Heart's surplus energy may help power pacemakers, defibrillators

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Surplus energy generated by the heart may one day help power pacemakers and defibrillators implanted in cardiac patients, according to research presented at the American Heart Association's Scientific Sessions 2008.

In a trailblazing experiment, a microgenerator powered by heartbeats produced almost 17 percent of the electricity needed to run an artificial pacemaker. "This was a proof-of-concept study, and we proved the concept," said Paul Roberts, M.D., first author of the study and a Consultant Electrophysiologist at Southampton University Hospital in the United Kingdom. "Harvesting surplus energy might be a major transition in implantable pacemakers and defibrillators because engineers will have more energy to work with."

In their study, researchers found:

-- At a heart rate of 80 beats per minute (bpm), the device yielded an average harvested energy of 4.3 microjoules per cardiac cycle.
-- Increasing changes in the heart rate produced corresponding increases in energy. At 104 to 128 bpm, the harvested energy level increased 140 percent.
-- Decreases occurred when the researchers slowed the heartbeat or lowered blood pressure.
-- Implantation and surplus energy harvesting caused no significant injury to the lining of the heart's chambers.

"What this might mean is that in the next era of pacemakers, you'd get devices that lasted significantly longer and we could add more functions to help monitor the heart," Roberts said. "It's possible they could be efficient enough to allow complete and indefinite powering of pacemakers."

Since their introduction into clinical medicine, implantable pacemakers and defibrillators have saved lives and become more sophisticated. However, adding new monitoring capabilities to the devices has led designers to a critical point.

"The small devices now are really very good, but power consumption must increase if we want to take them to the next level," Roberts said. "Battery technology has plateaued and the only way we are going to increase power is to increase size."

This, in turn, would increase the units' weight, making them more uncomfortable and less cosmetically acceptable to patients because the devices are implanted under the skin.

The innovative generator — called the self-energizing implantable medical microsystem (SIMM) — helps the heart produce more than enough energy with each beat to pump blood.

The SIMM uses two compressible bladders and a microgenerator mounted on the lead of a pacemaker or defibrillator, the wire that connects the device to the heart.

The lead is attached to the end of the right ventricle, and the bladders relay the energy from the pressure of each heartbeat to the microgenerator, which transforms it into electricity for use by the battery.

A consortium of companies including InVivo Technology, Perpetuum and Zarlink Semiconductor developed and tested the SIMM microgenerator with United Kingdom government funds. Researchers used an in-vivo porcine model to evaluate the study. The researchers are now working to improve the materials used in the SIMM microgenerator.

"With different materials, we're seeing even greater energy harvesting," Roberts said. "While at the moment we see about 20 percent harvesting, we're anticipating that will be significantly more in the next iteration of the device."

Source: American Heart Association