Cool Ideas: Remote Surgery

Will Robotic Surgery Work in the Canadian North?
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Key issues

• This paper, the second in the Cool Ideas series, starts a conversation on whether remote robotic surgery could reduce costs, expand access, and/or improve surgical services in the North, in the near term or distant future.

• Access to quality, timely surgery in Northern and remote Canada is a long-standing challenge. Surgery performed at a distance via the use of robotics, which is a reality in the South, could help to mitigate this challenge.

• Telehealth services are now being implemented with success in some Northern communities—but remote surgery technologies still face a host of technological, cultural, logistical, and social barriers.

• Remote surgery must align with Northern needs and values and complement, not substitute, trusted human services.

• Poor Internet connectivity means that the use of remote surgery technologies within Canada’s Northern and remote regions is still years, if not decades, away.
Cool Ideas

The Cool Ideas series is designed to spark a nationwide conversation about the technological future of the Canadian North. This series aims to raise awareness about emerging opportunities in a thoughtful and creative manner, while weighing the costs and benefits of new systems against their risks and challenges. Promising new technologies could address long-standing, pivotal objectives that Northerners have identified as priorities; they can also be disruptive and carry unintended consequences. Examples discussed in the Cool Ideas series are typically in the initial stages of development. They may emerge as major forces in the North in the next few years, or they may not be viable for several decades or possibly ever.

Map of regions of Northern Canada

The series hopes to encourage further research on the technologies it addresses and highlights areas where additional investigation would offer the most value. There is much that is unclear, and many considerations and issues need analysis. By profiling new products, services, or devices, Cool Ideas encourages Northerners to explore how technologies are likely to disrupt community life—positively, negatively, or both. In this series, we examine one technology at a time, reflecting on the challenges, opportunities, and potential benefits of recent innovations.
Remote surgery: Emergency care at a distance

The idea of having major surgery performed by a robot controlled by a doctor who is many kilometers away is both exciting and, to some, terrifying. Surgery can be a tense experience. But imagine talking to the surgeon over a speakerphone, perhaps following a video meeting in the pre-operation period. A nurse preps you for the procedure and wheels you into a small operating room. Instead of a doctor, you see an impressive-looking machine, with digital controls, flashing lights, various medical devices, and a couple of odd-looking mechanical arms.

You might think that the prospect of such surgical interventions is decades away. It is not. Experiments with robotic surgery have been going on around the world for more than 10 years.1 Surgeons in Europe and North America demonstrated the functionality of a trans-Atlantic surgical operation conducted over a high-speed fibre-optic network some 18 years ago.2 In 2014, Dr. Mehran Anvari of McMaster University was working out of St. Joseph's Hospital in Hamilton, Ontario, operating on patients 400 kilometres away.3 The United States Army is testing the application of remote surgical procedures by working on trauma pods—portable, remote-controlled surgical suites for remote field surgery on soldiers. As the military contractors describe the exploratory concept:

Telepresence surgery technology, first developed by SRI for the U.S. Army in the 1980s, could one day help military units dramatically increase the chance of survival. Injured soldiers could receive rapid medical intervention on the battlefield, without requiring the physical presence of medical providers. With advances in stereo imaging, telerobotics, video, telecommunications, and haptics (the technology of touch), telepresence simulates the sensory experience of conventional surgery, except that surgeons operate through a console interface. The surgeon sees a three-dimensional image of the surgical field while operating through a buttonhole-size incision. The less-invasive nature of the surgery means the patient experiences less pain and has a shorter recovery time.4

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2 Marescaux and others, “Transatlantic Robot-Assisted Telesurgery.”
3 Eveleth, “The Surgeon Who Operates From 400 Km Away.”
4 SRI International, “Trauma Pod.”
What seemed like a space-age fantasy only a few years ago is now a practical reality, even if it is not uniformly or even widely available. However, although the functionality of the general technology has been demonstrated, there are still many technical elements to work out. For example, the possibility of disruptions counted in milliseconds can be a serious problem for remote surgeries.

The Mayo Clinic is one of the foremost American medical innovators. While presenting the idea of remote surgery with considerable caution, the Clinic notes that robots have been used in surgery for nearly 20 years and offer promising applications.\(^5\)

Robotic systems, such as the NASA-related Aesop,\(^6\) Zeus,\(^7\) and da Vinci,\(^8\) have been used primarily in the United States and Western Europe. Da Vinci machines alone have completed some six million procedures since they came onto the market in 1999. Many of the world’s leading hospitals in urology, cancer, gynecology, and other fields are now using these machines.

The robots combine physical manipulation—think of the work of a highly skilled surgeon—with high precision and accuracy through video connections that provide complex, 3D images of the surgical area. (See “The technology of remote surgery.”) According to the Mayo Clinic, surgeons find they have greater control and accuracy during procedures, with built-in protection against a surgeon’s slip. Practitioners and sales representatives argue that these systems produce fewer surgical complications and promote faster and less painful recoveries.\(^9\)

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5 Mayo Clinic, “Robotic Surgery.”
6 NASA, “Robotic Surgery.”
8 Intuitive Surgical, “About da Vinci Systems.”
9 Intuitive Surgical, “Intuitive for Patients.”
Research pushes forward to enhance and improve the technologies. Key areas of focus include:

- visualization, so the surgeons can see what they are working on;
- latency times—the speed and reliability of transmissions between sites—with the goal of 100 milliseconds of response time;
- improving “haptic” or tactile feedback, so surgeons can “feel” what they are working on;
- expanding the frontiers of remote telesurgery to incorporate neurosurgery and other fields.¹⁰

The technology of remote surgery

The technologies surrounding remote surgery are relatively simple. That said, a variety of technological approaches to surgery exist, with many machines either commercially available or in development. The goal of the new machines is to provide better and quicker access to care, more efficiency, greater precision in surgery, and safer medical interventions. There are robots capable of surgery, computer-driven devices that support surgical techniques, and surgical robotic assistants. They all share one characteristic: a machine or digitally controlled device interposed between the surgeon and the patient.

However, human beings are involved with these remote surgeries. Surgeons are fully engaged with the procedures and use video game-like consoles, monitors, and controllers, as well as various digital or robotic devices, to manipulate the cutting materials. Often, the surgeon is in the same room as the patient, only a few feet away in case direct engagement is required. Nurses are also there, monitoring vital signs, preparing for the operation, cleaning when required, and providing highly skilled services to the patient.

However, from a technology standpoint, the moment the surgeon is no longer handling the surgical tools directly, distance becomes irrelevant. If surgeons can be five metres away from a patient, operating through digitally controlled implements, they could just as easily be 50 metres, 50 kilometres, or even 500 kilometres away.

¹⁰ Choi, Oskouian, and Tubbs, “Telesurgery: Past, Present, and Future.”
Military research leads the field

Military devices, designed for rapid emergency response in difficult environments, could have practical civilian applications. For example, while large-scale machines get most of the attention in robotic surgery, armed forces research is pressing forward with miniature surgical robots designed for use on the battlefield. These small robots, created for diagnostic advice and preliminary medical interventions, would allow a remotely located trauma specialist to provide potentially life-saving interventions. As one futurist described the possibilities:

As the bleeding soldier screams, the medic arrives on his mag-lev hoverboard, unstraps a surgical robot from his back and flips the switch. The medic trains the robot’s camera on an injury. Using its built-in sat phone, the robot calls a medical hub on the other side of the planet. A doctor watching the feed instructs the robot how to operate on the soldier, using minimally invasive technologies....

While the advantages of remote surgery are numerous, not all surgeries have gone smoothly. A retrospective analysis of Food and Drug Administration (FDA) data found that robotic surgeries were linked to over 140 deaths and hundreds of injuries over a 14-year period. While the overall incidence of negative outcomes is small compared with the large and growing number of robotic surgeries, patients do not respond well to reports of communication interruptions or broken medical instruments. People expect precision and accuracy from machines—if not perfection—and hold technology to a high standard. (See “The future of medicine?”)
Why should we consider remote surgery within Northern and remote contexts?

Northern health care and services are improving and are expected to continue to improve in the years ahead. That said, many residents in the North live in a context where the provision of medical care is uniquely challenging. Key services—including surgical procedures—may be unavailable at the local or regional level or may fall short of desired standards. It is worth considering, therefore, whether remote surgery technologies can address some of the challenges associated with the Northern and remote context.
Progress and promise: Improving health and wellness in Nunavut

While Canada’s northern and remote regions present some of the most challenging conditions for the delivery of medical services and health care, many jurisdictions have made significant progress. For example, at Iqaluit’s Qikiqtani General Hospital, recent changes—such as relocating clinical services and public health alongside the emergency room (ER)—have resulted in an ability to handle higher volumes of patients. These changes have also resulted in shorter ER wait times. From the perspective of access to physicians and surgery, Nunavut’s medical evacuation system has reduced mortality and morbidity rates in the territory since its inception.

At the hamlet and community level, nurses, paramedics, volunteers, and on-call physicians work together to address the health needs of Nunavummiut through a system of local health stations. To help overcome the lack of specialists and physicians in communities, nurses play a broader role than is typical in the south. At the same time, the search continues for ways to improve and enhance the system and its ability to effectively address the needs of Nunavummiut across the territory.

14 Pemik, “Bringing Iqaluit’s Health Services Under One Roof.”
15 McDonnell and others, “Non-clinical Determinants of Medevacs in Nunavut”; Health Quality Ontario, Health in the North.
Reliance on medevacs

If it were possible to introduce remote surgery technologies in the North, the current need to travel to faraway destinations to receive surgical care might be reduced. Individuals living in remote, isolated locations and in the high North are, by definition, far from major medical centres. As a result, life-threatening emergencies or the need for specialized treatment often requires medical evacuation to a distant urban centre. For instance, the vast majority of Nunavut’s communities must send residents who need acute care or surgery to either Iqaluit, Cambridge Bay, or Rankin Inlet. The most serious cases must go as far south as Yellowknife, Edmonton, Winnipeg, and Ottawa. (See Exhibit 1.) Indeed, “Nunavut is the only region in Canada to have such a heavy reliance on hospitals located outside its own territory.” That said, access to physicians and specialized surgical treatment can present significant challenges in the northern regions of other provinces as well, such as Ontario, British Columbia, and elsewhere.

Exhibit 1
Medical emergencies in Nunavut can result in evacuation to distant hospitals.


16 Oosterveer and Young, “Primary Health Care Accessibility Challenges.”
17 McDonnell and others, “Non-clinical Determinants of Medevacs in Nunavut.”
18 Health Quality Ontario, Health in the North.
19 Huot and others, “Identifying Barriers to Healthcare Delivery and Access in the Circumpolar North.”
Limiting dislocation
The presence of remote surgery technologies and devices in northern and remote regions could reduce the need to relocate patients and alleviate dislocation from family and community. When residents of northern and remote Canada are forced to travel elsewhere for care, they face both cultural and physical dislocation from community and family. Southern hospitals and health practitioners may be poorly suited to address the cultural and linguistic needs of Northerners. This can contribute anxiety to already stressful situations and increase emotional discomfort. Indeed, simply being away from one’s children and the responsibilities of parenting for a prolonged period of time can have a significant emotional impact.20 On the other hand, the dehumanizing process of foreign devices operated by distant surgeons could lead to new forms of cultural strain.

A snapshot of key health care challenges in Northern and remote Canada
Some of the main challenges to health care in the far North that have been identified by scholars, medical practitioners, and northern residents include the following:21

• Physical geography: This includes the distance and isolation of many northern and remote communities from urban centres. This also includes the weather, seasonal conditions, and limited transportation options, all of which influence access to health care.

• Health care staffing: This includes staff shortages linked to recruitment and retention issues and barriers to accessing training and skills development.

• Cultural differences: Differences in language and cultural backgrounds between health care providers from other areas and patients, along with discrimination and racism, can impede the development of trusting relationships and effective diagnosis, treatment, and care.

• Systemic factors: This includes such things as inadequate funding, poor lines of communication between management and staff, jurisdictional issues, and fragmented management and delivery of health services.

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20 Ibid.

Lowering costs
Remote surgery technologies have the potential to reduce the costs associated with medical evacuations. A single medical evacuation in Nunavut, for instance, could cost as much as $22,000, with almost all the costs borne by the territorial government. Over the course of a year, this travel runs into the tens of millions of dollars, adding to the North’s fiscal challenges. In 2016–17 alone, Nunavut spent $60 million on medical travel, which included emergency relocations, scheduled evacuations (crucial but not time-sensitive relocations), and the movement of medical personnel throughout the territory. And the number of medevacs in Nunavut is increasing, with the territorial government currently registering about an 8 per cent annual growth for the service. However, it should be noted that medical evacuations make up a major portion of the revenue for northern airlines and charter firms. Without regular patient use of these services, the commercial viability of some airlines could be at risk.

Reducing avoidable death
An investigation into whether remote surgery technologies and devices in Northern and remote communities could help reduce the number of avoidable deaths seems warranted. Serious injuries and medical issues are commonplace: an arm caught in mining machinery, a gunshot wound, a serious heart attack or a stroke, a ruptured spleen, or a car or snowmobile accident. These present significant challenges even when they occur in the vicinity of a major urban hospital. In remote locations like Gjoa Haven, Old Crow, or Fort Good Hope, they can be especially daunting. A remarkable group of community health nurses and other medical assistants provide patients with excellent on-site care. But the challenges outlined above limit what they can do. If a plane is not in or near the community, the resulting delays could prove fatal to an injured person. Though far from perfect, an indicator that can shed light on the challenges surrounding the lack of access to physicians and acute care specialists is “avoidable deaths.” Between 2014 and 2016, avoidable deaths in the Northwest Territories were almost 70 per cent more than the national average. Stark comparisons can be found when looking at the north of the provinces as well. For instance, comparing the Local Health Integration Networks (LHINs) in northwestern and northeastern Ontario with the province as a whole over 2010–12, the ratio of potential years of life lost per 100,000 people is much higher in Northern Ontario. (See Exhibit 2.)

22 McDonnell and others, “Non-clinical Determinants of Medevacs in Nunavut”; Nunavut Department of Health, Medical Travel – Medevac.
23 Nunatsiaq News, “Nunavut Health Department Spends $74M on Medical Travel.”
24 Rogers, “Medevacs Growing in Nunavut, Pushing Up Medical Travel Costs.”
25 Medical and duty travel in Nunavut makes up one-third of the territory’s air travel market. (Frizzell, “Nunavut Government Mulls New Approach to $60M Air Travel Budget.”)
26 While the period in question dates back almost a decade, it nevertheless reflects a problem that persists in Northern Ontario and other remote regions of the country.
Exhibit 2

Avoidable deaths are more common in Northern Ontario than in the South
(potential years of life lost due to avoidable deaths per 100,000 population, by LHIN region, 2010–12)

<table>
<thead>
<tr>
<th>Region</th>
<th>Avoidable Deaths</th>
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<tr>
<td>Ontario</td>
<td>3,243</td>
</tr>
<tr>
<td>Northeast</td>
<td>4,763*</td>
</tr>
<tr>
<td>Northwest</td>
<td>6,023*</td>
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*significantly different from the Ontario value
Source: Statistics Canada, Canadian Vital Statistics, Death Database and Demography Division. Results are age-standardized.

Building on success
Remote health delivery systems and technologies have been piloted and tested in Canada’s northern and remote regions to address some of the challenges highlighted above. While robot-conducted or robot-assisted surgery remains an area for future exploration, Northern health care has already made important strides in adapting to new technologies, including telehealth-based devices. (See “Telehealth and medical innovation in Nunatsiavut and northern Saskatchewan.”)
Telehealth and medical innovation in Nunatsiavut and northern Saskatchewan

Although surgical procedures have yet to take place, telehealth is already used in several locations across Canada’s North.

In Nain, Labrador, Rosie the Robot has supported timely access to medical care and alleviated the need for local and regional patients to travel long distances, significantly reducing the cost of health care provision within the community. Rosie is an FDA-approved, remote presence robot that can be controlled at a distance by a medical specialist via laptop. Rosie—thanks to two embedded cameras—moves independently throughout the medical station in Nain and enables medical practitioners located hundreds of kilometres away to provide real-time point of care to a patient. Since 2010, Rosie has been used to perform a range of tasks, from basic patient consultations and diagnostics to double-checking prescriptions and reading ultrasounds.27 Research on Rosie’s impact, receptiveness, and effectiveness found that, in general, Rosie was well received and deemed to be improving the health care experience for patients, nurses, and physicians alike, while medical evacuations were reduced by 60 per cent.28

Saskatchewan is home to several other remote health initiatives. Between 2016 and 2017, throughout the province as a whole, there was a 49 per cent growth in clinical service for patients via eHealth technology while patients and their family members avoided having to travel roughly six million kilometres.29 As of October 2017, 50 First Nations communities within the province had telehealth equipment available to them.30

In northern Saskatchewan, another “Rosie” is playing a similar role for Pelican Narrows First Nation:31


27 Stack, “A Change for the Better.”
29 Exner-Pirot, Telehealth in Northern and Indigenous Communities.
30 Ibid.
31 Allen, “5 Ways Robots Are Delivering Health Care in Saskatchewan.”
Another example is “Doc-in-a-Box”, a portable, hand-held, audiovisual device that can be used by medical practitioners to address the basic health needs of patients in remote locations. In La Loche, the Doc-in-a-Box was employed to support the recovery of a severely injured teenage girl. According to the girl’s grandmother, “she needed to have frequent medical follow-up and physiotherapy and, without the Doc-in-a-Box she wouldn’t have had those treatments” because she could not “travel as frequently as necessary to see the physicians and physiotherapists in Saskatoon.”

32 Government of Saskatchewan, “Increased Access to Health Services in La Loche.”

There have been laudable and impressive improvements in northern and remote health care. However, acute care and specialized surgical treatment remain long-standing problems that require technically viable, medically sound, culturally relevant, and financially realistic solutions. And this is true not just for the territories, but for the remote northern reaches of the provinces as well. It is therefore worth investigating whether remote surgery could present even a partial solution.
But ... will remote surgery work in Canada’s North?

Put simply, the viability of long-distance telesurgery in Canada’s North is unknown. The systems can and do work. Experiments have been successful. Field tests have produced impressive results. But even specialists in the field are uncertain about the future.\textsuperscript{33} Despite impressive investments in robotic surgery, efforts tend to focus on ultra-precise and fine-motor surgical procedures. Connecting remote locations to surgeons has been a lower priority than creating better tools for surgeons working in high-end urban hospitals. Ultimately, the question is not “if” the system can work in northern and remote contexts, for it can.\textsuperscript{34} Instead, the key questions and fundamental challenges are whether surgeries can be done reliably, safely, and effectively in medical, cultural, and financial terms.

Backup is needed

Moving beyond proof of concept has been difficult. There are more than technical challenges for managing telesurgical interventions at a distance. As one specialist, Dr. Richard Satava of the University of Washington, noted:

\begin{quote}
You get a speciality surgeon that can do robotic surgery and they could theoretically do it through a smaller hospital in a smaller city, but there still has to be a surgeon right there in case something goes wrong with the robot, so the local surgeon can take over and finish the operation.\textsuperscript{35}
\end{quote}

\begin{footnotes}
\item[34] Takács and others, “Origins of Surgical Robotics.”
\item[35] Densford, “Does Robotic Telesurgery Have a Future?”
\end{footnotes}
Given that most Northern communities have a medical station rather than a hospital and rarely have an on-site physician—let alone a surgeon—to provide backup, the prospect of even medium-term implementations of robotic surgery is extremely unlikely. The end stations would require the equipment—expensive and requiring high-end technical support—as well as staff who are specifically trained to assist with robotic surgeries and capable of stepping in to take over the procedure if required.

**Connectivity is pivotal**

The effectiveness and safety of remote surgery is contingent on the availability of quality, reliable, high-speed Internet. A critical obstacle in most remote locations is poor digital connectivity and bandwidth or, in some instances, the absence of connectivity altogether. Some major technical barriers to telesurgery may be addressed by 5G Internet service that improves the speed and reliability of the digital connections. The first remote operation using remote surgical techniques over 5G networks was performed on an animal in Fujian, China, in spring 2018. High-quality network service was instrumental in this experiment. But 5G is not coming to the North in the near future and will likely depend on expensive satellite platforms.

Living in Northern Canada should not automatically mean technological isolation. The Government of Canada has recognized the problem and made yet another major budgetary pledge in March 2019 to implement rural/remote broadband—albeit at a limited level that will not fully bridge the existing gaps—with a target completion of 2030. Svalbard, a Norwegian island hundreds of kilometres from the mainland, is one of the most digitally enabled places on the planet. Similarly, through Greenland Connect, with connections to Iceland and Newfoundland, Greenland has had access to high-speed Internet in Nuuk for a decade. In Canada, Nuvitik is promoting the installation of a fibre-optic cabling system to connect Nunavik, Nunavut, and the Northwest Territories. Such infrastructure is only the first of many requirements for full connectivity but, without it, the prospects for northern Canadian participation in technological advancement are thin.

**A partial solution?**

While the wholesale application of remote surgery technology is not immediately viable, can it offer a partial solution to the North's challenges? In the short term, the answer is probably not. Looking forward five to 10 years, the plausibility is somewhat greater. But the potential seems more likely for targeted practical interventions (such as adapting military field-based innovations) rather than expensive large-scale hospital implementations. At the same time, without careful planning, costly northern investigations may produce limited returns in terms of patient care and emergency intervention.

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36 Zhang, Liu, and Zhao, “Towards 5G Enabled Tactile Robotic Telesurgery.”
38 Chhabra, “Satellite Internet Might Be Necessary for 5G in Rural Communities.”
39 Shekar, “Budget 2019 Invests $1.7 Billion for High-Speed Internet Access by 2030.”
40 Nuvitik Communications, “The Arctic Network.”
Different perspectives on remote surgery

Patients’ trust must be earned
It is unclear if Northerners would be receptive to the introduction of robotic surgery. Trust is key to patient receptiveness and acceptance of telehealth. Any effort to bring telemedical technologies into the North must be based on extensive consultation, investigation, and evaluation with northern residents. And Northerners must drive these discussions. For example, an exploratory study under way in northern Saskatchewan is examining the receptiveness to emergency use of remote presence and telehealth for its life-saving potential.41 In Quebec, there was a study that examined factors influencing mental health providers’ intention to use telepsychotherapy in First Nations communities. This study demonstrated that perceived usefulness of the treatment systems, influenced further by ease of technology use, had a positive impact on attitudes toward telemental health.42 Local staff will require training as the future advocates and translators who will be essential for building relationships among patients, families, and remote providers.43

Communities are wary of trade-offs
Communities may worry that the introduction of robotic medical care will be a substitute for human services, and that robots will be traded off against nurses and full-time medical attendance. Northern and remote communities and their governments continually wrestle with concerns about the cost, availability, and quality of medical care. Most communities do not have a physician, let alone a surgeon, based permanently in their settlements; they rely instead on a health care model based on community health nurses (with telephone access to advising physicians), whose achievements in primary care are often underappreciated on a national scale.44 Robotic surgery, if and when it is available, will have to show a significant benefit to the local population and not be a substitute for familiar medical services and quality personal care.

42 Monthuy-Blanc and others, “Factors Influencing Mental Health Providers’ Intention to Use Telepsychotherapy in First Nations Communities.”
43 Lavoie and others, “Supporting the Development of Telehealth for British Columbia First Nations.”
44 Society of Rural Physicians of Canada, “Northwest.”
Doctors are cautious

Robotic surgery cannot be forced on northern medical personnel; it would need to be implemented with their input and concurrence. Doctors, like other professionals, may be understandably suspicious of new innovations that threaten their work and income. But they can also be open to technologies and techniques that provide safe and effective services and improve patient care. Research from the United Kingdom found that adoption and acceptance of telehealth by staff required “reliable and flexible technology and dedicated resources for telehealth work” that were “essential in helping to overcome early barriers to acceptance, along with appropriate staff training and a partnership approach to implementation.”

Administrators are well informed

There is reason to expect that northern hospitals and medical professionals will be open to trying remote surgical systems, if and when they are available and deemed to be safe, medically effective, and acceptable to patients. Medical administrators are generally well informed about developments in the medical field and interact with government officials who are usually responsible for funding new initiatives. Money for medical care is tight in the North, and the demands and imperatives of the current system remain in place even as experiments are launched. If the initial investments and investigations prove successful and northern technology can support a large-scale rollout, the Government of Canada and northern administrations will be more likely to embrace the new system.

45 Taylor and others, “Examining the Use of Telehealth in Community Nursing.”
Recommendations and next steps

While remote surgery is not a short-term option, it is vital that Northerners consider future possibilities for technological innovations in the medical space. The following recommendations are offered:

1. **Raise awareness about technological innovation**
   In anticipation of emerging technological innovations within the medical field, such as remote surgery, it is vital that northern governments (and, where appropriate, the federal government) and the medical establishment inform Northerners about robotics and remote surgery. Given the imperatives of the technological age, with rapid and sustained changes occurring and more forecast to come in the next few decades, Northerners need technological awareness and preparedness. This can start with common technologies, adapted for classroom use. Much of this is already under way across the North. This effort needs to be sustained, systematic, and purposeful.

2. **Ask Northerners what they want**
   Northern governments and health care systems should not wait until a practical technological application is at hand before testing the public’s interest in remote surgery and related solutions. They should be engaging with Northerners and asking what they want, now. Notably, some of this type of work has already occurred or is under way in the territories and provinces. Northern governments could collaborate on a series of surveys and focus groups to determine whether there is public support for remote surgery (and related distance medical technologies) and to identify specific concerns and questions that northern residents have about remote medical services.

3. **Address the North’s connectivity challenges**
   Reliable, high-quality, high-speed Internet is essential for innovations like remote surgery. Governments should keep abreast of all emerging proposals for mass satellite implementations and other options for improving connectivity across northern and remote Canada. Game-changing broadband implementations could alter the northern context overnight. In April 2019, Amazon announced Project Kuiper, a plan to deploy over 3,200 satellites that would reach the majority of the world’s citizens although, perhaps, not in the Far North.\(^46\) This initiative came on top of SpaceX’s plan to set up some 12,000 satellites in a mass global service.\(^47\) OneWeb jumped into the field, launching 5G satellites in February 2019, although not with northern coverage.\(^48\) Eventually, one of these systems or a proposed fibre-optic system for the Arctic could well deliver high-speed Internet to the Canadian North.

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\(^46\) Holt, “Amazon Plans to Launch Thousands of Internet Satellites.”
\(^47\) PBS NewsHour, “SpaceX Plans Launch of 12,000 Satellites Into Earth’s Orbit.”
\(^48\) Wattles, “OneWeb Launches First Batch of Internet Satellites.”
Build on existing research and expertise

The North’s beautiful landscapes, peoples, and cultures are as far removed from the battlefield as is conceivable. Yet cutting-edge military research on miniature remote surgery technology is resulting in advances that cannot be found elsewhere. Given the prominence of battlefield innovations in the military, northern medical services may consider working with the Canadian Armed Forces to experiment with remote surgical tools. Also, the Canadian Space Agency is already investing in transferring space robotics technology to surgical applications for remote health care environments. This might lead to a faster and less expensive approach to the development, testing, and implementation of remote surgical techniques. Lessons learned from the use of telehealth for diagnostic and consultation purposes in places like northern Saskatchewan and Nunatsiavut (and elsewhere) should also feed into research and investigations on the merits and risks associated with the adoption of remote surgery technology in the North.

Build the right partnerships

Should the people of Northern Canada demonstrate an interest in exploring how innovative technologies might address long-standing medical challenges facing the region, Northern Canada has an opportunity to be a leader in innovation and experimentation. Northern governments and stakeholders—in addition to potentially partnering with, and learning from, the military—need additional collaboration with universities, private companies, and southern hospitals. A consortium of post-secondary institutions, hospitals, regional health care systems, and medical schools from across the territorial and provincial norths could establish themselves as testing sites for medical innovation, including the potential adaptation of remote surgery systems.

Remote surgery could be an important part of the future of medical care in the Far North. It is a “cool idea” that warrants further investigation and serious consideration by the medical professions, Northern communities, and governments.
Deep analysis is required that addresses the pros and cons of remote surgery through questions such as:

• Will remote surgery save lives and help to reduce the number of “avoidable deaths” in Canada's Northern and remote regions?
• Will it help to alleviate the cultural and emotional stress that can arise as a result of medical evacuations to distant hospitals?
• Will it introduce new forms of cultural duress and emotional stress?
• Will it lead to genuine savings over the medevac approach, or will the costs of remote surgery prove similarly (or even comparatively) high?
• What is the current morbidity and mortality associated with surgical intervention for Northerners?
Appendix A

Methodology

The Cool Ideas papers are opinion pieces written to encourage discussion. The information presented in this paper draws on the extensive experience of the authors, three academics working in the field of northern and international innovation. Their knowledge of the field was supported by a review of secondary sources in academic literature as well as grey literature published on the Internet. No primary research was conducted for this paper.
Appendix B

Bibliography


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