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IMPACT

Destination Mars

The path from wilderness medicine to deep space

For more than two decades, John "Jay" Lemery, MD, has delivered healthcare in remote and austere places, where providers must make do with limited supplies. But the Professor of Emergency Medicine at the University of Colorado School of Medicine and Section Chief of Wilderness and Environmental Medicine has interests that span beyond earthy medical concerns.

As a young child, Lemery recalls urging his mother to repeatedly read him *National Geographic* stories about the planets.

> **"I WAS COMPLETELY ENAMORED WITH SPACE," LEMERY SAYS.**

As an eighth grader, he developed and submitted a project to be sent to NASA's Space Station on how light sensitivity and gravity would affect earthworms migrating to space. "The idea was that you're going to need earthworms to help grow food in healthy soil," he recalls, but he ended up being too young to qualify for the competition.

Toward the end of an intense four-year emergency medicine residency at Bellevue Hospital in New York, he found out about a space medicine rotation at NASA and traveled to Houston to work with a group there. He wrote a paper addressing treatment of atrial fibrillation on Mars, and in 2007 co-authored a book chapter on space medicine for the journal *Wilderness Medicine*.

FINAL FRONTIER

Lemery recently joined NASA's Human Research Program as a contributing scientist on the initiative's Exploration Medical Capability Element (ExMC). The program is geared to optimizing human healthcare systems for deep space missions — travel to the moon and to Mars.

Work on keeping humans physically and mentally strong in space began with the first space station in 1969 and continued with the International Space Station (ISS), which launched in 1998 and hovers about 230 miles above the earth. Reaching the moon, at 240,000 miles away, and Mars, at an average 140 million miles afar, requires giant leaps, to put it mildly. The distances create a range of new questions for the human body and medical care.

"All the work about health and health risk has been predicated on the space station," Lemery says.

The ISS has a large pharmacy and an ultrasound machine, and protocols call for a sick or injured astronaut to be returned to Earth in 24 hours. Travel to the moon will take a week and a return trip will require a rocket launch from its surface. As for Mars, merely making communication transmissions involves a 15- to 30-minute delay.

These immutable physical challenges in the context of answering practical questions about how to deliver medical care to astronauts and settling on recommendations to colleagues make up Lemery's work. What we learned from the space station experience is only a starting point, he adds.

> "FOR HUMANS TO HAVE A SUSTAINED PRESENCE IN DEEP SPACE, ALL THE MEDICAL RISK ASSUMPTIONS WE'VE MADE HAVE TO BE REWRITTEN AND REIMAGINED," LEMERY SAYS. "THE STAKES GO WAY UP. HOW DO WE OPTIMIZE CARE AND MINIMIZE RISK IN A SCIENTIFIC MANNER?"

SPACE MEDICINE

Lemery characterized the ExMC work as part of a "great leap forward" from thinking about healthcare delivery during low earth orbit missions like the ISS (600 miles or less) – with astronauts connected to Earth with a lengthy umbilical cord learning to conduct "Earth-independent medical operations" in deep space, during which crew members will have far less access to help. "This is the grand pivot," he said. "How do we begin to get our hands around this?" He compares the ExMC element to "a medical think tank" whose aim is to "effectively advocate for remote and austere care" in planning for space flight.

A fundamental question is how to overcome communication gaps imposed by the vast distances of space, such as in a scenario that a Mars mission crew member shows signs of stroke or heart attack. Technologies like artificial intelligence, augmented reality, virtual reality, and just-in-time training could help to fill the void in that situation and many others.

Augmented reality – superimposing computer-generated images over a person's view of their environment – could enable astronauts to conduct a physical exam or look for signs of neurological weakness, while video links sent to a virtual reality headset could help to guide a crew member inserting an IV line. Astronauts will need a library of evidence-based resources to help them respond to routine medical concerns to life-threatening emergencies.

The ExMC team is developing its ideas in tandem with other elements of the Human Research Program, and Lemery is mentoring numerous colleagues to solve these problems.

> **"WE'RE PRACTICING OUR CRAFT," HE SAYS. "WHAT ARE THE ISSUES? HOW DO WE OPTIMIZE HUMAN HEALTH AND PERFORMANCE? IT'S A CHALLENGE, AND THAT'S WHAT MAKES IT COMPELLING AS A SCIENTIST."**

Lemery is also interested in helping to train more physicians who can help advance missions in space. He is senior mentor to the team creating a first-of-its-kind, joint MD-MS degree program between CU School of Medicine and CU Boulder's Department of Aerospace Engineering.

"There is a big need for well-educated, informed healthcare providers at NASA and in private space agencies," Lemery says. "We also realized that one of the grand challenges for a physician working at NASA is liaising with engineers. Often, we speak a different language. We have an opportunity to train clinicians who could be true leaders in their field with a Master's degree in aerospace engineering."

UNIFYING FORCE

The forests of the South Adirondack Mountains where Lemery grew up, the frozen terrain of Greenland, the tight environments of the International Space Station, the stark surfaces of the moon and Mars, and the vast emptiness between them may seem to have little in common with one another. But for Lemery, these remote and austere places offer unique opportunities to consider how to help humans survive.

"That's the unifying thing for my career. I'm an educator and I think about how we thrive in non-traditional areas," he says.

As to goals for the future, Lemery is both practical and aspirational. There is hard work ahead to face an environment under stress and how it will affect life for present and future generations.

"Space medicine a totally different species, but it inspires us again to think about what we can do as humans. I want to advance human potential," he says. "If I can inspire our community and constituents to bring out the best in the human spirit, that, for me, will be a career well spent." ■