Researchers develop innovative imaging system to study sudden cardiac arrest

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A research team at Vanderbilt University has developed an innovative optical system to simultaneously image electrical activity and metabolic properties in the same region of a heart, to study the complex mechanisms that lead to sudden cardiac arrest. Tested in animal models, the system could dramatically advance scientists' understanding of the relationship between metabolic disorders and heart rhythm disturbances in humans that can lead to cardiac arrest and death, and provide a platform for testing new treatments to prevent or stop potentially fatal irregular heartbeats, known as arrhythmias.

The research is supported in part by the National Heart, Lung, and Blood Institute (NHLBI), part of the National Institutes of Health.

The design and use of the dual camera system is described in the Nov.1 issue of *Experimental Biology and Medicine.* Additional support for the project has also been provided by the Vanderbilt Institute for Integrative Biosystems Research and Education (VIIBRE), the American Heart Association, and the Simons Center for Systems Biology at the Institute for Advanced Study.

"The challenge in understanding cardiac rhythm disorders is to discern the dynamic relationship between multiple cardiac variables," said one of the coauthors of the paper and the project's principal investigator, John P. Wikswo, Ph.D., Gordon A. Cain University Professor and VIIBRE director. "This dual camera system opens up a new window for correlating metabolic and electrophysiological events, which are usually

studied independently."

The 11-year-old research project would have been terminated this year due to lack of funding, according to Wikswo. But a $566,000 American Recovery and Reinvestment Act grant from the NHLBI is enabling the 13-member research team to continue developing and testing the innovative optical system. Recovery Act funds are also allowing the team to purchase a pair of $60,000 high-speed and highly sensitive digital cameras to record the changes in the metabolic and electrical activity of isolated cardiac tissue using low-intensity fluorescent dyes under conditions associated with heart failure, ischemia, fibrillation and other pathological circumstances.

"Through the Recovery Act, the NHLBI is able to support promising research to develop and enhance innovative technologies to help us better understand the complex mechanisms involved in potentially fatal conditions such as sudden cardiac arrest," said NHLBI Director Elizabeth G. Nabel, M.D. "This research will allow us to better understand how to prevent and treat life-threatening cardiac rhythm disturbances and potentially save thousands of lives every year."

Each year, 250,000 to 450,000 people die in the United States as a result of sudden cardiac arrest, a condition that is triggered by arrhythmia. Usually, a complex series of electrical and metabolic changes precede sudden cardiac arrest.

The Vanderbilt researchers created and tested an innovative way to visualize the electrical activity of the heart in relation to its structure and changing metabolic state under different pathological conditions. Their multimodal cardiac imaging technique uses a two-camera approach to integrate electrophysiological imaging with optical fluorescence imaging of metabolic activity associated with damaged heart tissue and tachycardia, or accelerated heart rate. The biochemical and

electrochemical studies of heart tissue under controlled conditions will enhance scientists' understanding of electrometabolic cardiac disorders and their clinical treatment.

The advantages of this imaging system over others include rapid setup, two-color image separation, high spatial resolution, and an optional software camera calibration routine that eliminates the need for precise camera alignment. The authors provide a detailed description of a camera calibration procedure along with multiple examples.

In addition, the multimodal imaging system will be a less-invasive, instrumental tool in helping scientists discover and test safe and effective ways to prevent or treat arrhythmias. Current treatments include medications that can produce undesirable side effects and the implantable cardioverter defibrillator, a small device that's placed under the skin in the chest and uses electrical pulses or shocks to help control life-threatening arrhythmias.

Source: NIH/National Heart, Lung and Blood Institute