When technology becomes, literally, indistinguishable from magic. Just starting its fourth decade, UCH’s pioneering electrophysiology lab looks like something out of Battlestar Galactica, but it is now treating all sorts of electrical problems from inside the heart.

Pioneering cardiac electrophysiology program innovates into its fourth decade

Thirty Years On, the Magic Continues and the Electricity Crackles

By Todd Neff

“Any sufficiently advanced technology is indistinguishable from magic,” the scientist and author Arthur C. Clarke wrote a half-century ago. What goes on every day in UCH’s cardiac electrophysiology labs bears out his observation.

Consider: a patient rolls into the hospital with an irregular heartbeat, feeling lousy due to lost blood flow. Via a vein in his inner thigh, specialists snake catheters three feet into the heart. On six screens above the table dance a complex array of data and imagery. These are the product of real-time biplane X-ray fluoroscopy, produced by an arcing assemblage of hardware that would look at home on Battlestar Galactica; a chevron-shaped ultrasound image taken from inside the heart itself (from the tip of an intracardiac ultrasound catheter); horizontal scribbles tracking a dozen flavors of the beating heart’s electrical action; and a 3-D digital construct that melds the real-time ultrasound data streaming from inside the heart with magnetic resonance imagery captured before the procedure.

Using the screens to guide them, cardiac electrophysiologists with protective lead under their surgery gowns steer an ablation catheter to rogue heart muscle, painstakingly burning circles to isolate areas that trigger the heart’s electrical trouble. A couple of hours later, the patient wakes up with a sore spot on his leg, but more importantly, a steady heartbeat and a better quality of life.

It’s a scenario that today seems routine to many, but it’s the result of decades of technological and scientific progress.

“If you would have told Dr. Reiter back in the 1980s what [electrophysiology procedures] would be like today, he’d think it was science fiction,” said William Sauer, MD, who directs the hospital’s electrophysiology program.
The pioneer. Dr. Reiter, in this case, is Sauer’s mentor and cardiac electrophysiology (EP) pioneer Michael Reiter, MD, PhD, who launched UCH’s cardiac EP program in 1982. In aviation terms, that would be akin to launching an airmail service during the Wright Brothers era. Back then Reiter, now professor emeritus at CU, worked with technicians to construct equipment to diagnose the heart’s electrical tendencies out of Hewlett-Packard oscilloscopes, amplifiers, and something called a Mingograf, the first ink-jet electrocardiography printer. The output spat forth on green-and-white-barred dot-matrix paper.

There were, at the time, perhaps 20 electrophysiology programs in the United States, Reiter estimates. They recognized that the heart is as much a complex electronic device as it is a romantic symbol and a ball of muscle, and, with still-blunt tools of their own design, dedicated their careers to teasing out its circuitry and bugs and fixing what they could.

Their annual meeting fit into a single room, and they all went out for dinner together afterwards, Reiter recalls. This year, the Heart Rhythm Society’s confab in Boston is expecting 13,000 people.

These specialists serve patients whose hearts have a wide variety of electrical problems. Among them: atrial fibrillation, in which one or both of the heart’s upper chambers flutter rather than beat, throwing the entire organ’s rhythm and pumping ability into disarray. In the more powerful lower chambers, ventricular tachycardia has a similarly disruptive effect. Electrophysiology specialists implant defibrillators – tiny, nuanced versions of the paddles that whine and then jolt quivering hearts back into action – into those at risk of cardiac arrest. They implant pacemakers, to regulate the heart’s electrical signals. And they study ways to keep the technology and patient care in general moving forward.

New Demand. Sauer says his colleagues’ advances in cardiology and interventional cardiology are driving more patients to electrophysiological care.

That’s because people are surviving more heart attacks, but then developing arrhythmias in the damaged tissues and facing higher risks of sudden death years later.

In addition, Sauer says, EP treatments are now coming into play for patients with – or at risk of – chronic heart failure, whose enlarged hearts engender signaling problems. These phenomena, combined with an explosion of new technology available to treat arrhythmias, are resulting in the growth of a once small subspecialty of cardiology.

The hospital’s EP program’s six physicians, one nurse practitioner, and 10 nurses handle about 5,000 outpatient visits and roughly 1,000 procedures a year, Sauer says. Minimally invasive catheter procedures using radiofrequency ablation (heat) or cryotherapy (cold) are reserved for those whose arrhythmias and other electrophysiological problems can’t be managed with medicine.

The physical space the EP program occupies also continues to grow. In addition to the two primary EP procedure suites, clinicians have separate rooms for non-invasive procedures, including tilt-table testing, programmed stimulation, and electrical cardioversion, which uses chest patches to reset the heart’s rhythm. The tower expansion project will open up another procedure suite.
The engineers. Despite all the impressive technology, hardware and software are only part of the story. In the decades since Reiter founded the program, specialists have also increased exponentially their knowledge and expertise.

One place this manifests is in the elaborate safeguards built into the procedures. Earlier this month, for example, Sauer and colleague Russell Heath, MD, an electrophysiology fellow, defibrillated a patient’s heart twice to confirm the precise locations of the sources of electrical interference.

In the process of ablation – spot welding, in essence, one millimeter-wide bits of heart muscle at a time using a liquid-cooled, electrically-fueled catheter — they watched for subtleties such as temperature in the esophagus (to ensure they did not inadvertently burn it) and paid special attention to the phrenic nerve, which skirts the heart and can impair the patient’s breathing if it’s damaged.

These and many other facets of EP treatment have emerged from the experience and research that continues to evolve the field. Thirty years after coming to UCH, Reiter still sees a few patients, attends (and gives) lectures, consults with EP vendors and conducts research. He’s studying the mechanical-electrical feedback changes that happen when the ventricles of cardiomyopathy patients stretch out. How and when does such stretching develop into arrhythmias? Understanding that could help prevent them.

These and other questions drive the program’s research and innovation. Sauer is interested in developing and improving EP devices and technologies to tackle arrhythmias. Ryan Aleong, MD, is investigating pharmacogenetic (drug-gene) interactions with arrhythmia treatments. Duy Nguyen, MD, studies how fibrosis can affect arrhythmias. Joseph Schuller, MD, is studying arrhythmias in patients with hypertrophic cardiomyopathy and cardiac sarcoidosis (inflammation that causes clumps of cells to form in heart tissue). Wendy Tzou, MD, is interested in preventing sudden death by ventricular arrhythmias. Paul Varosy, MD, concentrates on improving the safety and effectiveness of procedures and therapies in managing arrhythmias.

Reiter’s old Mingograf is to today’s EP systems what a scratchy 45 record is to a Blu-ray concert video in 7.1 surround sound. Thirty years from now, the technology and expertise will have leaped ahead again, in part due to the continuing work of the EP team at UCH. What it will look like then, no one knows. But it will seem like magic.