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Mobile technologies are ushering in a new kind of patient/physician partnership

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A recent cartoon in The New Yorker magazine depicts a human resource manager behind a desk, holding up a form and emphatically telling the person in front of him, "You can't list your iPhone as your primary physician!"

The drawing makes us laugh, mostly because we see the grains of truth planted within. As mobile devices propel the health-care industry into a new, wireless universe, patients are reaping benefits far beyond vacation selfies. UCLA physicians, software developers and computer science engineers are in the lead on this transformation, which experts say will forever alter health, fitness and chronic disease management in our everyday lives.

Getting Smart

"We all know how popular wearable fitness devices like Fitbit and Jawbone have become," says Dr. Andrew Trister, a radiation oncologist and senior physician at Sage Bionetworks, a Seattle-based nonprofit that promotes open science and participant involvement in the research process. "But they can't offer the sophisticated, interactive data that smartphones can aggregate to both researchers and physicians."

Using data gathered both from smartphones and fitness trackers, the app for Sage's interactive research study, "Share the Journey," is a prime example. It was developed by Sage with scientific advisers from Penn

Medicine, Dana-Farber Cancer Institute and UCLA's Jonsson Comprehensive Cancer Center—most notably Dr. Patricia Ganz M.D. '73, Jonsson's longtime director of cancer prevention and control research, whose efforts toward creating personalized care for cancer survivors are known worldwide.

Since March 2015, the app has tracked the experiences of thousands of women, some of whom are breast cancer survivors, between the ages of 18 and 80. Women supply personalized data on five common results of breast cancer treatment: fatigue, cognitive difficulties, sleep disturbances, mood changes and a reduction in exercise performance.

Across the campus, similar breakthroughs are occurring regularly. Last summer, UCLA Associate Professor of Electrical Engineering and Bioengineering Chi On Chui won a $1.65-million Small Business Innovation Research (SBIR) Fast-Track award from the Heart, Lung, and Blood Institute of the National Institutes of Health for developing a biosensor device that brings laboratory-quality bio-molecular assessments to point-of-care settings, such as clinics, ambulances or homes.

Chui's SELFA (Semiconductor Electronic Label-Free Assay) device, which was developed with UCLA Engineering's Institute for Technology Advancement (ITA)—a start-up incubator that helps secure intellectual property licenses for UCLA research—could reduce emergency room time for heart attack patients by two to three hours. Not unlike a palm-sized glucose sensor used by diabetics, SELFA employs a single drop of blood—taken at home or wherever symptoms occur—to help screen out those patients who do not require further medical care. Chui says the cost-savings potential alone is enormous.

"Eighty-five percent of patients who present with symptoms of acute coronary syndrome in emergency rooms across the U.S. and

Europe—some 12.75 million per year—have actually not had heart attacks after a standard test comes back, hours later, from the lab," he says.

Chui says the reason his device is being fast-tracked toward commercial use is the synergy among departments at UCLA. "We have the best hospital on the West Coast," he says. "I can literally walk across the hallway and have physicians validate a [new mobile health platform] I created in my lab. That relationship between engineering and medical, along with Southern California's rapidly growing biotechnology sector, is unparalleled anywhere else in the country."

Going Mobile

Also without precedent are two new apps from UCLA engineering professors that merge wearable wireless sensor technology with diagnostic medical testing and preventive health care/lifestyle analysis.

Electrical Engineering Professor Aydogan Ozcan has done extensive work to leverage wireless mobile technology, including using smartphones to image a single DNA molecule and analyze white and red blood cells. He says the ability to turn mobile devices into lab-quality measuring instruments can revolutionize clinical care, particularly for rural or indigent populations who live beyond the reach of urban centers.

A first-ever biomedical app Ozcan developed for Google Glass enables users to photograph results of remotely taken advanced diagnostic tests for diseases like HIV, prostate cancer and malaria. The engineer and his team previously created digital readers integrated into smartphones that detect potential disease biomarkers and convert them into differentiated optical color bands. This rapid diagnostic testing (RDT) technology has already been licensed by the UCLA spinoff Holomic, is in use in 10 countries and winding through FDA approval.

"Using the voice-activated interface of Glass, [patients and physicians] can capture an image of the diagnostic test and send it to a [Holomic server], which we then process and send back to Glass [as a dynamic spatiotemporal map and real-time test results and statistics]," Ozcan says. "One example of where this technology makes sense is inside an emergency room, where surgeons and clinicians need swift, hands-free feedback of diagnostic data. Another would be clinical work in the field during an infectious disease outbreak, where removing hand protection is not feasible."

Making care affordable and accessible to everyone is a prime goal of those working in mobile health. Majid Sarrafzadeh, distinguished professor of computer science and co-director of UCLA's Wireless Health Institute, wants to create apps and devices that allow patients to receive continuous support without the constant attention of caregivers and medical professionals.

"There are [commercially available] wearable devices that measure our weight, blood pressure and how much we walk, but nothing that measures how much we eat, which has a great impact on our health," Sarrafzadeh says about the WearSens, a wireless necklace device his team created that captures vibrations from the act of swallowing, transmits those signals to a smartphone and then translates the data into a visual spectrogram.

Sarrafzadeh says the device's Android app uses the Bluetooth 4.0 low energy protocol to provide users with daily, weekly and monthly views of their eating history, personalized feedback based on eating habit analysis, and manual entry of fitness goals and weight history.

The WearSens was tested for data efficacy in three ways, Sarrafzadeh says: "Detection of swallows, which can be used to determine meal timing; skipped meals; late-night snacking; or eating too quickly." He

continues, "Distinguishing between a small subset of foods like nuts, chips and bread, [and the] ability to identify when a user is taking a capsule-based medication as detection of adherence, is an important topic in the medical domain."

Designing Devices, Changing Lives

Some UCLA wireless initiatives are already changing lives. About three years ago, Maxim Batalin, associate director of UCLA Engineering's Institute for Technology Advancement, created an app for off-the-shelf heart monitoring devices that could remotely chart the activity and stress levels of emergency responders, who carry a high risk of heart attack due to their professions.

After the platform had been deployed around the country, Batalin wanted to "leverage the experience we gained with this remote monitoring system for other applications. And it found another life with Dr. Sally Maliski at [the UCLA] School of Nursing."

Maliski's ongoing research study, "Staying Strong and Healthy During Androgen Deprivation Therapy for Latino Men," uses smartphones and heart-rate monitors to improve outcomes for men on long-term therapy for prostate cancer. One unique twist: Working with bilingual researchers on Maliski's staff, Batalin ensured that the app worked in either English or Spanish, using written or spoken language.

"The whole key to these remote health systems," Batalin explains, "is that, as in this School of Nursing study, a few experts at UCLA are able to monitor and give feedback to many people in real time, so that each individual doesn't have to come into an office or clinic on a regular basis. The app is very simple and only requires the user to respond to three buttons—initiate, start recording and end recording—and two selections: type of activity and RPE [Rate of Perceived Exertion]. All of

the [heart rate] data [during exercise] flow seamlessly in the background to the UCLA monitors, who can encourage a faster pace or modify the exercises. The men also get messaging from within the app that encourages them to work harder, or slow down if they are at risk."

Monica Mallet, 40, of Los Angeles says her high level of stress had increased her risk for heart disease before she entered a 2014 School of Nursing mobile health study that used smartphones to track her daily activity and eating habits. "I'm a single mother of an 8-year-old, I'm finishing my doctoral research and I'm working full time in K-12 education," she says. "I also love salty foods and didn't work out, even though I wanted to lead a healthy lifestyle."

Nurse practitioner and Associate Professor Jo-Ann Eastwood M.N. '95, Ph.D. '04 led the study, which was funded by the American Heart Association. She gave Android-based smartphones to 40 African-American women between the ages of 25 and 45 who had at least two risk factors for early-onset heart disease. The phones, which could only text, were loaded with an app Eastwood had configured that posed questions such as "Did you eat six servings of fruit today?" and "Did you get at least 30 minutes of activity today?"

Mallet says that with no time to visit a clinic or doctor's office for weekly check-ins, the study fit her busy life. "It was based around a smartphone, something I have with me all the time," she adds. "I learned how to recognize and manage stress. And having that sense of accomplishment when you achieve [your individualized goal] of 10,000 steps every day was inspirational."

The women wore the phones in passport pouches around their hips. Eastwood and UCLA Ph.D. candidate Nabil Alshurafa '03, M.S. '10 beta-tested the phones with members of the Faithful Central Bible Church in Inglewood, which provided study participants.

"This study was directed at a medically neglected population with very high risk factors, who have added stress from being in the sandwich generation—taking care of their children and their parents," Eastwood says.

Preliminary data taken over three months showed a decrease in total cholesterol and waist circumference, an increase in HDL and a positive adherence to lifestyle changes. Eastwood says that because there is so little data for wireless health, she and her team wrote a paper about compliance, which included tracings from app data that revealed that two women in the study had shaken their phones to simulate daily exercise.

Eastwood says one of the most surprising results of the mobile health trial was something she calls "diffusion" within the subjects' families: "We had teenage kids of the women [in the trial] who were overweight and being ostracized by their peers become inspired seeing their moms losing weight and exercising. I don't think I'd ever talk to my own kids if not for texting and smartphones, so this is a natural road for [health professionals] to go down."

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