

# A steady stream of innovations point to the day when electronic pacemakers may be obsolete

Development and advancements on the heart-regulating apparatus over the past decade have been phenomenal

By Chris Atchison

**DR. GORDON CHONG MAY HAVE DEDICATED HIS CAREER TO FIXING TEETH,** but his golden years have included an unexpected education in cardiac care – specifically, his own.

A retired dentist, Dr. Chong has been the recipient of four pacemakers since being diagnosed with congestive heart failure in 2011. His pacemaker has since been fitted with a defibrillator to keep his heart functioning in the event of a major cardiac incident.

“It seems to be working well, but the condition I have is still deteriorating,” says Dr. Chong. “I’m being assessed for a heart transplant or a mechanical device that will get me over the hump for a while.”

Dr. Chong, a patient of the Peter Munk Cardiac Centre (PMCC), is one of more than 10,000 Canadians who receive electronic pacemakers each year and one of more than 120,000 Canadians currently living with the life-saving technology.

The tiny devices treat arrhythmias – abnormal heart rhythms – and help the heart beat at a steady, normal pace. Pacemakers average about a seven-year lifespan before their

batteries need replacing.

Dr. Chong has a unique perspective on the evolution of the heart-regulating apparatus, thanks to his medical background.

“I spent two years [studying] at the Hospital for Sick Children when I graduated and have been following (pacemaker development) for the past few years...and in the last decade, the amount of knowledge and technology, and bringing together of biometrics and biology, has been phenomenal,” the 73-year-old says.

Indeed, the devices have come a long way since the invention of an external, toaster-sized pacemaker in 1950 by Canadian engineer John Hopps, in conjunction with researchers from the University of Toronto.

Despite its many shortcomings – the device required an AC power source, creating obvious mobility challenges for patients – Hopps’s pacemaker was regarded as a drastic improvement over previous rudimentary devices.

That was until a team in Minnesota developed a battery-powered, belt-worn pacemaker later that same decade.

Fully implantable devices



became available in the 1960s. Continued improvements have reduced the pacemaker's size, while improving battery life and overall effectiveness. The development of specialized models, such as biventricular pacemakers, has further improved patient survival rates and quality of life.

It's not only the direct technological advancements in pacemaker design that have researchers and clinicians excited, but also innovations in related treatments and diagnostic procedures that could one day make electronic pacemakers virtually obsolete.

One of the most common heart rhythm disorders is atrial fibrillation, which affects millions of people worldwide. The condition causes disabling symptoms of palpitations and an increased risk of heart failure, stroke and death. An important treatment option for patients who cannot be managed with medications is a heart procedure known as catheter ablation, where regions of the heart muscle causing atrial fibrillation are burned away. However, this procedure may not work well in many patients because the

regions causing atrial fibrillation are not apparent with current technology.

This is where University Health Network's Thomas I. (Toby) Hull Centre of Excellence in Heart Rhythm Disease program aims to be innovative.

Consider the work of Dr. Vijay Chauhan, a cardiologist at the PMCC who is developing new technology to localize atrial fibrillation electrical drivers in order to improve catheter ablation for patients with atrial fibrillation.

Dr. Chauhan and his team have set out to find what he calls "the flashing beacon in the heart" that may sometimes trigger and sustain the condition.

To curb atrial fibrillation, doctors often begin with drug treatments, and if unsuccessful, they will then perform a catheter ablation around the pulmonary veins to normalize the patient's heart rhythm.

But catheter ablation has only a 50 per cent success rate, particularly in patients whose atrial fibrillation persists all the time, due largely to the fact that atrial fibrillation in these patients often stems from abnormal electrical areas in the heart

outside the pulmonary veins that doctors can't see or treat.


"That brings in the notion of finding and ablating electrical drivers that can be outside pulmonary veins," Dr. Chauhan says.

But without an effective tool to do exactly that, Dr. Chauhan and his team developed a mapping technology which systematically analyzes the atrial fibrillation electrical signals from hundreds of regions in the heart. With a study currently underway, researchers should know in a year whether the new treatment does, indeed, improve catheter ablation success rates.

Other researchers, including Dr. Gordon Keller, Director of the University Health Network's McEwen Centre for Regenerative Medicine in Toronto, are using trailblazing biological innovations to improve heart health and potentially mitigate the use of pacemakers.

In 2016, Dr. Keller and his team announced that they had produced sinoatrial node pacemaker cells – which regulate the heart's rhythm with electrical impulses – from human pluripotent stem cells. The pacemaker cells were injected

into rat hearts and assumed a biological pacemaker function, exactly as planned.

"The groundbreaking advancement could lead to the development of a biological pacemaker for humans that would offer immediate benefits over current electronic pacemaker devices, which have limited battery lives and are unable to adapt to changes in heart sizes in pediatric patients. The team's long-term goal is to produce the human heart cells that make up the organ's chambers, including the ventricles and atria. The goal is to use these ventricular cells to create new muscle in the hearts of patients who have experienced a heart attack. The whole idea of using cells we make in a lab to treat patients may be closer than we thought," Dr. Keller says. 

**01** Drs. Vijay Chauhan and Andrew Ha, cardiologists at the PMCC, and their team looking for "the flashing beacon in the heart" that may trigger atrial fibrillation.

**02** Dr. Gordon Chong, a retired dentist and patient at the PMCC, has had multiple pacemakers since 2011.



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<sup>1</sup> RON KALEN and MARSHALL S. STANTON, Current Clinical Issues for MRI Scanning or Pacemaker and Defibrillator Patients (PACE 2005; 28:326-328).

<sup>2</sup> Medical Imaging in Canada: <http://www.cihi.ca/CIHI-ext-portal/internet/EN/TabbedContent/types+of+care/specialized+services/medical+imaging/cihi010642>.

<sup>3</sup> Consult the conditions of use with your physician.

<sup>4</sup> Chronic, intractable back and/or leg pain.