THE FUTURE IS NOW

From rehab clinics to operating rooms, robots are revolutionizing care in Canadian hospitals

TAYLOR BLEWETT

Mobility researcher Edward Lemaire watched as a patient, long bound to his wheelchair, stood up and looked around the room. He marvelled at his own height. And then he started to walk.

A robotic exoskeleton called ARKE was attached to the patient's lower body, strapped around his waist, legs and feet. Its carbon fibre walking frame was powered by a lithium battery pack and actuators at the hips and knees.

Controlled by a tablet, ARKE held the patient upright and bent with his human leg joints. It prevented his limbs from collapsing and helped him take his first robotically assisted steps.

Developed by Toronto-based company Bionik Laboratories and studied by The Ottawa Hospital Research Institute, ARKE is a wearable robot with life-altering potential for paraplegics and other users with impaired mobility.

"His wife was able to walk up and hug him, standing, for the first time," recalled Lemaire, a researcher at the Institute. "We're at really the initial stages and it's kind of exciting to think where things can go. It all comes down to these devices getting smarter."

In 2017, Bionik announced it had integrated Amazon's "Echo" technology and "Alexa" voice service into ARKE, allowing users to tell their exoskeleton it's time to stand up, or walk — and have the robot execute the task.

ARKE is currently in clinical development but the goal, Bionik explained on its website, is to have the exoskeleton available in rehabilitation centres and users' homes.

Walk through the halls of Canada's leading hospitals, and ARKE is just one of a growing cast of robots found working alongside doctors, nurses, researchers and therapists, increasingly integrated into the continuum of care on offer. These machines typically come with a hefty price tag, but they're helping health practitioners overcome human

limitations — from fatigue that can plague a surgeon's hand, to physical distance between doctors in hospitals and patients in remote communities.

At Humber River Hospital in Toronto, visitors are greeted in the main entrance hall by Pepper, a four-foot-tall humanoid robot who can help them navigate the hospital and find their loved ones. At health care centres in Ontario and Quebec, the CyberKnife robotic system delivers hyper-precise radiation therapy to patients battling cancer.

Back in the nation's capital, The Ottawa Hospital's robotic surgical program just completed its 2,000th robotic case.

Since acquiring the da Vinci Surgical System in 2011, the machine has run "virtually every day" said Dr. Chris Morash, the hospital's head of Urologic Oncology.

> "We're at really the initial stages and it's kind of exciting to think where things can go. It all comes down to these devices getting smarter."

The surgeon likened operating with da Vinci to playing an organ. He commands the robot from a seated console about 10 feet away from the operating table, looking through a 3D viewer that illuminates and magnifies the inside of his patient's pelvic area.

Using his hands and feet, Dr. Morash remotely manoeuvres da Vinci's steady, robotic arms around a prostate gland slated for removal.

"These instruments have little wrists on them, so as we move our hand in any movement that's possible, the little wrist on the robotic instrument moves exactly the same way. It's just like having these two … miniature hands down in the pelvis, doing the surgery."

Compared to traditional open prostate surgery, the surgeon-controlled robot performs a minimally invasive prostatectomy with less pain, faster recovery time, fewer opioid prescriptions,

The price of privacy: Insurance companies want your fitness data, and discarding your Fitbit could cost you, expert predicts

A wearable device or personal electronic that tracks your daily fitness habits — from steps taken to quality of sleep — may well prompt a spike in health-conscious behaviour immediately after its purchase. Also common, however, is neglecting these habits as the novelty of your Fitbit or Apple Watch wears off, or you come down with the flu, or you just get busy.

Now imagine your life insurer could see this decline happening in real time. You, along with countless others, have signed up for a plan that collects your fitness data and rewards your progress with discounts on insurance premiums.

Alternatively, you could opt not to share your data with the insurer, or get rid of your Fitbit altogether. But given the ubiquity of these devices, and the utility of fitness data to insurance companies, one Canadian privacy expert believes doing so could have seriously negative consequences.

and lower rates of infection for the patient, according to Dr. Morash.

Beyond prostate cancer operations, The Ottawa Hospital also uses the da Vinci for gynaecological and head and neck surgeries, performing hysterectomies and base-of-tongue tumour removals.

"Prior to the robot … you'd have to do things such as split the person's jaw to get access," Dr. Morash said. "With the robot, they don't have to do that."

There are upwards of two dozen da Vinci robots operating across the country, according to Dr. Christopher Schlachta, medical director of the CSTAR research and training centre for minimally invasive surgery in London, Ont.

Since arriving in Canada in 2003, Intuitive Surgical's da Vinci system has cornered the market for multifunctional robotic surgery platforms, and access to the robot varies across the country.

Bringing da Vinci to a Canadian hospital requires major capital — millions of dollars to acquire the robot, hundreds of thousands for its service contract, and an additional $2,000 to $2,500 per case to perform robotic surgery, according to Dr. Schlachta.

Philanthropic donations have enabled the purchase of most da Vincis in Canada, and the debate over public funding for robotic surgery is ongoing. However, Dr. Schlachta believes its accessibility has reached a tipping point.

Some of Intuitive Surgical's patent licenses have expired, and much of the technology it's been using for da Vinci is now available to other companies.

"We're on the cusp of seeing a bunch of new, competing technologies come to market," Dr. Schlachta said, predicting that at least five other vendors will debut their own multifunctional surgical robots in Canada in the next five years — and in so doing, drive a drop in their price tag.

Dr. Morash agrees. "I would predict that once we start getting some reasonable cost reduction, every hospital is going to be operating with robots."

But urban centres and operating rooms aren't the only places in Canada benefiting from the rise of medical robotics. In fact, University of Saskatchewan head of surgery Dr. Ivar Mendez is using robotic technology to bring hospital care to patients in some of the province's most remote communities.

"I think there will be enormous pressure on individuals to use this information," said Ann Cavoukian, a three-term Ontario privacy commissioner who's currently leading the Privacy by Design Centre of Excellence at Ryerson University.

"If you don't provide it, you'll be viewed as a negative, you'll have to pay higher premiums, I'm guessing."

The insurance industry isn't there yet, but a recent announcement by U.S. life insurer John Hancock has Cavoukian concerned about a shift towards interactive, fitness-tracking insurance plans, and how policyholders' intimate health data is being commoditized.

John Hancock announced in September that it would be expanding across all of its life insurance policies an optional "behaviour change platform" called Vitality that tracks customers' fitness data through their personal electronic devices and rewards healthy choices.

Customers can log their fitness and health activities through an app, website or wearable fitness device, and based on their progress, qualify for discounts at major retailers or on their annual insurance premiums.

"The remarkable results of our Vitality offering convinced us this is the only path forward for the industry," said Brooks Tingle, president and CEO of John Hancock Insurance. "We have smart phones, smart cars and smart homes. It's time for smart life insurance that meets the changing needs of consumers."

The company cited a number of impressive statistics — Vitality is available around the world, including in Canada, and its policyholders have been found to live 13 to 21 years longer than the rest of the insured population, and generate 30 per cent lower hospitalization costs.

"I see the benefits of this," Cavoukian said, "as long as it's not used in some way that can backfire on the individuals."

Many people backslide on their healthy living habits, she pointed out. "Maybe you're ill, or maybe you've broken up with your spouse, or maybe you're having a hard time at work — there's a hundred million reasons for it, and it's nobody's business, and I don't want you to have to share that with the insurance companies."

While Reuters reported that John Hancock has promised its coverage won't be contingent on customers logging their activities, Cavoukian fears this type of program won't remain voluntary forever. Given the prevalence of fitness tracking technology, she predicted sharing the data it collects is something insurers will eventually require, or penalize policyholders for withholding — and that's a problem.

"Privacy — it's not about secrecy, it's about control. Personal control on the part of the individual to decide who he wants to share his information with, and how it's used."

— Taylor Blewett

The success of AI decision-making could pose major challenges for medical robots and the doctors who rely on them

Helpful as they're proving to be in hospitals across the country, medical robots and the artificial intelligence (AI) with which they're increasingly equipped also come with serious implications for the future of health care.

While AIs may be able to diagnose cancer with remarkable success, or perform sutures with more precision than a veteran surgeon, at least one expert is making the argument for drawing a line between human and robot.

"What we're starting to see is that in some limited contexts, the machines and the AIs are outperforming human beings," said Ian Kerr, Canada Research Chair in Ethics, Law and Technology at the University of Ottawa.

"What's interesting about that is our current medical malpractice law will then put pressure on hospitals to use the machines instead of the doctors."

Kerr published a recent article dedicated to exploring this outcome in the field of medical diagnostics. He and his colleagues found that once AIs demonstrate more success in diagnosing medical conditions than their human counterparts, there will be a legal and ethical impetus to hand over the responsibility from doctor to machine. And that could have serious consequences.

"They can be more precise, they can be more accurate, but they also can make mistakes in the way they sense the world around them," Kerr said, of medical robots.

When a machine makes a serious mistake, who do you hold responsible?

Take Watson, for example. IBM's much-lauded supercomputer was designed to diagnose and suggest cancer treatment options. Stat, a medical news outlet, reported that Watson frequently dispensed unsafe recommendations, like a drug that could increase blood loss for a cancer patient struggling with severe bleeding.

Delegating care to medical robots could also mean a loss of hard medical skills in individual surgeons, Kerr pointed out. And perhaps more dire, the obfuscation of medical knowledge from doctors.

When AI robots make medical decisions, they do so based on patterns in data, rather than scientific theory.

"They're not doing science, they're doing something else," Kerr said. "But they're successful, sometimes."

Where AI is less successful is in explaining its decisions — "So you have a machine that predicts really well, but we don't know why."

Kerr believes, despite additional cost, that policymakers need to incentivize keeping human doctors involved in medical decision-making. Otherwise, the consequences could be staggering.

"We feel that after a significant amount of time, if humans are left out of the decision-making process, they'll no longer have easy understanding or explanations in all cases of the kinds of decisions that machines make, and why — and that could lead to problems."

— Taylor Blewett

Using remote presence robotic devices, a specialist in Saskatoon can check vital signs or examine the injury of a patient hundreds of kilometres away in a northern part of the province.

With attached diagnostic devices and a screen for doctors and patients to communicate in real time over the Internet, these robots can facilitate long-distance specialist appointments, help direct acute care while patients wait for medical transport to an urban centre, or even remedy a health problem entirely, making travel unnecessary.

"We're showing that these are much more cost-efficient than transporting patients or delaying their treatment," Dr. Mendez said. "The adoption from the patients is very natural, they really appreciate [being] able to have somebody looking at their problem without the need for transportation, and especially that [their] issue can be seen in a timely fashion."

Using robots to bridge distance barriers is hardly new. Fifteen years ago, a surgeon in Hamilton remotely piloted a ZEUS robot — da Vinci's predecessor — operating on a patient 400 kilometres away, in North Bay.

But like their in-hospital counterparts, remotely operated robots are also being used in new, innovative ways. MELODY, a tele-robotic ultrasound system, is bringing prenatal care to Saskatchewan communities where mothers would otherwise have to travel long distances for an ultrasound, or simply go without.

"We're trying to use these state-of-the-art technologies to be able to deliver primary and specialized care to populations that have the least and need the most," said Dr. Mendez.

And then there's the development of robots that can mitigate entirely the kinds of health crises that lead to hospital visits.

Robotic surgeries will be commonplace within the next decade or two, according to Dr. Christopher Schlachta.

ViRob is a crawling micro-robot that can remain in the body for prolonged periods of time and reduce shunt blockages that regularly send children and seniors with hydrocephalus to hospital. SAM, a robot built for senior living facilities, conducts environmental assessments for fall hazards that could save a senior from a broken hip and visit to the emergency room.

"It might be five to 10 years, it might be 20 years, I'm not sure, but there is a coming onslaught of robotics," Dr. Schlachta predicted.

He was speaking specifically of surgical robots, but professionals across the medical spectrum expressed a similar vision of the future — a health system expanding to make automation, artificial intelligence and robotic technology a regular part of patient care.

"We are just at the tip of the iceberg." ■