The Big Idea

Q. How can doctors help their patients get a more restful stay in the hospital?

A. Unplug the wires.

By Ginnie Graham

Hazem Refai sees a hospital one day without wires.

Patients will roam halls and be more comfortable in their rooms. Doctors would be alerted to heart rates, blood pressure and hormone levels in real time. Nurses won't have to wake up patients every hour to take vital signs.

Even in an intensive care unit, the complicated system of wires to monitors will be gone. After discharge, patients can sync implanted devices to smartphones. Parents can track conditions of their children, such as glucose or breathing function, through their wireless gadgets.

"First, information gets sent directly to your doctor, and immediately a nurse can see stress and call someone in," says Refai, the founder and director of the Center for Wireless Electromagnetic Compliance and Design at the University of Oklahoma-Tulsa. "Second, there are the logistics of a person sitting in bed with all these wires. You remove that, then, it becomes much easier to move patients and get data.

"Having said that, you have to validate that the communication is in existence, important alarms are sent to the right nurse and actions in response to those alarms are done in a timely fashion."

There is no margin for error in the burgeoning industry of wireless medical devices. Ensuring this promise of safety keeps Refai, OU-Tulsa's Williams Professor of Telecommunications Networking and Electrical and Computer Engineering, and his graduate students busy.

A native of Syria, Refai received his graduate degrees from OU, a master's degree in electrical engineering in 1993 and doctorate in 1999. He sought an OU education after his uncle moved to Oklahoma City years earlier to practice cardiology at Integris Baptist Hospital.

A digital chess game Refai witnessed in 1983 sparked his interest in electrical engineering and electronics. He asked a college student how it worked.

"He said, 'It has a computer in it. So, you are playing against the computer.' Oh, I needed to know more about this. That is what attracted me to this field. I did not have a plan at all in electronics," Refai says.

"You can now have artificial intelligence in machines respond to actions taken. I was fascinated by that, literally."

Refai is familiar with the medical field; his uncle and two of his brothers are physicians. Among the physics and engineering books lining his office bookshelves are biology and medical texts.

"I find myself learning every day. Not just new wireless technology because wireless evolves very fast, but also biomedical," he says.

At the heart of his research is accessibility to the unlicensed bandwidth opened by the FCC for medical use among others. Wireless kits for interfacing electronic devices start at about $40, creating a competitive market for improving wireless medical tools.

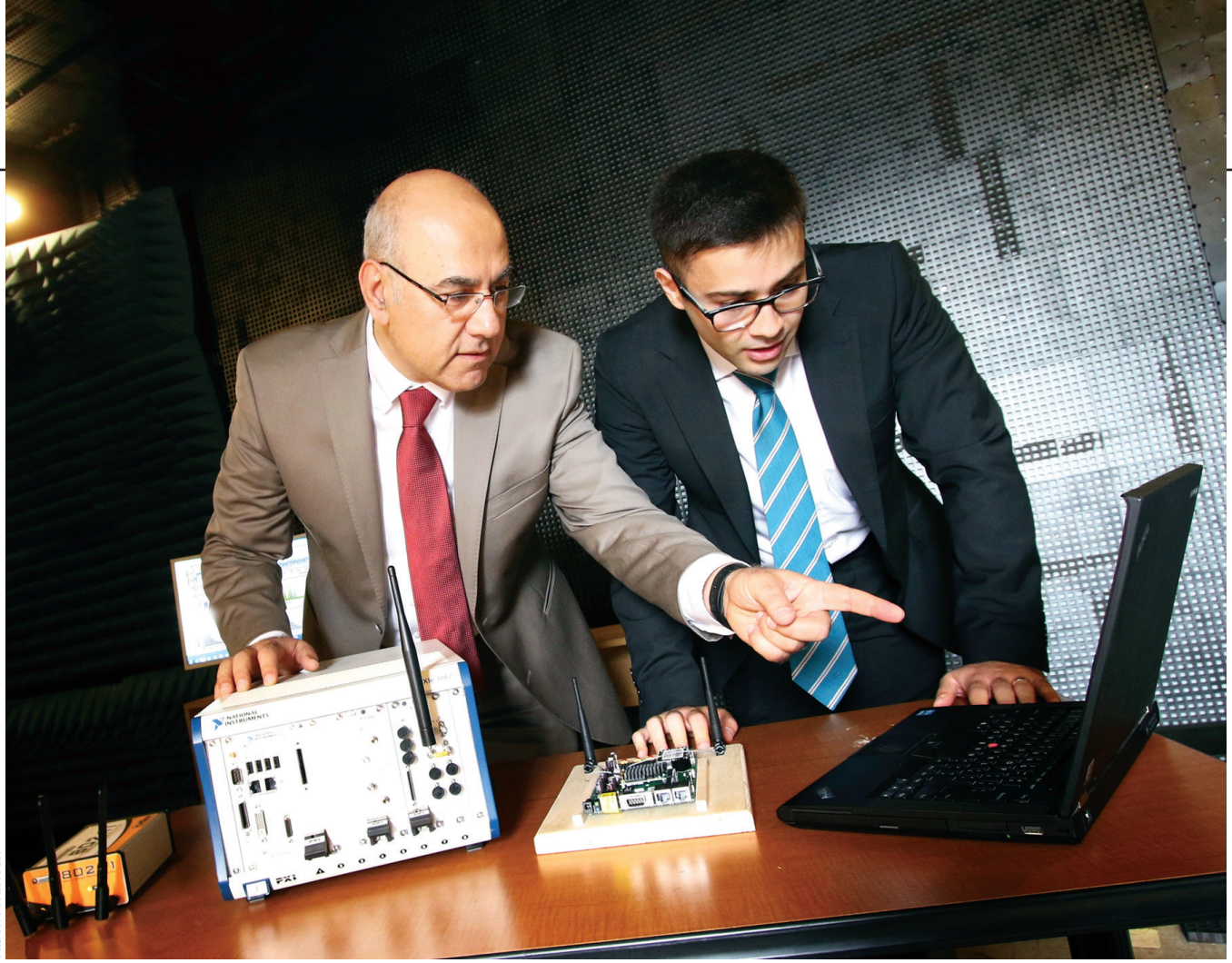
"The spectrum is limited, and we are trying to embed more information in the same spectrum. So it is always evolving. You have to keep learning new techniques," Refai says.

The research is teasing out better ways to share data between devices using various wireless technologies: Wi-Fi, Bluetooth, and ZigBee technology.

"The devices operating in an environment might not be one standard. It's a heterogeneous network, not a homogeneous network," Refai says. "You have multiple technologies that operate in the same space. How do you evaluate if these systems can co-exist?"

One of Refai's projects is measuring the baseline of radio frequency activities that may look like noise in a hospital. The goal is to find where all these different technologies fit on the bandwidth spectrum.

"Instead of noise we call it 'channel utilization,'" he says. "There are five or six different aspects we are examining. It looks like noise, but it's an intelligent communication we have



Aaron Anderson

Dr. Hazem Refai, left, and OU doctoral student Mohammad Omar Al Kalaa examine graphs of wireless traffic distributions and data collected by instruments on the table before them. Refai is on the cutting edge of research on wireless technology, which could impact everything from medical treatment to avoiding traffic accidents.

to identity in order to go around it. Ultimately, when you look at these, you can design things that co-exist.

"My idea for the devices is to build a system that can sense the environment outside and adjust its parameters to be able to co-exist. That's the ultimate goal. What I'm doing now is interfacing and validating these systems so they can operate within that environment."

"If you have tools to design these devices, then we have tools to evaluate how they operate. So, that is outreach to get companies to join a consortium for wireless coexistence testing ... We can validate and verify operations for these companies," Refai says.

The testing process can be fun. Students and mentors have to think of every emergency scenario for challenging the devices, which must always work.

"That's why the testing is atypical. You have to stress the system to test," Refai says. "A system in a typical scenario might pass. But, when you have a hurricane coming in and people stressing the system, you want that device to operate at that time. In telecommunication, we talk about peak hours. You have to communicate in peak hours. Here, you have to be assured your communication gets to destination during stress times."

In Tulsa, Refai and his graduate students have taken advantage of the Tandy Community Supercomputer to run analytics. The $3.5 million supercomputer takes up an entire floor in Tulsa's City Hall and came from a 2013 initiative between the Oklahoma Innovation Institute and participating Oklahoma universities. The goal of the collaboration is to support a research industry in Tulsa that will create jobs. OU benefits by any patents created and by contracts with companies to evaluate and develop their products.

Another project for Refai is with the Laureate Institute for Brain Research on functional MRI. The goal is to eliminate interfering signals resulting from normal biology, such as heart beats and eyes flickering, to allow psychiatrists to get a more accurate neurological reading.

A wireless sensor in road infrastructure to help drivers avoid accidents and traffic jams is also in development by Refai and his students. The next wireless frontier involves light, and the team is examining technologies for mobile aerial and space communication.

"One thing I do is cross disciplines," he says. "Ideas and thoughts into optical design, sending information using light waves instead of (radio frequency) wave. This is on the horizon — optical wireless."

Ginnie Graham is a columnist for the Tulsa World.