Next-gen pacemakers may be powered by unlikely source: the heart

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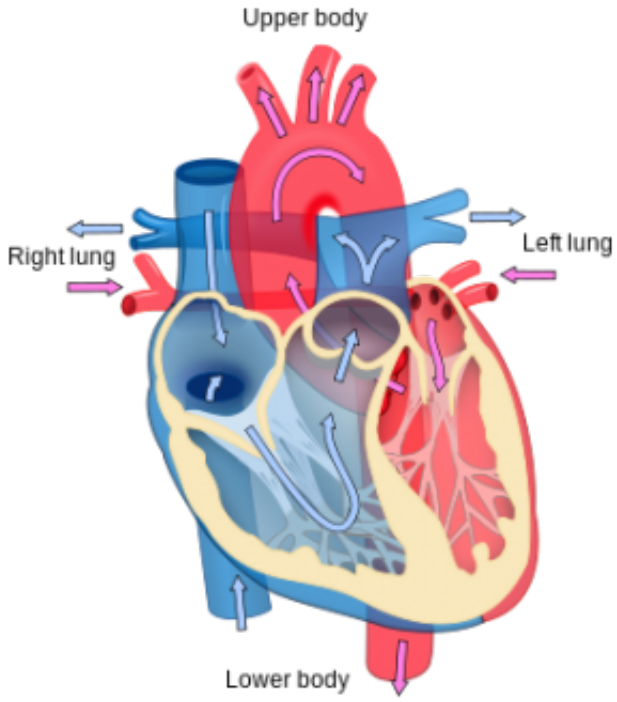

Heart diagram. Credit: Wikipedia

The implantable pacemaker, a medical marvel that has extended millions of lives since its invention nearly 60 years ago, is getting a 21st century makeover.

First came a wireless version; these pacemakers, which are AAA battery-sized and placed inside the heart via a catheter through the leg, are being

tested in humans in the United States, Canada and Australia.

Now, researchers are developing technology to make these devices battery-free. The advancement is based upon a piezoelectric system that converts vibrational energy - created inside the chest by each heartbeat - into electricity to power the pacemaker.

"Essentially, we're creating technology that will allow pacemakers to be powered by the very heart that they are regulating," says M. Amin Karami, PhD, assistant professor of mechanical engineering at the University at Buffalo School of Engineering and Applied Sciences, who is leading the research.

The technology may eliminate the medical risks, costs and inconvenience of having a battery replacement every five to 12 years for millions of people worldwide.

From the beginning

The development of pacemakers dates back nearly a century. At the beginning, most efforts focused on devices that patients would carry outside their body.

Surgeons first successfully implanted a pacemaker in a human in 1960 in Buffalo, New York. The device, invented by UB alumnus Wilson Greatbatch, enabled the patient to survive another 18 months. (Note: A patient in Sweden received an implantable pacemaker in 1958, but the device failed after three hours.)

While there have been advancements since 1960 - the devices are smaller, the batteries last longer, there are even "smart" pacemakers that are linked to computers - the basic design from Greatbatch is the same. About the size of a pocket watch, pacemakers are implanted under the

skin through an incision in the chest. Wires, also called leads, connect the device to the heart and deliver electrical signals that regulate the heart's activity.

The new wireless option does not require leads because it rests inside the heart. This removes a potential point of failure, but the device still relies on a battery that must be replaced as often as the batteries that conventional pacemakers use.

A state of constant motion

The idea of heart-powered pacemakers came to Karami after doing PhD work on piezoelectric applications for unmanned aerial vehicles and bridges. He wanted to apply that knowledge to the human body. The heart was an obvious choice because of its relative strength and constant motion.

"To see the heart in motion - even an animation - is to be awestruck," says Karami. "It moves significantly. In turn, that movement creates energy that we're just now figuring out how to harvest."

Karami is not the first person with the idea. He found designs from the 1960s attempting the same. But they lacked the scientific knowledge and modern technology available today.

He initially designed a flat piezoelectric structure for a conventional pacemaker. A prototype generated enough power to keep the pacemaker running at a range of 7 to 700 beats per minute. With the development of wireless pacemakers, however, he has revamped the design to accommodate the smaller, tube-shaped device.

Karami, who is already talking to device-makers, is building the new prototype and expects to have animal tests done within two years. From

there, it should be ready for human trials and, eventually, approval from the U.S. Food and Drug Administration.

Provided by University at Buffalo