the skeletal effects of muscle atrophy. Astronauts must land on Mars healthy and prepared to engage in arduous work.

However, OMM is not without limitations. OMM involves many HVLA treatments which can jeopardize someone’s health if they have certain preexisting conditions. One such contraindication is a herniated disc, or any spinal cord damage for that matter. In space, without the loading forces of gravity, astronauts can grow (expand) up to 7 centimeters [2]. This growth separates the space between two vertebrae, increasing the likelihood of a herniation. Such is the reasoning why astronauts are carefully carried out of the spacecraft upon landing back on Earth and are urged not to do strenuous activity for quite some time thereafter.

With that said, HVLA forms only a small part of OMM treatments. Still, it must be considered whether OMM techniques, the majority of which rely on gravity and/or the exertion of forces are practical in a zero-gravity environment.

Nonetheless, OMM boasts a large toolbox and is not limited to the treatment of a muscle imbalance. The human cardiovascular and lymphatic systems evolved under Earth’s gravitational forces. As a result, when in space, astronauts experience a mild form of fluid build-up in the head due to the zero-gravity environment, known rather comically as the “puffy head bird legs” condition. OMM lymphatic treatment will expedite the recovery of edema. After first treating the thoracic inlet, the Miller thoracic pump can be utilized, as it is designed to drain lymphatic fluid from above the level of the neck.

Those who engage in space flight use their bodies in ways the average person does not often encounter, whether that be fighting the strain of multiple G-forces in rocket ascent or navigating the tight environment of the International Space Station for lengthy periods of time. These unusual movements combined with muscle atrophy itself are recipes for somatic dysfunctions.

An osteopathic exam upon return to Earth serves two purposes. One, it can be used as a research tool. A trained osteopathic physician can very easily identify somatic dysfunction, and this will give researchers an additional method of examining the effects of space flight on the musculoskeletal system. Two, OMM is a necessity for quality, whole body care of any patient, and astronauts particularly will benefit from the evaluation and treatment of muscle dysfunction, or any other imbalance after exposure to a physically extreme environment.

The same application of forces, except by tight, spastic short restrictors, such as the multifidus muscles cause a dysfunction following Fryette Type 2 mechanics, where a single vertebra is in an extreme position (flexion or extension), sidebent one direction, and rotated the same. Although the cervical spine does not follow Fryette mechanics, muscle spasms still cause vertebral sidebending and rotations. Furthermore, forces acting upon the ribs cause inhalation or exhalation dysfunctions, whereas forces acting upon the pelvic area result in innominate shears or sacral rotations. The above is a brief introduction to the numerous possibilities of somatic dysfunction. After a somatic dysfunction has been diagnosed, the osteopathic physician can use OMM techniques such as muscle energy or high-velocity-low-amplitude (HVLA) to reposition the dysfunctional segment.

This is a brief introduction to the numerous possibilities of somatic dysfunction. After a somatic dysfunction has been diagnosed, the osteopathic physician can use OMM techniques such as muscle energy or high-velocity-low-amplitude (HVLA) to reposition the dysfunctional segment.
Furthermore, due to the structure of the lymphatic system, adequate lymphatic circulation is necessary to promote immune responses. Astronauts are faced with a unique microbiology environment. Although attempts are made to sterilize the space craft, microorganisms have and always will evolve. Extreme conditions effectively select for the resistant microorganisms to such a degree that there has already been a new species of bacteria discovered on board the International Space Station [3]. Surrounded by unique bugs, it is critical for the astronaut to maintain a fully functional immune system. There is a plethora of OMM lymphatic techniques, from techniques designed to promote lymphatic flow such as pectoral traction and the previously mentioned Miller thoracic pump; to techniques designed to remove lymphatic restrictions, such as thoracic inlet myofascial release treatment, re-doming the diaphragm, and rib raising. Rib raising improves lymphatic flow via restoring proper rib movement. This technique has been demonstrated to alleviate sympathetic nervous system tone [4]. An overactive sympathetic nervous system may be present in an astronaut who is faced with stressful situations throughout their mission in space, and rib raising is a quick and simple treatment that has the potential to minimize the undesirable physiologic effects of this prolonged sympathetic stimulation.

This paper is intended to scratch the surface of what OMM has to offer. With these examples in mind, we should begin to explore exactly how the OMM field can serve a vital role in space medicine. A current Medline search for “Osteopathic Manipulative Medicine” and “Space Flight” will turn up nil results.

However, as the future of space flight is ever changing and ever flirting with the idea of both long duration flights and commercial flights, more people will need to be screened before and after flights or treated during flight, opening the door for the osteopathic physician in this field.

References
**Womxn in Aerospace Medicine**

WAM is a new organization for female-identifying aerospace medicine practitioners, researchers, and their allies. Our goal is to promote diversity, representation, scholarship, and leadership in Aerospace medicine. This year, we hosted monthly conversations with a high-achieving woman in the field: astronauts, heads of organizations, and professors of Aerospace medicine. We are aiming to match mentors and mentees; and raise awareness for opportunities for involvement. Find out more about us and join us here.

**Mentorship Committee**

Ste’Von Voice and Ben Johnson: This year the committee focused on hosting a virtual speed mentoring program as well as establishing a long-term mentoring program. The virtual event occurred during AsMA, co-hosted with the Education and Training Committee and had 40 student and resident attendees. The long term mentorship program successfully paired 36 students with mentors across the aerospace industry (Academic, Government & Private). We are excited to offer future rounds of mentor-pairing and continuing to offer opportunities to AMSRO members.

**Diversity Committee**

Nic Nelson and Karen Ong: This year the committee successfully established an annual AMSRO Diversity Scholarship/Mentorship program, with the first awardee using funds to complete a clerkship at SpaceX. Members of the committee also hosted the first AMSRO-run student panel at AsMA 2021, presenting evidence-based insights about diversity in astronautics and aerospace medicine. The team is building on their findings in order to publish in AMHP, generate current data from the field, and develop actionable benchmarks for supporting diversity, equity, and inclusion. In addition to other online initiatives intended to increase access and share information, they held six online events featuring diverse speakers sharing a variety of aerospace experiences and expertise.

**International Outreach Committee**

Ahmed Baraka: This year the committee has strengthened its relationship with the Space Generation Advisory Council and is working toward collaborations with the respective Egyptian, Bahraini and African space agencies.
EXPERIENCES:

SPACEX CLERKSHIP

Our awesome AMSRO member Shilpi Ganguly was in the first class of the SpaceX Medical Student Rotation. She’s an MS3 at the University of Miami Miller School of Medicine and leads AMSRO's Womxn in Aerospace Medicine subcommittee.
EXPERIENCES: INSIGHTS FROM THE UTMB PRINCIPLES OF AVIATION AND SPACE MEDICINE COURSE 2021

by Sophie Rosahl

8am in Houston, 3pm in Germany, 10pm in Japan. If this sounds like a meeting of ISS Control Centers around the world to you, it's a good guess, because this schedule describes a Mission Control bootcamp in the UTMB Principles of Aviation and Space Medicine (PASM) Course 2021.

27 students, residents, physicians, and military flight surgeons from 9 different countries came together over the first three weeks of July to develop their medical knowledge pertaining to air, underwater, remote mountains and of course space. We did not have much time to mourn the fact that the course would be online again this year, since we were so thoroughly spoiled with talks from the finest experts in Aerospace Medicine: space surgery and gynecology with Dr. Richard Jennings, cockpit automation with Dr. Melchor Antuñano, behavioral health issues in aviation with Federal Air Surgeon Dr. Susan Northrup, hyperbaric medical support at the NBL with Dr. Robert Sanders, space radiation with Dr. Jeff Chancellor, and space neurology with Dr. Jonathan Clark just to name a few.

We even received an interactive lesson in orbital mechanics and kinematics from Dr. Rebecca Blue – a real treat for math-deprived medical students. Another course highlight was Astronaut Day, with multiple astronauts talking about their research or operational experience: DNA sequencing in space, Antarctic expeditions, an invention – the space coffee cup - developed ON the ISS. We were also guided through several clinical cases by Dr. Michael Barratt, a resource that is slowly accruing as the number of flown astronauts gradually increases.

Have you ever thought about how differently a drug acts upon the body and vice versa in space? As the lead pharmacist at NASA, Dr. Tina Bayuse certainly has, though it turns out a rather limited number of pharmaceuticals have been studied in space. PASM not only flooded us with knowledge, but enabled us to also identify gaps in fields of research to explore in the future.

So how do you become a flight surgeon? PASM also had an answer for this (hint: it is not 42) – with one panel of UTMB Aerospace Medicine residents and one of FAA and NASA flight surgeons, the speakers were full of great advice. Dr. Ronak Shah, Medical Director of Clinical Services at JSC, shared an especially inspiring insight: “One of the most rewarding aspects of the job is the development of a trusting relationship with an astronaut, and working together to optimize their performance amidst the challenges of a mission.” To me, this seems to be one of the most telling descriptions of both the dedication and the stakes involved with the job of being an astronaut which, in turn, is key for the flight surgeon to keep in mind.

The course was capped off with presentations by the participants themselves, a format that felt like twenty-seven rapid-fire business pitches, except they were fun and fascinating: we heard about everything from space nutrition to police aviation for the control of drug trafficking. A final talk was given by Dr. Karen Ong who focused on the demographics of space medicine and elegantly highlighted to us the factors that keep students from entering or staying in the field.

Whether we joined PASM as a medical student or flight surgeon in training, PASM offered all participants various new perspectives into the world of aerospace medicine and a meaningful connection with a great group of space nerds. I want to thank our wonderful Course Directors Dr. Ed Powers and Dr. Serena Auñón-Chancellor, who not only invited top aerospace medicine people to talk to us but livened the course by sharing their own unique stories and experiences, and Rachel Fowler who enabled it to run so smoothly. I would encourage everyone to apply!
During my first year in medical school, I spent months learning complex structures in anatomy classes, but nothing fascinated me more than the brain. As a future physician with an interest in aerospace medicine, this led me to question - what happens to this critical system in space?

Unsurprisingly, this is a fairly complex issue. Studies using animal models have found that mature neurons in the brain are sensitive to charged particles that are found abundantly in space. Specifically, mice that were subjected to conditions that mimic space were found to have deficits with cortical and hippocampal activities after 6 weeks of exposure. This is potentially concerning as the hippocampus controls functions such as motivation, learning and memory [1].

When examining the neurons of these mice, there was evidence of decreased dendritic spine density and complexity in prefrontal cortical neurons as well as an increase in postsynaptic density protein [1]. Dendritic spines are important for determining synaptic strength and undergo morphological change and increase during learning and memory formation, and pathology similar to what was seen in the mice is associated with neurological diseases such as Alzheimers [2]. These data suggest that the central nervous system is more susceptible than we once thought to space radiation and unfortunately, manned flights could pose long term threats to cognition [3].

Recent research on mouse and rat models has also shown that neurotransmitters and neurotrophic factors can be affected by space travel. One study found that there was a decrease in gene expression for genes leading to both dopamine synthesis and metabolism after 1 month of space flight [4]. Because of the diverse actions of dopamine in the brain, including pleasure and neuroplasticity, this could have a multitude of effects that are still topics of intense research. Furthermore, astronauts commonly report vision problems after returning to earth, called ‘spaceflight-associated neuro-ocular syndrome’ (SANS). This is due to increased pressure on the optic nerve caused by an increase in intracranial pressure: without gravity, fluid migrates away from the extremities and toward the head [5].
The pressure change may be so severe that the retina can hemorrhage and lead to permanent vision deficits. Curiously, this change in pressure does not seem to resolve quickly after returning to earth, and MRIs show increased pressure in the cerebrospinal fluid (CSF) of astronauts even a year later. These findings are important to be aware of as astronauts have to be in impeccable physical and mental health to respond to the many unknowns of space travel and memory and cognitive function are critical aspects to this.

So what can be done about these concerning findings? Unfortunately, there is no clear answer. If there was a way to stop the build-up of CSF, this could eliminate the problem. Scientists are trying to find ways to do this, including developing special suits designed to direct blood toward the legs [5]. More research needs to be done to answer these questions and ensure astronauts are safe to complete missions and return to live long healthy lives on earth.

References
A LOOK AROUND

A collection by Nora Eisner

Nora Eisner studies exoplanets at the University of Oxford using Citizen Science and connects with the public through podcasts and illustration. Her art gives glimpses of worlds real and imagined, and envisions our role and future in their discovery. For more see coffeeinspace.org
Congratulations on being selected to join the largest private space exploration company in the Solar System, now sending teams to three planets and one moon. You are the scientists, engineers, technicians, culturalists, and communitarians that will assure success in a variety of temperatures and gravities. In addition to your mission briefings, one of our culturalists prepared this season summary to assist in understanding of your mission locations. Almost all of you are accustomed to our three-month four-season cycle on Earth, but you may not know that seasons at mission sites are a product of solar proximity, axial tilt, atmospheric density, and day length.

Red Planet Teams at any of our six Mars sites will only experience three seasons: Perihelion, Aphelion, and Harmattan, named after a dusty wind in West Africa. Although day length (24.5 hours) and orbital tilt (25 degrees) on Mars are similar to Earth, the seasons are longer and vary in duration. Perihelion is about one month shorter than Aphelion because Mars’ orbit is less circular, and the planet orbits faster during its closer approach to the sun. Northern sites have short winters, and southern sites have short summers. With a thin atmosphere (1% as dense as at sea level on Earth), this means no atmospheric buffer and vast temperature swings during the Perihelion and Aphelion seasons.
Despite this, southern teams still prefer southern winter over summer because the thin Martian atmosphere is 25% denser during that time, equivalent to a 8,000-foot altitude change on Earth. This happens because the northern Martian icecap absorbs much more dry-ice during northern winter, making the air even thinner in southern summer. This seasonal air density shift causes the third season, Harmattan, when strong winds kick up fine dust and circulate from one pole to the other as the carbon dioxide icecaps wax and wane. Teams love the blue ombre sunsets during Harmattan especially when the sun is largest at the end of northern winter.

Evening Star Teams especially revere sunrises and sunsets as they see them so rarely. Days on Venus are longer than years, coming only once or twice per 225-day Venusian year. Therefore days and nights on Venus are more like seasons on Earth, and the teams have started calling them Diem and Nox. The sun only rises through the thick sulfur dioxide clouds and sulfuric acid rain once every eight months. At the eight stations floating high above the scorching surface, they have made a holiday of the Nox to Diem transition. The whole station gathers every four months to watch the sun rise through the beautiful sienna clouds in the West or set in the East since Venus revolves in the opposite direction of Earth. The difference in light between Diem and Nox is stark, as the sun is nearly twice as bright compared to Earth. However, with such a thick atmosphere and its almost upright axial tilt, Venus has no true seasonal temperature variation. The scorching surface temperature is very stable (at about 482 degrees Celsius) all year. The only change in seasonal wardrobe is sunglasses.

Team reviews on Mercury differ substantially, reflecting the bizarre experience of working at either the polar or equatorial stations. At the polar stations, it is always twilight and its perpetual season, Asgard, can be balmy enough to allow organic molecules and water ice to form, with fairly stable temperatures, especially in craters. Polar teams typically love how Mercury’s near-zero axial tilt grants them a moderate climate, a stark contrast to the two bizarre seasons at the equatorial stations: Niflheim and Muspelheim. Without an atmosphere to buffer the powerful solar radiation, the temperature variations from night to day on Mercury are immense. Niflheim or nighttime is named for the cold dark realm in Norse mythology for good reason, dropping to negative 173 degrees Celsius. Fortunately, the Niflheim and Muspelheim seasons cycle rapidly since they are actually just long days. During Muspelheim or daytime, named for the realm of fire giants and lava, temperatures skyrocket to a stifling 427 degrees Celsius, and the sun gets seven times brighter than on earth.

(continued)
Teams report enjoying Muspelheim’s other eccentricities: double sunrise, double sunset, and Big Sun. Mercury rotates three times during two of its years. With this bizarre 2:3 ratio, you could sometimes see multiple sunrises and sunsets depending on where you are located. For example, the sun could rise above the horizon, start to increase in size, then change its mind, reverse directions and set, before finally rising again. As extreme as Niflheim and Muspelheim can be, teams find this strange solar dance one of the most unique phenomena they can observe at any site.

As you can tell from this quick run-through of the conditions at a few of our 22 extraterrestrial facilities, you are entering an exciting moment in your career. We hope this gives you a broad idea of what you can look forward to encountering during your explorations. Good luck!

Virgin Blue Origin Enterprises
Human and Robot Resources
EVENTS & OPPORTUNITIES

INTERNATIONAL CONFERENCE ON AEROSPACE MEDICINE (ICAM)
PARIS, FRANCE
SEPTEMBER 22-26, 2022

NASA HUMAN RESEARCH PROGRAM INVESTIGATORS’ WORKSHOP (HRP IWS)
VIRTUAL
FEBRUARY 7-10, 2022

ASSOCIATION OF OCCUPATIONAL HEALTH PROFESSIONALS NATIONAL CONFERENCE
AUSTIN, TX
SEPTEMBER 7-10, 2022

APPLY TO ASMA SCHOLARSHIPS!

DEADLINES:
- JANUARY 31 OR MARCH 1, 2022

NEXT PAGE: ASMA 2022 CONFERENCE DETAILS
The annual ASMA meeting is a forum for all aerospace medical disciplines and provides continuing education credits and maintenance of certification for attendees. Lectures, seminars, panels, poster presentations, workshops, films, and technical and scientific exhibits present data on the latest results of research studies.

No other meeting brings together such a diverse, international group of specialists - clinical health directors, physicians, scientists, and nurses from the armed services, civil and military aviation, academia, and industry, plus the many private practitioners in all clinical specialties - who care for the total civilian flying population.

EVENTS TO LOOK FORWARD TO:

> AMSRO meeting
> Speed Mentoring
> Subcommittee meetings
> Informal get-togethers