ASU bioengineers will expand work to solve cardiovascular health challenges

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Biomedical research at Arizona State University will be boosted with support from the American Heart Association for the work of three bioengineers.

Grants from the association were recently awarded to associate professor Brent Vernon and assistant professors David Frakes and Xiao Wang. Each is a faculty member in the School of Biological and Health Systems Engineering, one of ASU's Ira A. Fulton Schools of Engineering.

Vernon, director of the Center for Interventional Biomaterials at ASU, and Frakes are seeking to help develop new treatments for brain aneurysms through research they are conducting in partnership with the Barrow Neurological Institute at St. Joseph's Hospital and Medical Center in Phoenix.

Wang is developing mathematical modeling to predict behavior of cellular processes and engineered gene networks and their impact on cardiovascular health.

Brain aneurysms can be major factors in the onset and progression of cardiovascular diseases, including heart disease and stroke, which are among the leading causes of death in the United States.

Aneurysms form in weak spots in junctions where arteries join, causing them to balloon into pouches of tissue that fill with blood. If the pouches leak or rupture, blood spills out into surrounding tissues, which can potentially cause stroke and related serious threats to the body's vascular system.

Vernon is focusing on improving techniques to deliver therapeutic drugs to aneurysm sites to "seal them off" and prevent those dangerous leaks and ruptures.

Devices now used to treat aneurysms are made of platinum coils that cause blood to clot inside the aneurysm, cutting off further blood flow into the pouch – essentially arresting growth of the aneurysm.

A drawback, Vernon explains, is that the coils tend to compact over time and a stable layer of new protective tissues doesn't consistently form over the coils. The result can be reoccurrence of blood flow into the aneurysm.

Vernon is developing a technique that will use a type of gel to deliver the medicinal drugs. That would enable the injection of liquid medicinal materials into an aneurysm site. The materials then turn into a solid material that will more thoroughly fill up the aneurysm than platinum coils, and thus better prevent reforming of canals that would let blood resume flowing into the area.

He's also looking at how to make the injected materials gradually degrade – unlike the coils – so that no foreign material remains in the body perpetually and threatens to eventually cause complications.

At same time, he is working on enabling this method of treatment to also release a protein that will enhance and accelerate the growth of healthy protective tissue over aneurysms.

Post-doctoral bioengineering student Celeste Riley is assisting Vernon in the research.

Frakes also will work on methods to keep fluids from continuing to flow into aneurysms and cause potentially fatal ruptures. He'll develop experiments and simulations to study the effectiveness of applying various engineering techniques to predicting and controlling fluid dynamics (the behavior of fluids) in such preventative clinical treatments.

He expects the results to offer improved physical and computational models and methods for simulating fluid dynamics in treated brain aneurysms, as well as improved methods for measuring fluid behavior experimentally in treated physical cerebral aneurysm models.

His work will also provide improved computational models for new devices being developed to treat aneurysms.

Frakes will be assisted in the project by bioengineering doctoral students Priya Nair and Hiathem Babiker.

Vernon's research progress has drawn support from previous American Heart Association grants. Frakes' work has also attracted support from the Brain Aneurysm Foundation and the ASU Women in Philanthropy Society.

Wang describes his project as "mathematics applied to a biological problem." His work involves study of the mechanisms of cell differentiation – the process by which cells develop to perform more specialized functions – and its impact as a factor in cardiovascular disease.

He also is exploring approaches to engineering gene networks and determining how they perform in treatments for cardiovascular ailments.

Mathematical modeling he will apply to studies in both areas will provide precise looks at the fundamental principles guiding cell and gene network behavior. Such models will help provide formulas for predicting the effectiveness of clinical treatment methods under varying conditions.

Wang will be assisted by bioengineering doctoral student Benjamin Albiston.

The grants to Vernon, Frakes and Wang each provide more than $130,000 over two years.

The knowledge gained from their research will be incorporated into undergraduate and graduate courses, as well as student research projects.

Provided by Arizona State University

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