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Student invention delivers better, safer heart shocks

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Johns Hopkins undergraduate students have invented a system to shock a dangerously irregular heart back into normal rhythm more safely and effectively.

The two-component system is designed both to expand a doctor's options in routing electric current through the heart and to improve the application of pressure to the patient's body to help treatment succeed.

This system, called the PrestoPatch, won first place in the undergraduate division of the 2013 national Collegiate Inventors Competition. Team members said they will use their $12,500 prize money to help launch a company and move their invention closer to clinical use.

"Our system is simple," said team member Sandya Subramanian of Grand Rapids, Mich. "That means clinicians are more likely to use it." She was one of the eight Johns Hopkins biomedical engineering undergraduates who worked on the PrestoPatch project beginning in the spring of 2012.

The system is designed to better deliver electric shocks to patients experiencing arrhythmia, an erratic heartbeat that can be fatal. About 14 million people in the United States alone have been diagnosed with some form of arrhythmia, which can include a heartbeat that is too fast, too slow, too early or out of synch.

When the condition becomes life-threatening, medical teams may have

only three to five minutes to jolt the heart back to normal rhythm. The doctor first must choose two of three locations for electrode patches: on the front, side or back of the patient. Electric current is then shot between the two electrodes, passing through the heart.

If the first shock doesn't work, present-day patches cannot be moved to a new position that might yield better results.

"When a shock fails, a physician's options for what to do next are very limited," said team leader Piyush Poddar of Plainsboro, N.J. "The usual next step is to increase the energy of the shock, that is, if it's not already maxed out. But this increases the patient's risk for burns and death of heart tissue."

But team members say the PrestoPatch system could be used at the onset of the treatment. The team devised an electric switch that would allow doctors to attach three patches to the patient in all three locations, instead of choosing two. If the first shock fails, the doctor can quickly flip a switch and change the current's path through the body without necessarily increasing the energy of the next shock.

The PrestoPatch system's second component addresses excessive transthoracic impedance, a problem that occurs during defibrillation when the patient's body resists the life-saving current. Doctors now mitigate this crudely, pressing down on a patient's patch with their fists. To improve upon this, the students devised a manual compression tool to apply pressure in a safe, standardized way. Lights and an embedded speaker on the tool alert the doctor when the proper pressure is applied and warns if there is too much pressure.

In addition to Poddar and Subramanian, the PrestoPatch team members are Aaron Chang of Grand Prairie, Texas; Kevin George of Acton, Mass.; Peter Malamas of Bucks County in Pennsylvania; Melinda Chen

of Baltimore; Rohil Malpani, of Kolkata, India; and Joon Eoh, of College Station, Texas.

The team's clinical sponsor was Todd J. Cohen, who earned his undergraduate and medical degrees at Johns Hopkins and is now director of electrophysiology at Winthrop University Hospital in Mineola, N.Y. "The team developed an actual working product which dramatically improves on the standard electrical cardioversion or defibrillation procedure," Cohen said.

He added, "My ultimate goal was to give the students a very positive entrepreneurial experience and allow them to explore their own creativity. The team excelled in every task and had fun at the same time."

The students' project emerged from the undergraduate design team program offered by the Department of Biomedical Engineering, which is shared by the university's School of Medicine and its Whiting School of Engineering. The work is conducted within the Center for Bioengineering Innovation and Design. The team's faculty adviser was Robert Allen.

This was the second consecutive year that a Johns Hopkins undergraduate biomedical engineering team finished first in their division of the Collegiate Inventors Competition, which is conducted by Invent Now and the National Inventors Hall of Fame. Winners were announced Nov. 12 after the finalist teams presented their projects to contest judges at the U.S. Patent and Trademark Office in Alexandria, Va.

Provided by Johns Hopkins University