Outer space assets offer benefits to health care

Family doctors play a key role in supporting innovative work

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Technological requirements of spaceflight drive innovation and economic growth. Outer space assets, such as satellites, have played roles in Canadians' daily and digital lives for decades, but most do not realize it. The Global Positioning System that we use for navigation and the weather forecasts and traffic reports that we check as we plan our activities all involve space technology.[1] Similarly, benefits that space technology can offer health care are not well known.

Health and space

Providing medical care for astronauts involves several challenges, including the need to deliver it remotely from a great distance and limited room for diagnostic tools and other resources onboard compact spacecraft. Over time, space medicine and technology have adapted to better cater to the needs of missions, such as by enhancing the use of remote medicine protocols and developing technology that can easily be transported and used in outer space.

Not only does health care play a crucial role in space missions, but technologies used in space have also been playing a vital role in supporting Earth-based health care. These innovations include telemedicine that provides medical care to rural areas or other locations lacking resources.[1,2-6]

Adapting to challenges of space has led to the innovation of portable and self-scanning medical devices used in health delivery, diagnosis, and management.[2-6]

Such technology, although developed for use in space or by space agencies, can in turn have impacts on health care on Earth.[1,2,4,6] Among such devices are the Canadian Space Agency's Bio-Monitor, which provides continuous health monitoring, and its Bio-Analyzer, which tests blood and other bodily fluids and provides results within minutes. Being portable, such devices can easily be used anywhere, including in remote locations and during relief missions.[2-4,6]

Environmental and public health monitoring

Remote sensing data (provided through satellites) have several applications, including in disaster medicine, where data can be used to evaluate a disaster's impact and plan relief and rescue missions.[2-5] Remote sensing data also are used during disease outbreaks to help in risk mapping, identifying and investigating risk factors, infectious disease forecasting, and planning vaccine delivery.[2-5] Space assets have also been playing a substantial role in monitoring climate change and the environment.[5] Several satellites are able to track effects of climate change and of pollutants such as carbon dioxide, methane, carbon monoxide, nitrous oxide, ozone, and sulfur dioxide.[5]

Experiences of family physician astronauts

In Canada, 4 physicians have become astronauts. Three are family physicians—Drs Dave Williams, Robert Thirsk, and David Saint-Jacques—with 1 (D.W.) further specializing in emergency medicine. The fourth physician—Canada's first female astronaut and the world's first neurologist in space—is Dr Roberta Bondar, for whom 2022 marked the 30th anniversary of her historic space flight.

Being both an astronaut and a physician can be synergistic at several levels, with the physician's ability to work under pressure and fulfil various CanMEDS roles (leader, collaborator, communicator, etc) coming in handy.[7] Our physician-astronaut coauthors (D.W. and D.S.J.) share their experiences here of synergies in their dual careers.

Dr Dave Williams: In 2021 the venturing into space of an 82-year-old former pilot—Wally Funk, one of the women in the Mercury 13 group training as astronauts in the 1960s—and a 90-year-old actor—William Shatner—provided clear indications that the medical selection criteria for spaceflight are evolving.[8] Through the development and use of novel technologies and operational concepts, humans will be able to travel farther, and stay longer, in space. Within this millennium, humans will become a spacefaring species. It is said that lessons for the future are written in the past, and throughout history physicians have accompanied explorers on their journeys.

Astronaut training, and the experience of spaceflight as a whole, not only enhances clinical skills but also provides the unique opportunity to appreciate the diversity of the human experience. Viewing Earth from space, there are no visible borders separating countries, and it is clear that what happens in one part of the world affects our entire planet. Philosopher Marshall McLuhan coined the term the *global village* in reference to the interconnections enabled by media technologies and their impact on society.[9] As we struggle to emerge from the current COVID-19 pandemic, that phrase is more relevant than ever. One of the greatest lessons from the International Space Station program is the importance of global collaboration. Numerous countries worked together to build the International Space Station; similarly, global collaboration was critical to building our understanding of COVID-19 and to developing vaccines and treatments for it.

Astronauts are required to collaborate effectively in teams working in environments where time-critical decisions must be made to ensure operational success and crew safety. Preparing crews to work well together in such demanding environments is based on an understanding of human factors research in aviation and aerospace. Many principles that have emerged from that research are directly applicable to clinical practice; arguably, they could help achieve high levels of safety and quality in health care delivery if human factors in medicine were to become part of future clinical training programs. Space is an environment intolerant of error, and yet we know that "to err is human." Astronauts are trained to work together to control risks, reduce the probability of error, and *trap* errors (contain and fix them) before they have mission consequences. Incorporating the same principles into medical education and providing a simulated training environment where failure is a safe opportunity for learning is yet another example of how space exploration can enhance terrestrial health care.

Dr David Saint-Jacques: When I was recruited to the Canadian Space Agency's astronaut program, I was practising general medicine in isolated Inuit communities in northern Canada. It was perhaps the same spirit of adventure and exploration that had drawn me to the north that attracted me to space. But the parallels don't stop there.

Being a physician was great preparation for becoming an astronaut. It demands the same combination of scientific rigour and practical common sense and the same emphasis on teamwork, critical thinking, judgment, attention to detail, and focus under pressure. Admiring our planet from space reinforced my sense of duty to serve, to contribute to a healthy world—which, in the broadest sense, is the aim of medicine.

At a practical level, there are also striking parallels between the challenges and constraints of rural medical practice and medical care for on-orbit astronauts: isolation, self-reliance, limited equipment, and impractical or impossible medical evacuation. Similar problems often have similar solutions; that's why medical technology developed for space crews is usually relevant to medicine on Earth. And vice versa.

As we contemplate future missions in deep space, back to the moon, and beyond to Mars, the challenge of keeping astronaut crews alive and well will become exponentially greater. Requirements imposed by the unforgiving environment of space will provide fertile ground for innovation in point-of-care medical diagnostic technology, artificial intelligence–enabled decision-support systems, virtual-reality training tools, and customized therapeutics, leading ultimately to more patient-centric care for all.

In an opinion piece for the *Globe and Mail*, another family physician astronaut, Dr Robert Thirsk, echoes the sentiment that astronaut training enhances our abilities to face crises.[10] Dr Thirsk writes that we need training, contingency planning, and simulation-based exercises—all of which astronauts rigorously incorporate into their work—to be better prepared for the next global issue.[10]

Conclusion

Canada has played an important role in space, and family doctors have contributed to it. Rigours of the environment in outer space impose constraints that push the envelope of technology. Just as we continue to both develop our Earth-monitoring satellite infrastructure and venture farther in deep-space exploration missions, space will also continue to be a source of technical and other innovative benefits for health care.

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Competing interests
None declared

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