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EDGE

FIRSTS

Changing the way cardiac surgery is practised

With a history of “firsts” and a spirit of innovation among its staff, patients and benefactors, the Peter Munk Cardiac Centre has produced a legacy of breakthroughs in cardiovascular medicine. Its pioneering research is influencing cardiac surgery across the world today

by Mary Gooderham



It was a discovery that would change the way surgery is done and transform the future of cardiac medicine. In 1935, a team of researchers at Toronto General Hospital (TGH) led by Charles Best, known for his involvement in the discovery of insulin, and Gordon Murray, a prominent surgeon, developed a purified supply of heparin, a powerful blood anti-coagulant that they used for the first time in patients.  Heparin has remained essential in medicine, preventing blood clots from forming in procedures from open heart surgery to organ transplants, and preventing blood clots from enlarging in conditions such as deep vein thrombosis (DVT). And the hospital which now houses the Peter Munk Cardiac Centre (PMCC), has continued its record of pioneering research, with a spirit of innovation among its staff, patients and benefactors producing a legacy of breakthroughs in cardiovascular medicine. 

"It's truly amazing the number of world and Canadian 'firsts' that have happened here," says Barry Rubin, Medical Director of the Peter Munk Cardiac Centre (PMCC) and Professor of Surgery at the University of Toronto. "We've changed the way that cardiac surgery is practised everywhere."

Dr. Rubin, a vascular surgeon who started there in 1995, says that seminal technologies, groundbreaking discoveries and leading figures in cardiac health at the PMCC "have influenced cardiovascular care across the world today."

These include the invention in 1950 of the first pacemaker, which millions of patients depend on to keep their hearts beating, and the first use of hypothermia to perform heart surgery in 1953, both led by William (Bill) Bigelow, a remarkable heart surgeon and founding chief of cardiovascular surgery. The first unit in the world dedicated to the management of patients after a heart attack was created at Toronto General Hospital in 1971.

Such developments have saved and improved the lives

of patients across Canada and around the globe, Dr. Rubin says, with more recent firsts focusing on complex angioplasty and stenting procedures that make surgery less invasive.

"We're moving from big incisions to small incisions to no incisions at all," he comments, noting that the ability to fix heart valves, coronary arteries and aortic aneurysms this way means "patients even in their 80s and 90s can safely undergo life-enhancing therapies."

The almost 1,000 staff at the centre, part of the University Health Network (UHN), follow three core operating principles that Dr. Rubin developed in consultation with his executive team: they function in multidisciplinary teams, try to use the best equipment in the world and "have

a constant and unrelenting focus on innovation," he says.

Cardiac surgeon Dr. Tirone David has made history himself at PMCC since his arrival in 1979, with a series of firsts that include a procedure named for him. The David Operation, which he pioneered in 1988, preserves the aortic valve in treating aneurysms

at the root of the aorta, the main blood vessel coming out of the heart. It remains the worldwide standard for treating the condition.

Dr. David, 70, who was chief of cardiovascular surgery from 1980 to 2011 and has completed more than 15,000 operations, says that innovation, a collaborative approach and global outreach are "not encouraged, but expected" at the PMCC. He's brought his procedures to 59 centres in 27 different countries around the world, marked on a map in his office corridor.

He was the first clinician in Canada to develop a database of patient care, which revealed that the centre's surgeons had "unparalleled clinical outcomes" through their novel



Dr. Tirone David, cardiac surgery pioneer

"We're moving from big incisions to small incisions to no incisions at all."

Dr. Barry Rubin,
Medical Director,
Peter Munk Cardiac Centre

approaches. Highlights for him include the PMCC's brand-new facilities, the development of care maps for cardiac conditions and its imaging technologies. "Before the patient leaves the operating room, you know how the heart is working. Talk about quality assurance."

Dr. David would like to see advances in areas such as genetics and molecular changes in heart disease, noting that the PMCC encourages young researchers to use creativity, which attracts the donor community. "Excellence breeds

excellence...Everyone wants to be part of a successful story."

Dr. Rubin says the centre's vision to provide the best cardiovascular care in the world is shared and supported by the "staggering generosity" of philanthropists such as Peter Munk, founder and chairman emeritus of Barrick Gold Corporation, who, with a history of heart disease in his family, made his first gift of \$5-million in 1993. Mr. Munk and his wife, Melanie, established the Peter Munk Cardiac Centre in 1997; their donations to the centre have totalled \$65-million.

Such contributions allowed the centre to develop its unique co-ordinated, team-based approach and a structured way to manage innovation, Dr. Rubin says, supporting research initiatives by staff at all levels and studies that evaluate new technologies and procedures outside the Ontario Ministry of Health and Long-Term Care. The funds have helped the PMCC "attract superstars from around the world," creating endowed chairs and establishing Centres of Excellence, where clinicians and scientists are

profoundly affecting – indeed, revolutionizing – the diagnosis and treatment of cardiovascular disease.

Linda Flockhart, Clinical Director of the PMCC, who began as a bedside nurse in the Cardiovascular Intensive Care Unit in the late 1980s, says that "surpassing the boundaries" in complex areas such as stem cell research, heart failure, sleep studies, aneurysms and arrhythmia is "part of our identity." Staff take pride in each startling advance and "get restless if it's been awhile since something new has happened."

Patients are "offered a lifeline" by the centre, but are also critical to its success, she explains, with those in areas such as the adult congenital heart program, the largest in Canada, "advocating for care and pushing us forward. We're going through this journey together." It's especially gratifying to see patients who were gravely ill return for follow-up visits, "walking down the hall with their families, looking totally normal."

More and more patients are undergoing minimally-invasive surgery using advanced imaging

in facilities such as the Multi-Purpose Operating Room, named for the late R. Fraser Elliott, who left a generous gift supporting its state-of-the-art imaging equipment. Three times the size of a traditional operating room, the multipurpose operating room can handle complex chest, heart and vascular procedures and other types of surgery, and it was the first of its kind in Canada.

The family of Ted Rogers has donated \$130-million to establish the Ted Rogers Centre for Heart Research at the Hospital for Sick Children, UHN and the University of Toronto. It will allow the PMCC to do collaborative groundbreaking research in technologies, processes and strategies to fight heart failure, with a goal of reducing hospital admissions for the condition by 50 per cent within a decade.

Such external partnerships "expand our brand outside the four walls of the centre," Dr. Rubin says.

The centre is "ideally positioned to be a world-leader in cardiovascular care," Dr. Rubin says, but that requires constant vigilance and reinvestment. ▽

PMCC World Firsts

1950 First pacemaker

Dr. William (Bill) Bigelow was the first to thread a wire through a patient's vein to the patient's heart and deliver an electrical impulse that caused the heart to beat when its own electrical system had failed. Millions of patients now depend on pacemakers to keep their hearts beating.

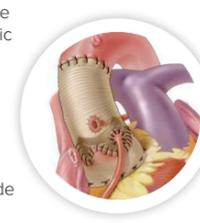


1977 First description of DNA associated proteins in any human disease

Drs. Michael Sole and C.C. Liew described the role of non-histone chromatin proteins, which are important for gene structure and function, in patients with excess heart muscle (hypertrophic cardiomyopathy).

1982 First surgery to map potentially lethal arrhythmias that did not require an incision in the heart. This built on previous work where it was necessary to cut open the heart muscle to cure the arrhythmia, and led to the development of non-invasive techniques to treat patients with life-threatening abnormal heart rhythms, like ventricular tachycardia.

1988 The first aortic valve sparing operation to treat an aortic root aneurysm (known as the David Operation). Young patients with aneurysms of the aortic root, the main blood vessel that comes out of the heart, are frequently associated with specific genetic syndromes. Previously, these patients were treated with a synthetic graft that had a mechanical aortic valve, which required lifelong anti-coagulation or a tissue valve with limited durability. This operation preserved the patient's own aortic valve, improved the quality of life and is now the established worldwide standard for treating this condition.



1990 First practical genetic test for viral infection of the heart. Drs. Michael Sole and C.C. Liew were the first to use gene amplification to identify Coxsackie virus infection of the heart.

2007 First analysis of the fatal heart rhythm ventricular fibrillation in explanted human hearts. Ventricular fibrillation is a leading cause of sudden death worldwide, and it could not previously be studied in humans. With this program, Dr. Kumar Nanthakumar's group was able to study the hearts of patients who had died from ventricular fibrillation. This led to the discovery of why some patients develop this lethal heart rhythm.

2010 First CorMatrix Regenerative Tricuspid Valve implant. The tricuspid valve allows blood flow from the main veins in the chest into the right atrium of the heart. CorMatrix is a regenerative medicine product that provides a scaffold for the body to recreate a natural tricuspid valve. More than 100 CorMatrix implants have now been performed worldwide to repair the tricuspid valve since PMCC first used this technique.

1935 First clinical use of heparin

Heparin stops blood from clotting and is used worldwide during the vast majority of open hearts surgeries. The first use of heparin to treat a patient was by a team led by Dr. Gordon Murray and Dr. Charles Best at Toronto Western Hospital.

1953 First use of hypothermia for heart surgery

During the Second World War, Dr. Bigelow noted that soldiers with devastating injuries who became very cold on the battlefield could survive their injuries. By lowering body temperature, he was able to safely stop the circulation, a discovery that made open heart surgery possible.



1962 First unit dedicated to the management of patients after a heart attack

opened with the support of Mr. Percy Gardiner, Toronto General Hospital (TGH) Trustee. This unit was established at TGH by Drs. Kenneth Brown and Robert MacMillan, focused nurses, physicians and surgeons on the care of patients with disease of the heart (coronary) arteries and was the precursor to all coronary intensive care units in the world today.

1976 First use of real-time ultrasound to assess the severity of narrowed blood vessels

Non-invasive ultrasound allows physicians to determine how narrowed blood vessels are. The PMCC designed and built the first device that could record blood flow in patients' arteries in real time. These real-time frequency analyzers are now an integral component of every ultrasound machine used to assess blood flow in arteries and veins.

1987 First prospective study of iliac and femoral artery balloon angioplasty

Narrowing or blockage of the arteries to the legs may cause disabling pain and may lead to amputation. The PMCC was the first to establish that balloon dilation (angioplasty) was a minimally-invasive approach that could effectively treat impaired circulation. Worldwide, angioplasty is now used much more than open bypass surgery to improve the circulation to the legs.

1991 First aortic valve replacement using the Toronto SPV bioprosthesis

St. Jude Medical (in St. Paul, Minn.) acquired the rights to manufacture the Toronto SPV valve, and the Toronto General Hospital was the main site to train surgeons from around the globe to learn this new technique of valve replacement. This valve proved to be better hemodynamically, but not as durable as stented valves and was discontinued in 2005.

2008 First demonstration that sleep deficiency can cause heart disease

This explains why chronic lack of sleep or shift work is not just associated with an increased risk of cardiovascular disease, but can actually cause heart disease by preventing the daily repair and renewal of tissues that happen in the heart.

2012 First completely intraoperative stem cell transplantation for cardiac repair

Previous efforts at stem cell transplantation for heart repair after a heart attack required processing of the cells over days to weeks. The PMCC was the first to harvest, process and transplant a patient's own stem cells during heart bypass surgery directly into the damaged area of the heart, with cell processing taking place completely within the operating room environment (in a dedicated regenerative medicine facility).

- ↑ Cardiovascular Intensive Care Unit (CVICU)
- ↑ Coronary Intensive Care Unit (CICU)
- Coronary Catheterization Lab (Cath Lab)