Disruptive technology changed the course of vascular surgery

A leader in the field, PMCC promotes big ideas and the move toward less-invasive surgeries, individualized treatments and personalized medicine

By Jennifer Hough

Vascular surgery was revolutionized in the early 1990s, when new technology allowed surgeons to enter blood vessels and repair aortic aneurysms from within.

"The advent of minimally-invasive surgery – endovascular surgery – whereby we can make a small incision in the groin and remotely position an arotic stent graft, is the most successful example of how disruptive technology radically changed vascular practice," says Dr. Thomas Lindsay, Division Head of Vascular Surgery at the Peter Munk Cardiac Centre (PMCC), based at Toronto General Hospital and part of Toronto's University Health Network (UHN).

When it comes to treating abdominal aortic aneurysms, which makes up the bulk of Dr. Lindsay's work, it means an overnight recovery versus six weeks.

The technique uses fluorscopic X-ray imaging in the operating room to guide a catheter containing a tube of strong fabric with steel stents through the arteries. Once in place, the stent is expanded and seals off the aneurysm.

While some more complex cases still need open heart surgery, this minimally-invasive method is used in the majority of cases.

Now, says Dr. Lindsay, the challenge for clinicians and researchers is to individualize treatments and move toward the same kind of personalized medicine approach being used in other disciplines.

At the PMCC, a leading cardiac centre that prides itself on hiring and retaining the best talent, researchers and clinicians are every day trying to marry research and science with real-life medical problems to advance the field.

According to Dr. Lindsay, who for 11 years held the Chair of Vascular Surgery at the University of Toronto, big ideas are encouraged and nurtured. "Every day we are questioning, 'How can we do this better?' We are encouraged to think like that, and to always be looking for new solutions to the challenges we face as clinicians."

Indeed, the PMCC has a long history of medical "firsts," from the first clinical use of heparin as a blood thinner in 1935, to the first pacemaker used in 1950, to more recently, in 2012, when the PMCC became the first in the world to harvest stem cells from a patient's bone marrow and transplant the cells into the heart during bypass surgery.

"It's this kind of research that sets the groundwork others can build on, that allows modern cardiac surgery to exist," Dr. Lindsay says.

Today, the promise of discovery is still alive and well.

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Division Head of Vascular Surgery,
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"There is real strength in numbers and expertise. That's what drew me here – the ability and potential to be a world-leader in discovery and innovation, and to educate tomorrow's leaders."

Dr. Thomas Forbes,
Professor and Chair,
Division of Vascular Surgery,
University of Toronto

INSIDE THE VASCULAR SYSTEM

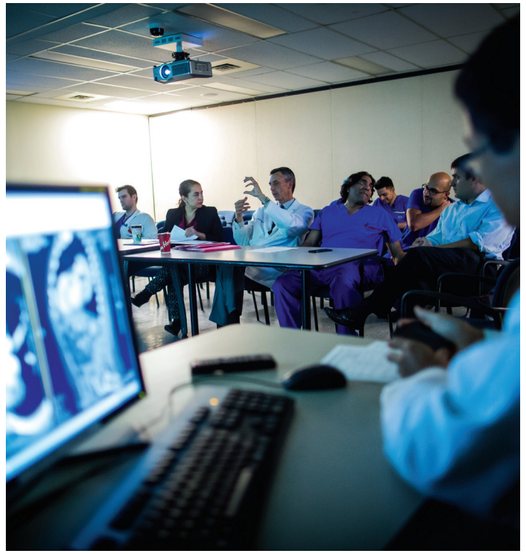
Responsible for carrying blood to and from all major organs in the body, the vascular system is essentially the plumbing upon which all systems in the body rely.

If the plumbing fails or is compromised, major organ systems are also at risk of failing.

Vascular surgeons treat disorders of the blood vessels outside of the heart and head – mainly blockages in arteries or aneurysms, which are enlarged blood vessels most common in the abdominal aorta.

The Division of Vascular Surgery at Toronto General Hospital is a world-class academic unit renowned for delivering care to highly complex cases through advanced diagnostic and surgical interventions.

Illustrations by Brent Phillips



A team of cardiac surgeons, vascular surgeons and interventional radiologists meet regularly to discuss cases that benefit from a multi-disciplinary approach to patient care.

therapies."

Dr. Lindsay's colleague, and the current University of Toronto Vascular Chair, Dr. Thomas Forbes, agrees that the PMCC provides an ideal environment for innovation: strong leadership, support and investment, state-of-the-art equipment and critical mass.

Speaking about his role as chair, he points out the "unique situation" in vascular surgery in Toronto, because all of the hospitals fall under the umbrella of one university, unlike other cities where they are divided.

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Looking to the future, Dr. Forbes believes the next transformation in vascular surgery is combining high-tech hardware with biologics.

Essentially, this means clinicians will decide on customized treatments based on what's found in a patient's genes.

"This is precision or personalized medicine," explains Dr. Forbes.

"It's taking the human genome and deciding on a therapy, based on what you see. If you take 100 people with aneurysms, they will not behave the same way. We need to explore the reasons why some aneurysms grow and some don't, why some rupture and some don't and why they are different – and be able to treat patients accordingly. Research projects at the PMCC are ongoing; some are in their infancy, others are more developed," he says.

The second part to this is the hardware, such as stents and other devices that go into the body to open up arteries and improve blood flow.

"Increasingly, we will have devices that are customized to the individual patient's anatomy," Dr. Forbes says. One ongoing project is a collaboration with engineering to see if aortic stent grafts (endografts) can be made to last longer, and how they can best be tailored to suit individuals.

"Sometimes, it can take a month or two to get a stent made. In a serious situation, that's a problem, but with the advent of 3-D printing, that will all change."

Work is ongoing at the PMCC to create new types of stents, and they have been used in animal models, but not yet in a patient, Dr. Forbes adds.

It's this kind of cutting-edge research that keeps the PMCC on the global stage.

Another study is imaging-based and uses advanced MR imaging to get a visual description of what a blockage looks like. Based on this information, doctors will make a more informed decision on how to proceed.

"We are also developing new imaging models. For example, the best way to get a CT scan," Dr. Forbes says.

"Normally, when you get a CT scan you are lying down. In their daily lives, people are standing up for two-thirds of the day, so we are looking at whether or not it's better to get a CT scan standing up."

Yet another area of research is the push to harness big data.

"We have the epidemiological data of thousands of patients and outcomes. The challenge is taking numbers and applying them to one person, finding out if there are any rules you can apply at an individual level," he explains.

But aside from the forward march in terms of science and innovation, both Dr. Lindsay and Dr. Forbes are clear that first-class patient care, delivered through multidisciplinary teams, is the No. 1 way that the PMCC stays ahead of the curve.

"One of the fundamental things we have tried to overcome here is getting specialists to work in complementary multidisciplinary teams," says Dr. Lindsay.

"We work together with surgeons, interventional radiologists, anesthetists" and in complex cases with other highly trained health-care professionals, such as cardiac surgeons.

Dr. Forbes concurs. "Our first obligation is to our patients. We get referrals from all over Canada as we specialize in certain areas that are not available in other places. Very often, we see patients who don't have just one disease. It's very important they don't get siloed into one area."

In other words, the PMCC ensures that patients and their illnesses come ahead of hospital administration that likes to pigeonhole people under one discipline.

"It sounds simple, but operationally it's sometimes difficult to do across a hospital with different divisions. That is a great strength of the PMCC – the way people can flow easily through the system because of this multidisciplinary approach that is one of the hallmarks of [the] Peter Munk [Cardiac Centre]," adds Dr. Forbes.

"Global success starts locally."

STEM CELL RESEARCH

Researchers at the Peter Munk Cardiac Centre are attempting to restore circulation using stem cells to alleviate the symptoms of peripheral vascular disease, a condition that develops when arteries that supply blood to internal organs, arms and legs become blocked.

Dr. Thomas Lindsay, Division Head of Vascular Surgery at the PMCC, based at Toronto General Hospital, is the principal investigator on the Hemostemix trial, which involves targeting diseased tissue with new cells grown from the patient's own blood.

"We are taking the patient's own cells, putting them in the right environment and with the right stimuli, trying to grow new cells to inject them back into the leg to regenerate the circulation," explains Dr. Lindsay, a world-renowned vascular surgeon with more than 25 years of experience.

"We know stem cells are important; they still have not reached their full potential. In the vascular field, it's about getting growth to happen in someone who is 70, not 7, and finding out what the conditions are that allow for that to happen."

A breakthrough in this field would be greatly beneficial for people suffering from critical limb ischemia (CLI), a severe form of peripheral artery disease (PAD) that can result in limb loss, Dr. Lindsay says.

Amputation or death occurs in approximately 50% of patients with CLI over 5 years, which is caused by reduced blood flow to the legs.