

Houston, we have a doctor

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A clear majority of the universe remains unexplored to humans despite thousands of years of evolution and progress. Piece by piece, explorer after explorer, we go deeper, we learn more, and we remain inspired to keep pushing. A Canadian contribution to this realm of exceptional explorers is Dr. Robert Thirsk. Having spent more time in space than any other Canadian, Dr. Thirsk has done far more than the typical engineer or physician.

After growing up in British Columbia, and graduating from both the Massachusetts Institute of Technology (1978) and McGill University medical school (1982), he was accepted into the Canadian Space Agency (CSA) in 1983. He launched into orbit on two occasions as a Crew Medical Officer (CMO), the first time for 17 days in 1996, then for six months in 2009 on a mission to the International Space Station. Thirsk, who at 63 is the Chancellor at the University of Calgary, says he hopes to inspire the next generation of Canadian pioneers to dream big and help represent Canada in humanity's journey to Mars. We spoke to him recently about his incredible career.

Becoming an astronaut

When did you start thinking about being an astronaut?

It started when I was in grade three in Powell River, British Columbia. My teacher turned on the class radio one morning when the base-to-ground communication of the mission of John Glenn [the first American to circle the globe] was broadcasted. Our teacher told us all about space and astronauts. That really caught my attention and I decided, if I ever had the opportunity, I'd sure like to become an astronaut.

Then, many years later, I was finishing up rounds in a small community hospital in New Brunswick when I opened up the newspaper and saw a huge advertisement saying that the CSA was recruiting. I thought I had lots of the qualifications, but so did about 4000 other people. I applied and it was a long screening process but I was very fortunate at the end of 1983 to be selected.

How did your education affect your training?

I was in the first real cohort of astronauts so there was no real proper way of preparing medically for a career as an astronaut. Once you become an astronaut, you become a generalist and you should have the capability to do whatever is asked of you onboard a space ship. For example, when a medical doctor joins the astronaut program, certainly they'll be designated as a CMO, but they're also going to learn how to fly a high-performance jet, operate robotics, and read schematic diagrams. Similarly, a jet pilot is going to have to learn how to diagnose a hip fracture, start an IV, and manage a cardiopulmonary resuscitation session. So, everyone becomes cross-trained. Everyone becomes a generalist.

How is mental health screened for?

The astronaut profession is unlike any other job in the world. It really takes you to your mental, your physical, and your emotional limits. Some medical issues will exclude someone from spaceflight, like a history of schizophrenia or depression. In the selection process there are hours of testing and interviews from psychiatrists and psychologists to make sure that the person considered has got the right stuff. Then, you begin your training and there's a lot of training that's given for some of these soft

skills. In astronaut lingo, we call them "expeditionary behaviors." These are self-care, self-management, leadership, followership, teamwork, and cross-cultural sensitivity. Also, once you're in space, you can contact family and friends by radio every day and by video every week.

What space feels like

What does space feel like?

The feeling in space is a surreal and magical experience unlike anything that we've ever experienced on earth. Imagine what it's like to be superman to fly from point A to point B with no pressure around any part of your body. It takes a few days to adapt to moving around in the weightlessness. You learn how to move efficiently and how to avoid hurting yourself or your crew mates with stray elbows and knees. After a week or so, it becomes very graceful. We're like swans and it's like we were born up there. It's remarkable how quickly the human body can adapt to the new environment.

Physiologically how does it feel?

There's a lot of goofy stuff that happens to your body in a weightless environment. Within seconds of arriving in space you feel this headward redistribution of fluid from the sinuses and major veins of the legs and pelvis. Within an hour of arriving in space, you've got this congested feeling in your head. Looking in the mirror, your face looks rounder than it did on the ground, all the creases around your forehead are gone, and your jugular veins are constantly sticking out because your head is edematous. I didn't feel any headaches but some people do when they go up there.

In fact, data from NASA suggest that 71% of astronauts experience space headache. This has been attributed to alterations in blood and cerebrospinal fluid (CSF) flow in zero gravity environments.¹ A possible complication of these alterations may result from a relatively increased level of CSF diffusion posterior to the orbit causing papilledema and optic nerve sheath dilation.^{2,3} This can result in reduced visual acuity with prolonged exposure to zero gravity. While Dr. Thirsk was the first to experience this phenomenon, it has since occurred in multiple astronauts.¹

Just for fun, we marked our height against a wall because we increase in height by about 4-6 cm in space. Some people feel that as a persistent, dull lumbar pain. Also, in spite of the fact that we work out religiously for two hours every day with aerobic and muscle resistance while in space, we still lose our strength.

What did it feel like when you landed back on earth?

The first couple days were the toughest. Usually my blood pressure is about 120/80 but when I got back it was 80/60. Right away my flight surgeon gave me a liter of saline to try to get my blood pressure up. Also, when you're in space your vestibular apparatus is basically on vacation for six months. When I got back, the slightest motion like walking was very nauseating. My stance was very wide-based and I needed someone right next to me to hold me up. But after six weeks of rehab I felt normal again.

The rule of thumb for bone recovery is that for every month in space you need two months on the ground to recover the bone you've lost. This is monitored with bone density scans and it probably took me one-and-a-half years to get back to my preflight level. My vision didn't come back entirely. You would think that whatever happened in zero gravity would be reversible but a lot of people are still trying to figure out what's going on.

Data from NASA suggest a profound impact of weightlessness

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on bone strength with evidence of 10% of femur bone resorption after six months in flight.⁴ The rate of bone loss experienced by astronauts can be up to 10 times that of patients with osteoporosis here on Earth.⁴ Therefore, the use of typical pharmaceuticals for osteoporosis has been suggested for astronauts to enable a quicker recovery upon return to Earth.⁴

Being a doctor in outer space

What medical complications can happen without the pull of gravity?

I categorize them into groups according to the duration of the flight. On short duration flights of days or weeks, the main problems are motion sickness and cardiovascular deconditioning. On a long flight of approximately six months, the problems we deal with are bone demineralization and muscle atrophy. For very long missions, like a year's length, it's ionizing radiation and psychosocial implications of being in a confined environment.

What did you do as a doctor in space?

Like on any routine flight we took care of upper respiratory infections, gastritis, back pain, and motion sickness. We also continued to train for medical emergencies while in orbit. By funny coincidence on my second flight, the two medical doctors, including me, became hyperopic so we had vision problems. The two of us did visual acuity tests, electron ophthalmoscopy to take images of our retinas, and ultrasounds on our eyeballs and optic nerve sheaths. We had to have those skills to diagnose the problem and we were the first two people to experience it. It is a problem unique to long duration space flight and, since we flew, 12 others have been affected by it and they still don't know what the cause is. But once you're in space, there is not a whole lot they can do so they sent up a new prescription for reading glasses for us on the next shuttle flight.

How do people get sick in space?

One week prior to launch, astronauts go into quarantine in order to minimize the exposure to infectious agents. But quarantine doesn't always work and sometimes someone comes up to space harboring a viral respiratory infection. About halfway through my six-month stay, the shuttle came up and one crew member had a viral infection, and it went rampant throughout everyone immediately. It was remarkable. Studies have shown that lack of gravity impedes early T-cell activation and can lead to alterations in organization of cell cytoskeleton so we're kind of set up to get bad infections up there.

Consistent with Dr. Thirsk's experience, cell-mediated immunity is impaired in space. Specifically, zero gravity alters signaling for cytokine production and lymphocyte proliferation.⁵ However, confounding factors such as sleep disruption, neuroendocrine adaptations and stress associated with space flight cannot be overlooked as additional contributors to immunosuppression in space.⁵

What did you do in your spare time?

Getting together with other crewmates was one of my favorite things. We were an international crew representing five countries so the conversation was very global. It was a really nice time. It felt like you were part of humanity rather than a Canadian or a Vancouverite. My other favorite thing to do was looking down at the beautiful planet. If I knew that we would be flying over Canada, I would stop what I was doing for five minutes and look at the Canadian cities I used to live in. That was special.

Lessons learned in space and thoughts about Mars

What perspectives for you changed?

Number one, we need to be taking care of our planet so that it's a suitable place to live. We should also be doing a better job of fighting poverty which is easily visible from space. Finally, we should be thinking of going elsewhere in our solar system for the survival of humanity

because Earth is a single point failure. We have one accident on Earth and millions of years of evolution is wasted.

What needs to be done before we shoot off to Mars?

When I travel across Canada, everyone is asking about Mars, and I definitely think that's going to be the next major destination in space and Canada needs to be a part of that. But it's going to be a really difficult mission and a lot of the obstacles are not only engineering or financial, they are medical. I would not volunteer for a Mars mission until we address the issue of radiation shielding or therapeutics. The risk would be too high. A mission to Mars, even without a major solar flare, would expose you to the amount of radiation that would accumulate if you were on earth for over 300 years. So if I was in your shoes, I would focus on protection against ionizing radiation and looking at the social implications of long duration confinement. That would be a major role for Canada.

Mars is situated 50,000,000 km from Earth, a distance that NASA estimates would take 30 months to cover on a return mission.^{6,7} As Dr. Thirsk highlights, this much time in unprotected regions of space would expose astronauts to approximately 900 millisieverts of radiation, nearly twenty times the maximum allowable annual work-site exposure.^{8,9} This estimate does not include any exposure to galactic cosmic rays, which may occur in deep space with outstanding radiation levels.⁸

What is your message to the next generation of aspiring Canadian astronauts?

I always want to be out of my comfort zone and pushing a frontier. I've never defined myself as an astronaut. I've defined myself as an explorer and now I'm keeping pretty busy exploring.

Ideal jobs don't fall out the sky into your lap. You have to plan, you have to focus, you have to sacrifice, and you have to get a really good educational background. I want to get that message out to today's generation. Dream audacious dreams, not all dreams come true but the ones that do are truly fulfilling. When I was in university, the Apollo moon program was occurring and I thought my chances of being an astronaut were zero. I want people like you to dream about going to Mars. I want to make sure that Canada is well represented in the future human space missions to Mars in the next 20 years. We need to encourage Canadians to dare the impossible.

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