With the opening of the Science & Engineering Innovation & Research building this fall, The University of Texas at Arlington is embarking on a new era in health science research. Faculty from the College of Engineering are helping lead the way.

In addition to making headline-grabbing breakthroughs in cancer, brain trauma, and cardio-pulmonary disease, College of Engineering researchers are looking at the health care industry itself, analyzing the delivery of care, monitoring of patients, and training of professionals to increase quality and efficiency of treatment for everyone.

Training Medical Students

Department of Industrial, Manufacturing, and Systems Engineering (IMSE) Chair Paul Comptonation and Associate Professor Susan Ferreira have worked with UT Southwestern (UTSW) Medical Center since 2015 to present a patient safety and quality improvement “boot camp” for medical, nursing, and engineering students. The boot camp has developed into a partnership between UTA’s College of Engineering and College of Nursing and Health Innovation and UTSW’s Department of Quality, Safety, and Outcomes Education.

The camp is a focused, one-week, 40-hour course, followed by an 11-week application-oriented project in UTSW clinics and labs. It was created in response to a change in regulations that required health care professionals to be trained in continuous quality improvement with an eye on cost efficiency and patient safety. While some classes presented introductions to the topic, none delivered the focused classroom training and application-oriented practicum needed.

The boot camp delivers classroom instruction on quality improvement methodology through daily participation in team activities and simulations. The students are also given a health system case study with a detailed database of relevant quality issues, patient safety issues, and medical data. To successfully complete the course and solve the case study, they must combine their individual discipline skills with their new quality improvement tools. Additionally, the course has the teams work with UTSW/UTA researchers on health care-focused projects over the summer. Recent examples of these projects include improving transfer care for cardiothoracic surgery patients and evaluating EMR (electronic medical records) opioid interventions.

“The UTSW/UTA partnership is helping us prepare our next generation of health care providers...
From Manufacturing to Cardiac Care

Heart disease is the No. 1 killer in the world, according to the World Health Organization. At UTA, IMSE Assistant Professor Chen Kan is developing new techniques to detect anomalies in cardiac electrical activity that would help physicians identify potential problems and begin treatment at an early stage to save lives.

Dr. Kan has research interests in both advanced manufacturing and smart health. For cardiac care in particular, he is developing mathematical models to extract key biomarkers from sensory data like EKGs, then use process monitoring techniques such as control charts to identify abnormal cardiac activity and provide the results to cardiologists. The doctors can then decide what actions to take.

Kan is now expanding his work to incorporate the new technology of the Internet of Things (IoT). Combining IoT’s sensing, wireless communication, and cloud-computing makes it possible to continuously monitor patients’ cardiac conditions and identify potential problems anywhere, anytime.

“This is the future of the health care industry,” Kan says. “People will be able to wear sensors 24/7, and instead of having to make appointments with their doctor, their doctor will contact them if they need to come in.”

In recent years, the National Science Foundation and National Institutes of Health have increasingly focused on personalized medicine. Kan believes that if researchers have data on patients over an extended period, they can develop a baseline for what is normal for each patient, allowing them to quickly detect anomalies and provide timely and personalized therapies.

“There are many challenges related to IoT-based cardiac care and I focus on addressing the challenge of big data analytics,” he says. “Longitudinal monitoring without personal interference generates large amounts of data, and IoT aims to connect tens of thousands of people. The question is how can we efficiently and effectively extract useful information from the data for disease diagnosis?”

Next, Kan hopes to use heterogeneous sensor fusion to incorporate other bio-signals and images to give a much more in-depth look at everything that a cardiac patient is experiencing. For example, if an anomaly were detected, the doctor could bring the patient in for an MRI, then use the image and EKG data together to detect damage from disease progression or other event, giving the cardiologist multiple sources of information on which to base a diagnosis.

In the future, he would like to take his process to the microscale and look at ion channels that regulate cardiac processes to detect distress in the earliest stage.

Applying Systems Modeling to Health Care

Yuan Zhou, an assistant professor in the IMSE Department, is applying modeling techniques to research involving the spread of disease in public places. She’s also investigating whether a negative outcome in one surgery affects a surgeon’s performance in successive ones.

Using an agent-based simulation model, Dr. Zhou is looking at micro-level behavior of patients, faculty, and staff on the UT campus to determine how the flu spreads through interactions of people. She’s also modeling how flu transmission could be delayed or swapped with other surgeries to increase the chances of a good outcome for the next patient.

“We expect that the longer a surgeon waits after experiencing a loss during surgery, the less psychological shock will affect the next surgery,” she says. “If we can determine a threshold of the time period as the ‘safety net,’ surgeries at risk could be delayed or swapped with other surgeries to increase the chances of a good outcome for the next patient. It’s really about patient safety. We don’t want to harm patients because of unintended consequences from an event that they weren’t part of.”

Zhou hopes to expand her research to test how this information could be applied beyond mortality cases to readmission rates, where patients might have recurrences of the issues they had surgery for in the first place. Additionally, it could potentially be used on a doctor’s social network: “If he or she practiced at multiple hospitals, and the nature of the affiliations and the resources available could affect his or her performance.”

Although Zhou is focusing on cardiac surgeons, her research could also be generalized to emergency room trauma surgeons or military doctors in war zones who deal with catastrophic injuries on a regular basis and might be negatively affected.